ANNUAL REPORT

2013-2014

CENTRAL INSTITUTE OF POST-HARVEST ENGINEERING & TECHNOLOGY
(An ISO 9001:2008 Institution)
P.O. PAU, Ludhiana - 141 004 (Punjab), India

Published by : Director
Central Institute of Post-Harvest Engineering & Technology
P.O. PAU, Ludhiana-141004 (Punjab), India
Phone : 0161-2308669, 2313103
Fax : 0161-2308670
Gram : CIPHET, Ludhiana
E-mail : ciphet@sify.com
Website: www.ciphet.in

Abohar Campus Address : CIPHET, Malout-Hanumangarh Bye-Pass, Abohar-152 116
District : Ferozepur (Punjab), India
Phone : 01634-224024, 222072
Fax : 01634-225313
E-mail : ciphetabh@gmail.com

Compiled & Edited by : Dr. R.K. Gupta
Dr. Mridula D.
Dr. (Mrs.) Indu Rawat
Mrs. Surya Tushir

Hindi Translation by : Mrs. Leena Kumari

Printed at : Printing Service Company
3801/1, Model Town, Ludhiana
0161-2410896 ; Mobile : 9888021624

PREFACE

It is our great pleasure to present the Annual Report 2013-14 for the Central Institute of Post-Harvest Engineering and Technology. The Institute, in keeping its customs and expansion, has moved from strength to strength. This Annual Report provides a snapshot of the thrust success, changes, development and improvements in research and extension activities during the reported year.

The highest priority of the institute is to intensify its research efforts to make difference to society, industry and field itself. The major research achievements includes development of processing machinery like mechanized system for makhana seed, compact grader for oblong fruit, bael pulper, apple corer and pedal operated grader for dried apricot. A number of processes like controlled release of pediocin, oligosaccahrides separation, removal of impurities from groundnut cake, enhanced shelf life of pomegranate arils and strawberry have been developed. Our scientists are working on thrust research areas of the institute i.e. value addition to food grains, oilseeds, spices, fruits, vegetables and their storage and environmental control. The value added products include developed corn based energy bar, probiotic peanut yoghurt, coarse cereal based nutritious extrudates, vegetable blended pasta, nutritionally rich functional flour, fortified soft rice and instant corn based *kheer* mix.

Dissemination of technologies to end users was done through licensing, exhibitions, and training to farmers and entrepreneurs. Our scientists were actively involved in showcasing the CIPHET technologies through workshops, sensitization programmes, documentaries of agricultural technologies, TV and radio programmes, news clippings and extension bulletins. Business Planning and Development (BPD) unit was inaugurated this year to take further step for effective dissemination of CIPHET technologies to the entrepreneurs/farmers. Various national and international training programmes were conducted for entrepreneurs and officials from different states and countries in the area of Post Harvest Technology, which included sponsored programmes by ATMA and other Government agencies. All India Coordinated Research Project on PHT has contributed significantly in the diverse areas of post harvest processing and value addition of various agricultural commodities and livestock produce. The second national assessment of harvest and post-harvest quantitative losses is underway, sponsored by Ministry of Food Processing Industries (GoI). Similarly, AICRP on Application of Plastics in Agriculture have also significantly contributed in the area of surface covered cultivation, pond lining, irrigation system, mulching and soil

solarization. CIPHET has obtained ISO 9001:2008 certification for the scope "Research and Development, Training and Extension on Post-Harvest and Technology". Our commitment is towards continuously executing novel and high quality scientific research in the field of post harvest engineering and technology.

We thankfully acknowledge constant encouragement received from Dr. S. Ayyappan, Hon'ble Secretary DARE and DG, ICAR and Shri Arvind R Kaushal, Additional Secretary, DARE, New Delhi. I also acknowledge support and cooperation extended by Dr D Rama Rao, DDG (Engg.), Dr. M.M. Pandey, and Dr N S Rathore both Ex-DDG (Engg.), Dr. K.K. Singh, ADG (PE), Dr. N.P.S. Sirohi, Ex-ADG (Engg.) and Dr Kanchan K Singh ADG (Farm Engg.), ICAR, New Delhi. Thanks are due to Dr S.N. Jha, Head (AS&EC) for his contribution as Director (Acting) CIPHET during the reported period. The help rendered by Dr. P.R. Bhatnagar, PC (APA), Dr. P.C. Sharma, Head, HCP Division, Dr. S.K. Nanda, Principal Scientist & In-Charge Head, TOT Division and all scientific, administrative and technical staff of CIPHET Ludhiana and Abohar in preparation of this Annual Report is also duly acknowledged.

R. K. Gupta
Director

CONTENTS

कार्यकारी सारांश

वर्ष 2013-14 में सीफेट ने अपनी अनुसंधान तथा विस्तार की गतिविधियों द्वारा नई ऊँचाईयों को छुआ है। सीफेट ने कटाई उपरांन्त अभियांत्रिकी एवं प्रौद्योगिकी पर अनुसंधान व किवास, प्रशिक्षण और विस्तार के लिए आई.एस.ओ. 9001:2008 प्रमाण पत्र प्राप्त किया। इस वर्ष अंतः संस्थान एवं बाह्य वित्त पोषित परियोजनाओं तथा विस्तारीकरण के क्रियाकलापों द्वारा महत्वपूर्ण अनुसंधान किए गए। अनुसंधान कार्यों के अंतर्गत मसालों, मखाना, फलों के श्रेणीकरण आदि के लिए मशीनों (यंत्रों) का विकास किया गया। इसके अतिरिक्त मूल्य संवर्धित स्वास्थवर्धक खाद्य उत्पाद, जैसे कि फंक्शनल आटा, मक्का, ज्वार एवं फलियों द्वारा बर्हिवर्धित खाद्य उत्पाद, मोटे अनाज द्वारा तैयार ग्लूटन रहित मफिन, अंकुरित अनाजों को भाप में पकाकर बनाए गए स्वास्थ्यकारी खाद्य मिश्रण, पुदीना एवं जामुन आधारित पेय पदार्थ बनाये गये। सीफेट द्वारा विकसित प्रशीतलन प्रणाली से मसालों की पिसाई करने वाली मशीन की दक्षता का परीक्षण किया गया। परीक्षण के दौरान -50° डिग्री सेल्सियस तापमान पर पीसे गए धनिया तथा काली मिर्च में वाष्पशील तेल, समग्र फीनोल तथा ऑक्सीकरण रोधी अवयवों की मात्रा, 10 डिग्री सेल्सियस पर पीसे गए इन्हीं मसालों की तुलना में अधिक पाई गई। मखानों की पॉपिंग के लिए 25-30 किलोग्राम प्रतिघंटा की क्षमता वाली मशीन का प्रारुप तैयार कर मशीन को बनाया गया। इस मखाना पॉपिंग मशीन की कार्यक्षमता 90 प्रतिशत से अधिक पाई गई। पशुओं को उठाने में सहायता के लिए पॉलिस्टर आधारित एनीमल लिफ्टर का निर्माण किया गया, इसके आवरण की चौड़ाई 0.78 मीटर और लंबाई 2.5 मीटर है।

फॉरियर ट्रासफोर्म इन्फ्रारेड स्पेक्ट्रोस्कोपी एवं कीमोमैट्रिक्स की संयोजित विधि द्वारा शुद्ध दूध में सोया दूध की मिलावट का पता लगाने की संभावनाओं को जाँचा गया। सिमका विधि द्वारा नमूनों के विश्लेषण से शुद्ध दूध एवं शुद्ध दूध में स्वीकृत सीमा में मिलाए गए यूरिया तथा दूध में स्वीकार्य सीमा से अधिक मात्रा में मिलाए गए यूरिया के नमूनों का अलग-अलग समूहों में श्रेणीकरण किया गया। संपुटीकरण (इनकैप्सुलेशन) विधि द्वारा ग्वारगम एवं एल्जीनेट के अतिसूक्ष्म कैप्सूल बनाए गए जोकि बैक्टीरियोसिन से भरे थे। इन्हें कैल्शियम क्लोराइड के उष्मक से मलमल के कपड़े द्वारा छानकर प्राप्त किया गया। इस प्रक्रिया को 60 प्रतिशत इनकैप्सुलेशन क्षमता प्राप्त करने तथा पीडियोसिन के नियंत्रित स्त्राव द्वारा सूक्ष्मजीवरोधी सक्रियता को बढ़ाने के लिए ऑपटीमाईज किया गया। रंगीन प्लास्टिक की सतहों द्वारा शिमला मिर्च के खेत में हानिकारक जीवों को विकर्षित (दूर रखने) करने की उपयोगिता का मूल्यांकन किया गया। लगभग समान एवं अधिकतम उत्पाद चमकीली काली (3.8 किलोग्राम प्रति पौधा), हरी (3.4 किलोग्राम प्रति पौधा) प्लास्टिक सतह वाले क्षेत्रों में तत्पश्चात् काली (3.2 किलोग्राम प्रति पौधा) तथा लाल (2.8 किलोग्राम प्रति पौधा) प्लास्टिक सतह वाले क्षेत्रों में पाया गया। पंजाब के अर्धशुष्क क्षेत्रों में अनार की फसलों में गर्मी द्वारा होने वाले तनाव को कम करने में छिड़काव यंत्रों, धूम्रिकरण यंत्रों तथा रंगीन छायादार नेट के इस्तेमाल द्वारा होने वाले प्रभावों को निरीक्षण किया गया।

काले छायादार नेट का इस्तेमाल कर मई महीने में फल निर्माण के समय फलों को धूप से झुलसने (सनबर्न) तथा फलों में पड़ने वाली दरारों से बचाया जा सकता है, परंतु कटाई उपरांत इस नेट को हटा देना चाहिए ताकि पेड़ उचित वृद्धि कर सके। दूसरी तरफ छिड़काव यंत्रों का प्रयोग अबोहर के अर्धशुष्क क्षेत्र में मई से अगस्त अथवा कटाई तक किया जा सकता है। फलों के श्रेणीकरण के यंत्र लिए बनाए गए। श्रेणीकरण यंत्र को अंडाकर तथा गोलाकर आकृति वाले फलों के लिए उपयुक्त पाया गया। यह फलों को चार श्रेणियों यथा < 25 मि.मी., 25-30 मि.मी., 30-35 मि.मी. तथा > 35 मि.मी. में वर्गीकृत करता है। कुट्टू के बीजों से छिलका अलग करने के लिए, 30 मिनट तक बीजों को भिगोने तथा फिर उन्हें 15 मिनट तक भाप में पकाने की विधि द्वारा छिलका उतारने की क्षमता 70 प्रतिशत पाई गई। पूरी तरह से पारबॉयल्ड बीजों के लिए छिलका अलग करने की दक्षता 70.6 प्रतिशत पाई गई। जौ का छिलका अलग करने के लिए सूरजमुखी डिहलर (इम्पैक्ट प्रकार) से प्रेरणा ली गई तथा इसकी कार्यक्षमता का मूल्यांकन किया गया। बीज उतारने की क्षमता 8.12 प्रतिशत नमी (आर्द्रता मात्रा) पर अधिक पाई गई (67.76 प्रतिशत), बजाय कि 13.3 प्रतिशत नमी पर जिसमें कि कार्यक्षमता 37.94 प्रतिशत दर्ज की गई।

मूंगफली से प्रोबायाटिक दही बनाने की प्रक्रिया को मानकीकरण किया गया। इस दही में स्ट्रप्टोकोकस फेकेलिस टी 110 नामक लाभकारी जीवाणु है। मूंगफली दूध बनाने के लिए 1 किलोग्राम मूंगफली को 6 लीटर पानी में मिलाया मिलाया गया। इसमें 3.93 प्रतिशत प्रोटीन तथा 1.83 प्रतिशत वसा पाए गए। प्रोबायाटिक स्ट्रेन स्ट्रप्टोकोकस फेकेलिस से युक्त प्रोबायटिक दही का पी.एच. स्तर 4.5 तथा टाईट्रेबल एसिडिटी 0.14 प्रतिशत (लैक्टिक एसिड) पायी गई। बर्हिवर्धन प्रसंस्करण (एक्सट्रूजन) द्वारा मकई, ज्वार तथा फली के पूरक आहार मिश्रण तैयार किए गए। तैयार मिश्रणों में 25 प्रतिशत से अधिक मात्रा में प्रोटीन पाया गया तथा इनकी संवेदी स्वीकार्यता भी उत्तम पाई गई। इन पूरक आहार मिश्रणों को 3 वर्ष की आयु से अधिक उम्र के बच्चों को प्रोटीन की परिपूर्ति के लिए दिया जा सकता है। मोटे अनाज जैसे कि झंगोरा (बार्नयार्ड) द्वारा ग्लूटन रहित मफिन तैयार किए गए। अनाजों (मकई, ज्वार, बाजरा), फली (वसा रहित सोया तथा सोया प्रोटीन) एवं तिलों द्वारा प्रोटीन से भरपूर अल्पाहार बनाए गए। विभिन्न अनाजों को सब्जियों के पाउडर तथा अन्य आवश्यक खाद्य पदार्थों के साथ मिलाकर चार प्रकार के पौष्टिक आहार तैयार किए गए जैसे अंकुरित अनाजों से तैयार, अंकुरित तथा भाप में पकाए अनाजों से बने, अनअंकुरित अनाजों से बर्हिवर्धन द्वारा तथा अंकुरण के बाद बर्हिवर्धन द्वारा तैयार स्वास्थयकारी मिश्रण। शीघ्र पकने वाला विविध अनाजों वाला दलिया तैयार किया गया। कम ग्लाईसेमिक सूचकांक वाले फंक्शनल पास्ता को तैयार करने के लिए 30 प्रतिशत गेहूँ, 23 प्रतिशत ज्वार, 13 प्रतिशत जौ एवं दालों का इस्तेमाल किया गया। तैयार पास्ता की प्रति 100 ग्राम मात्रा में 17 प्रतिशत प्रोटीन, 5.9 खाद्य रेशा, 6.7 मि.ग्रा. आयरन, 111.8 मि.ग्रा. कैल्शियम तथा 74.45 प्रतिशत प्रोटीन सुपाच्यता पाई गई।

जामुन के फल से गूदा निकालने के लिए उष्ण (तापीय) निष्कर्षण पद्धति को, शीत निष्कर्षण पद्धति से अधिक प्रभावकारी पाया गया। उष्ण एवं शीत

निष्कषर्ण पद्धतियों में जामुन के गुणवत्ता संबंधी मानदण्डों क्रमशः टी.एस.एस. 12.0 एवं 12.8° ब्रिक्स, अम्लता 1.18 प्रतिशत तथा 1.33 प्रतिशत, पी.एच. 3.35 व 2.27, ऑप्टिकल डेनसिटी 0.718 व 0.881 (632 नैनोमीटर पर फीनोल) मापी गई। तापीय निष्कर्षण विधि द्वारा प्राप्त जामुन के गूदे की ऑक्सीकरण रोधी क्षमता (0.213 ओ.डी., 517 नैनोमीटर पर) शीत निष्कषर्ण विधि द्वारा प्राप्त गूदे (0.211 ओ.डी., 5.17 नैनोमीटर) की तुलना में अधिक पाई गई। पुदीना एवं जामुन आधारित पीने को तैयार (आर.टी.एस.) पेय पदार्थ बनाए गए। यद्यपि पेय उत्पाद की संवेदी गुणात्मकता में क्रमिक घटोत्तरी दर्ज की गई परंतु फिर भी चार महीनों के सामान्य संग्रहण तक पेय अत्यधिक स्वीकार्य पाया गया। बेर फल को नरम तथा अधिक परिपक्व होने से रोकने के लिए 1-एम.सी.पी. तथा काईटोसन का लेप प्रभावी पाया गया। बेर के फलों की संग्रहण एवं उपयोग योग्य अवधि में अधिकतम बढ़ोत्तरी देखने को मिली। जब फलों पर इन दोनों का लेपन किया गया। हांलाकि सिर्फ 1-एम.सी.पी के प्रयोग द्वारा ही फलों की उपयोग योग्य अवधि दुगुनी (14 दिन) हो गई थी। काइटोसन से उपचारित फलों की संग्रहण अवधि 5 दिनों तक बढ़ गई तथा दोनों के सम्मिलित उपयोग द्वारा अवधि 8 दिनों तक बढ़ी। नाख फल की परिपक्वता का आंकलन किया गया जिससे कि यांत्रिक तरीके से इसके टुकड़े किए जा सके तथा संग्रहण के दौरान टुकड़ों को भूरा होने से बचाया जा सके। नाख के टुकड़े करने के लिए 52 न्यूटन की स्थिरता (फर्मनेस) को अधिक उचित पाया गया। इस स्थिरता के साथ नाख के टुकड़े अच्छी तरह से हुए तथा उनके रंग, स्वाद व मिठास को स्वीकार्य पाया गया। नाख के पॉलीफीनोल ऑक्सीडेस (पी.पी.ओ.) एंजाइम की उष्मा के प्रति स्थायित्व का अन्वेषण किया गया। अन्वेषण के लिए भाप, गर्म पानी तथा माइक्रोवेव ब्लांचिंग विधि का प्रयोग किया ताकि सुखाने के दौरान पॉलीफीनोल ऑक्सीडेस की निष्क्रियता का पता लगाया जा सके। ब्लांचिंग समय को बढ़ाने से पी.पी.ओ. एंजाइम की सक्रियता कम हुई। अन्य सभी तरीकों की तुलना में माइक्रोवेव ब्लांचिंग विधि पी.पी.ओ. एंजाइम को निष्क्रिय करने में बेहद प्रभावी रही।

माइक्रोवेव ब्लांचिंग विधि को विटामिन सी के अतिरिक्त अन्य पोषक तत्वों के संरक्षण में सबसे अधिक प्रभावकारी पाया गया। ताजा कटे नाख फल में एंजाइम द्वारा होने वाली भूरे होने की प्रक्रिया को रोकने के लिए कई प्रकार के एंटीब्राऊनिंग कारकों का विश्लेषण किया गया। एस्कार्बिक एसिड तथा सिस्टीन द्वारा उपचारित करने पर भूरे होने की प्रक्रिया में महत्वपूर्ण कमी आई। 1.0 प्रतिशत एस्कार्बिक एसिड से उपचारित टुकड़ों की तुलना में जिनमें दो दिन के भण्डारण के दौरान एंजाइम सक्रियता अधिक देखी गई। 0.50 प्रतिशत सिस्टीन द्वारा उपचारित टुकड़ों में लंबे समय तक भूरे होने की प्रक्रिया रूक गयी।

ए.आई.सी.आर.पी. (पी.एच.टी.) के अंतर्गत कई मशीनों का निर्माण किया गया जैसे मध्यम क्षमता का बाजरे का छिलका निकालने वाला डिहलर, सेब का भीतरी भाग अलग करने के लिए मशीन, सेब के बीज अलग करने के लिए यंत्र, केले के छिलके उतारने के लिए (पीलर) यंत्र, वनीला ओलियोरेसिन प्लांट, हस्त चालित चीकू क्लीनर, सब्जियों के खुदरा भण्डारण के लिए संवहन योग्य इवोपरेटिव शीत कक्ष, थैलियों (बोरियों) को उठाने में होने वाले नुकसान को कम करने के लिए हुक (कुण्डी) का निर्माण आदि। इस परियोजना के अंतर्गत कम प्रयोग में आने वाली फसलों (क्षेत्रः जम्मू कश्मीर) का प्रयोग कर बहिवर्धन प्रणाली द्वारा अल्पाहार बनाए गए तथा कट्टू के लिए प्रसंस्करण तकनीकें तथा पायलट प्लांट विकसित किए गए।

ए.आई.सी.आर.पी. (ए.पी.ए.) के अनुसंधान कार्य के अंतर्गत फूलों और सब्जियों की पालीहाऊस में खेती का विश्लेषण, भारत में संवहनीय एफ.आर.पी. कार्प हैचरी तकनीक के प्रभाव का आंकलन, स्वच्छतापूर्ण तरीके से मछलियों को बेचने के लिए प्लास्टिक यंत्र का निर्माण एवं अन्वेषण किया गया। इसके अतिरिक्त हीट एक्सचेंजर का उपयोग कर पॉलीहाउसों के ढाँचों का निर्माण किया गया। अर्द्धशुष्क क्षेत्रों में इन पॉलीहाउसों में मौसम के अनुसार बदलाव करने पर, इन्हें मशरुम की खेती के लिए उपयुक्त पाया गया। एन.ए.आई.पी. परियोजना के अंतर्गत स्थापित बी.पी.डी. इकाई इन्क्यूबेशन सुविधाओं का लोकार्पण किया गया। उद्यमिता विकास कार्यक्रमों (ई.डी.पी.) के प्रभाव का आँकलन किया गया। परिणामों द्वारा पता चला कि 27.55 प्रतिशत लाईसेंस धारी व्यक्तियों तथा ई.डी.पी. में भाग लेने वालों में से कुछ ने सीफेट की तकनीकों को पहले से अभिग्रहण कर रखा है तथा कुछ अभिग्रहण की प्रक्रिया में है। सोया प्रसंस्करण तथा हरी मिर्च का पाऊडर बनाने वाले एक उद्यमी को होने वाला आर्थिक लाभ लगभग क्रमशः 5.8 तथा 1.5 लाख प्रति वर्ष आँका गया। उद्यमियों, किसानों एवं अधिकारियों को तकनीकों के लाईसेंसीकरण द्वारा, प्रशिक्षण तथा प्रदर्शनियों द्वारा तकनीकों के प्रचार के लिए प्रयास किए गए।

कृषि संबधी सूचना के प्रभावी प्रसार के लिए 102 न्यूज क्लिपिंग तथा 13 रेडियो कार्यक्रमों का प्रकाशन/प्रसारण किया गया। केंद्रीय आलू अनुसंधान संस्थान (सी.पी.आर.आई, शिमला) की आलू किस्मों तथा कश्मीर में केसर की खेती पर आधारित दो वीडियो फिल्मों का निर्माण किया गया तथा जनमानस में प्रचार के लिए इन्हें 'यूट्यूब' पर अपलोड किया गया। सीफेट द्वारा विकसित तथा बाह्य वित्त पोषित परियोजनाओं के अंतर्गत विकसित 12 तकनीकों के ब्रोशर तैयार किये गए। कटाई उपरांत प्रंबधन के लिए देश के विभिन्न क्षेत्रों के अधिकारियों तथा किसानों के लिए प्रशिक्षण कार्यक्रमों का आयोजन किया गया। कुछ कार्यक्रम आत्मा, एम.ए.सी.पी. तथा कुछ अन्य सरकारी संस्थाओं द्वारा आर्थिक रुप से प्रायोजित थे। 'ट्राइबल सब प्लान' के अंतर्गत प्रशिक्षण कार्यक्रमों का प्रारंभ किया गया। मत्सय प्रबंधन पर सीफेट द्वारा कॉलेज आफ फिशरीज, राहा (असम कृषि विश्वविद्यालय, असम) के सहयोग द्वारा प्रशिक्षण कार्यक्रम आयोजित किया गया। दिसंबर 2013 के दौरान आँवला प्रसंस्करण से नये मूल्यवर्धित खाद्य उत्पाद बनाने के लिए उद्यमिता विकास कार्यक्रम (ई.डी.पी.) का संचालन किया गया। पंजाब तथा गुजरात के कई उद्यमियों ने इस प्रक्रिया में भाग लिया। देश के विभिन्न क्षेत्रों में होने वाली प्रदर्शनियों में भी संस्थान ने महत्वपूर्ण उपस्थिति दर्ज कराई। भारतीय कृषि अनुसंधान परिषद के विभिन्न संस्थानों (जैसे सीफेट, सी.एस.एस.आर.आई., करनाल, सी.आई.आर.बी, हिसार तथा आई.आई.एस.आर. लखनऊ) की तकनीकों के क्षेत्र में प्रदर्शन के लिए सीफेट के नेतृत्व में प्रोग्रेसिव पंजाब एक्स्पो (चण्डीगढ़, 16-19 फरवरी 2014) के अंतर्गत आई.सी.ए.आर खेमें का आयोजन किया गया।

EXECUTIVE SUMMARY

CIPHET reached a new height through its research and extension activities in the year 2013-14. CIPHET has been awarded the ISO 9001:2008 certification for "Research and Development, Training and Extension on Post-harvest Engineering and Technology". The year was earmarked with significant research output through in-house and externally funded projects and extension activities. The research work covered development of machines for spices, *makhana*, compact fruit grading etc and various value added health products like functional flour, extruded products from maize, sorghum and legumes, millet based gluten free muffins, health mixes from sprouted and steamed grains and mint based *jamun* RTS beverages. Performance of CIPHET developed cryogenic grinding system was evaluated. A higher value of volatile oil, total phenols, flavonoid and antioxidant content was found in coriander and black pepper powder ground at -50°C as compared to coriander powder ground at 10°C. *Makhana* (Gorgon nut) popping machine was designed and developed with 25-30 kg/h capacity of conditioned nut and more than 90% popping efficiency. An animal lifter of polyestser web sling was developed. Width and length of wrapping are 0.78 m and 2.5 m.

The potential of Fourier Transform Infrared (FTIR) spectroscopy together with chemometrics was investigated as a rapid quality monitoring method for detection of soymilk adulteration in milk. Pattern recognition analysis by Soft Independent Modelling of Class Analogy (SIMCA) showed well-separated clusters of pure milk, milk adulterated with permissible limit of urea and those adulterated with above permissible limit of urea. Hybrid microcapsules of alginate-guar gum with nanoliposomes loaded bacteriocin were retrieved from calcium chloride bath using muslin cloth. This process was optimized to yield about 60% encapsulation efficiency and good antimicrobial activity with controlled release of pediocin.

Suitability of coloured plastic mulch was evaluated for the repulsion of insect-pests in capsicum field. Almost similar and maximum yields were found in silver black (3.8 kg/plant) and green (3.4 kg/plant) plastic mulched plots; followed by black (3.2 kg/plant) blue (2.9 kg/plant) and red (2.8 kg/plant). Effect of over-tree sprinklers, foggers and colour shade nets were evaluated in order to reduce heat stress to pomegranate crop in semi-arid region of Punjab. Sunburn and fruit cracking could be reduced by installation of black shade net house during May month or when complete fruit set takes place. This net should necessarily be removed after harvesting to attain tangible plant growth. On the other hand, use of overhead sprinkler from May to August or up to harvesting can be recommended to reduce sunburn and fruit cracking in pomegranate in semi-arid region of Abohar. A compact fruit grader was designed, it was most suited for both round and oblong fruits, it grades the fruit in four different grades viz. <25 mm, 25-30mm, 30-35mm and >35mm diameter. For buckwheat dehulling, maximum dehulling efficiency of 70% was obtained for the seeds soaked for 30min and steamed for 15min using abrasive dehuller. The dehulling efficiency of completely parboiled buck wheat seeds was determined as 70.6%. The sunflower dehuller (impact type) was adopted for dehulling of oats and its performance was evaluated. The dehulling efficiency was found higher (67.76%) at 8.12% mc than 37.94% at 13.33% mc.

Process protocol for development of probiotic peanut yoghurt containing *Streptococcus faecalis* T110 has been standardized. Peanut milk was prepared by adding one kg of peanut in 6 l of water. The milk was found to have 3.93% protein and 1.83% fat. Probiotic peanut yoghurt containing probiotic strain *S. faecalis* T110 was developed, which has pH 4.5 and titratable acidity 0.14% (% lactic acid). Complementary food mix was developed from extrusion processing of maize, sorghum and legumes. The developed mix contains more than 25% protein content and possesses good sensory acceptability, which can be used as a protein supplement for children above 3 years of age. Barnyard millet based gluten free muffins were prepared. Protein rich (18-22% protein) extruded snack utilizing cereals (maize, sorghum, pearl millet), legume (defatted soy flour and soy protein) and sesame seeds were prepared. Four types of multigrain based nutritious health mixes i.e. health mixes from sprouted grain, sprouted and steamed grains, extrudates from un-sprouted grains and extrudates from sprouted grains were developed with vegetable powder and other important food materials. Quick cooking multi-grain *dalia* was prepared utilizing sprouted wheat and mixture of three other grains (barley, sorghum and pearl millet) in the ratio of 25:75. Low glycemic functional pasta was developed using 30% wheat, 23% sorghum, 13% barley along with legumes, which provided 17% protein with 74.45% protein digestibility, 5.9% crude fibre, 6.7mg iron and 111.8mg calcium per 100g sample.

For extraction of *jamun* pulp, hot extraction method resulted in high recovery of pulp (68%) as compared to cold extraction method (63%). The quality parameters in hot and cold extracted *jamun* pulp were found to be 12.0 and 12.8°B TSS, 1.18 and 1.33% acidity, 3.35 and 2.27 pH, 0.718 and 0.881 OD at 632 nm (Phenols), respectively. Total antioxidant capacity of hot extracted pulp was higher (0.213 OD at 517 nm) as compared to cold extracted pulp (0.211 OD at 517 nm). Mint based *jamun* RTS beverages were prepared. There was progressive decrease in sensory quality of the product but the beverage was still highly acceptable up to four months of ambient storage. In delaying the softening and ripening of *ber* fruit, 1-MCP and chitosan coating were quite effective. Maximum extension in shelf life of *ber* fruit was noticed when the fruits were treated with the combination of both. However, 1-MCP alone doubled the shelf life of *ber*. The storage life of chitosan treated fruits increased by 5 days and it was further enhanced to 8 days when the fruits were treated with the combination of both. Ripeness of pear fruit was assessed for mechanical slicing and subsequent storage of slices with least browning. Firmness of 59 N (average firmness) was found more appropriate for slicing of pear. Pear at this firmness sliced well and had acceptable colour, flavour and sweetness. Heat stability of polyphenol oxidase (PPO) enzyme of pear was investigated using steam, hot water and microwave blanching with respect to total inactivation of PPO activity for subsequent drying. Enzyme activity decreased with increase in the blanching time. Among different methods, microwave blanching was found most effective in inhibiting the PPO activity. Microwave blanching was more effective in retaining the maximum nutrients except vitamin C. Different anti-browning agents for inhibition of enzymatic browning in fresh cut pear were evaluated. Treatment with ascorbic acid and cystein significantly reduced enzymatic browning but the slices treated with 0.50% cystein prevented cut surface browning for a much longer period as compared to 1.0% ascorbic acid treatment, which showed high enzyme activity within two days of storage. The AICRP on PHT developed machinery like medium capacity millet dehuller, apple corer machine, apple seed extractor, banana peeler, vanilla oleoresin plant, manually operated sapota cleaner, portable evaporative cool chamber for retail storage of vegetables, development of hook (*kundi*) for minimizing the pilferage losses during handling/ lifting of bags etc.

The project has developed extruded snacks using underutilized crops of J&K, process technologies and pilot plants from pumpkin, etc. The research under AICRP on APA included the evaluation of poly house cultivation of flower & vegetables, impact assessment of portable FRP carp hatchery technology in India, design and evaluation of plastic gadget for hygienic fish marketing. Poly-house structure was developed using earth air heat exchanger. Mushroom cultivation under poly-house conditions in semi-arid region was found quite feasible with certain seasonal modifications.

BPD unit under NAIP project was launched for incubation facility. Impact of Entrepreneurship Development Programmes (EDPs) conducted by CIPHET was assessed. The results revealed that 27.55 percent of licensee and EDP participants have either already adopted CIPHET technology or are in the process of adoption. The economic benefits accrued to an entrepreneur from soya processing and green chilli powder were estimated to the tune of 5.8 and 1.5 lakh rupees per annum, respectively.

Dissemination of technologies was done through licensing of technologies, publication, presentation and trainings of officers, entrepreneurs and farmers. Around 102 news clippings, 13 radio programmes were published/ broadcasted for effective dissemination of agricultural information. Two video films on CPRI potato varieties and saffron cultivation in Kashmir were prepared and uploaded on 'you tube' for wider outreach in public domain. Brochures of 12 technologies developed by CIPHET as well as developed under externally funded projects were prepared. Various training programmes sponsored by ATMA, MACP and other government agencies were conducted for officers and farmers from different states of the country in the areas of post-harvest management. Trainings under Tribal Sub-plan (TSP) programme were initiated and training on "Post-Harvest Management of Fish" was organized by CIPHET, Ludhiana in collaboration with College of Fisheries, Raha, Nagaon, Assam (Assam Agricultural University, Assam). One EDP was conducted on processing and utilization of aonla into novel value added products during December 2013. Entrepreneurs from Punjab and Gujarat participated in this training programme. Various exhibitions held across the country were also attended by the institute. An ICAR pavilion was organized under the leadership of CIPHET for exhibiting the technologies from different ICAR institutes in the region (viz. CIPHET, Ludhiana; CSSRI, Karnal; CIRB, Hisar and IISR, Lucknow) in the Progressive Punjab Expo held at Chandigarh during 16-19 February 2014.

CIPHET - AN OVERVIEW

The Central Institute of Post-Harvest Engineering and Technology (CIPHET) was established on 29th December 1989 at Ludhiana, Punjab, India as a nodal institute to undertake lead researches in the area of post-harvest engineering and technology, appropriate to agricultural production catchments and agro-industries. The institute's second campus was established on 19th March 1993 at Abohar, Punjab and is primarily responsible for conducting research and development activities on fruits and vegetables. CIPHET is also headquarter for two All India Coordinated Research Projects (AICRPs) viz. AICRP on Post-Harvest Technology (PHT) with 38 Centres and AICRP on Application of Plastics in Agriculture (APA) with 11 Centres.

Mandate

- To undertake basic, applied, strategic and adaptive engineering and technology research in post production sector of produce of plant origin, livestock and aquaculture produce including agricultural structures and environmental control, quality and safety.
- To act as national institute for research, education/teaching and training in post-harvest engineering and technology.
- To act as national repository of information on processes, equipment, products and technologies on post-harvest engineering and technology.
- To transfer technology and provide advisory and consultancy services and promote entrepreneurship.
- To develop and strengthen linkages with the growers/farmers, private and public sector food processing enterprises in the mandated areas.

Research Divisions

Ludhiana Campus

1. Agricultural Structures and Environment Control
2. Food Grains and Oilseeds Processing
3. Transfer of Technology

Abohar Campus

4. Horticultural Crops Processing

Infrastructure

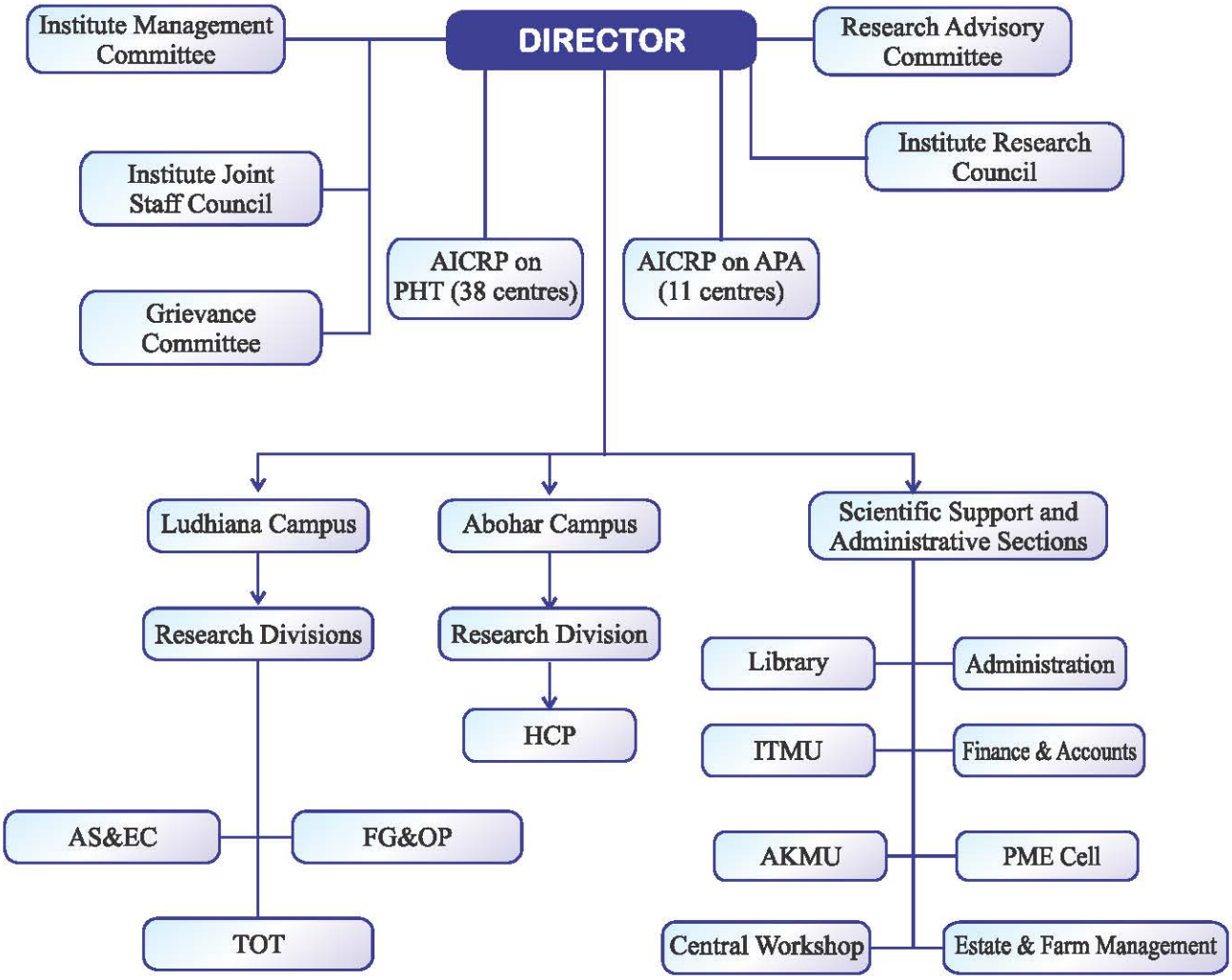
Workshop

The workshops at CIPHET, Ludhiana and Abhor manages fabrication and modification of post-harvest machineries, designed and developed under different research projects. Workshops also extend service support to repair and maintenance of institute facilities/ work etc. from time to time. Workshops have machines/ equipments to deliver its services such as lathe machines, drilling machine, gas welding set, arc welding set and sheet bending machine etc. Besides these, there are various measuring instruments also, which are useful in day to day research work.

Library

The library of CIPHET has good collection of books and journals in the area of post-harvest engineering, food processing, food engineering, food microbiology and biotechnology, that attracts many researchers / visitors from all over the nation to review the literature in post-harvest technology. It has a huge collection of books and various referred journals. The current stock of books in the library is 4868; Annual Reports and Research highlights etc. 970, 12 Indian and foreign journal were subscribed during the year. The current stock of bound volumes collection is 967. Library also arranged research papers/articles as per request of the readers on a specific subject through CERA. Current content service of journals and list of new arrivals is also being circulated among the CIPHET staff.

ORGANIZATIONAL STRUCTURE



STAFF POSITION

Category	Sanctioned strength	Filled		Total Filled
		Ludhiana	Abohar	
Scientific	76*	28	08	36
Administrative	21#	18	03	21
Technical	29	19	07	26
Supporting	04	03	01	04
Total	**130**	**68**	**19**	**87**

* Excluding Director # Including SAO & F&AO

Agro Processing Centre (APC)

Agro-processing centre is designed to process the agricultural produce in production catchment with a view to enhance employment and income opportunities in rural areas. At CIPHET, modest agro-processing centre has been established for processing of wheat, pulses, oilseeds and spices. The processed products are being regularly sold to customers in and around CIPHET. During the reported period, the total purchase of raw materials was Rs. 1, 69,748.66. The gross profit amounts Rs. 34165.59 against the sale of processed products like dial, wheat flour, *besan*, powdered spices, green chilli puree and powder etc. Besides, the APC facility is also used to impart training to potential small rural entrepreneurs.

Guest House

CIPHET, Ludhiana and CIPHET Abohar have guesthouse facilities to provide accommodation to ICAR/SAU/Government employees and farmers. CIPHET Ludhiana has one guest house consists of 2 VIPs suites with internet facilities, 7 double bed AC and non-AC rooms, and one training hostel having 24 beds. One international guest house is upcoming at Ludhiana campus. Guest house of Abohar campus has 4 AC rooms and dormitory to accommodate 10 visitors. New guest house with 4 dormitories is under construction. Guest house consists of common kitchen and dining facilities, visitors' room and TV room. Facilities are extended to visitors subjected to availability. Booking of guest house can be made by writing an e-mail, fax or letter well in advance.

Units

Prioritization, Monitoring and Evaluation (PME) Cell

Prioritization, Monitoring and Evaluation concept is the management tool in R&D system to enhance scientific productivity and is the requirement of most of the funding agencies. It helps in setting a unified priority and monitoring of externally funded and inhouse projects. PME cell at CIPHET conducts Institute Research Council meeting and maintains all research project files. The monthly and quarterly reports of individual scientist are collected and compiled into progress reports, Results Framework Document, quarterly and half yearly performance review reports. PME cell also acts as link between various regional committee meetings, directors conferences etc. and the institute scientists. The exchange of information takes place through PME cell. The database of parliament questions and their answers, action taken reports, and issues related to scientific activities of the institute are dealt by PME cell. In addition to this, the research information related to ongoing and completed research projects is uploaded through Project Information and Management System (PIMS) software to avoid duplication in research.

Institute Technology Management Unit (ITMU)

ITMU plays a crucial role in management of technologies. It provides:

1. **Advisory and Consultancy**: For general information regarding CIPHET developed technologies, anyone can enroll as member of the institute by paying fees @ Rs 1000/- only per year. In return, institute provides all the general information to their members.
2. **Training and Licensing**: For practical training on a particular technology and hands on experience for 3-5 days, fees are charged. In this case, training certificate and license of technology is issued to the contracting party after successful completion of training.
3. **MoU**: Institute signs MoU with firms and NGO's interested in training (paid), general information, guidance, establishment of food processing industries and various activities related to post-harvest technologies, value addition etc.

AKMU

The Institute has an Agricultural Knowledge Management Unit (AKMU) for the scientists and staff for data analysis and electronic communication. The unit has latest eighteen desktop computers including three servers. More than 100 desktop computers of the institute are well connected through Local Area Network (LAN) and Wi-Fi connectivity is available through 100 Mbps line provided by National Knowledge Network (NKN). All the computers are protected by the server based Symantec Anti Virus. Internet is provided to

different nodes through proxy server Nebero. The Nebero facility provides the information of internet bandwidth; user details, firewall security and stability on the network. Besides, AKMU houses a number of analysis and design software such as Front Page 2003, Corel draw graphics Suite, Adobe Professional, SAS, Design Expert Software, Leap Office 2000 (Hindi Software). The Institute's website **www.ciphet.in** is also being maintained by AKMU. At present following services are provided by AKMU.

- Electronic communication to all institute staff and trainees.
- Data analysis facility.
- Assistance in software application in different research works.
- Internet browsing.
- Software and computer hardware support.
- Assistance in online patent search through various databases.

STATEMENT OF BUDGET ESTIMATES AND EXPENDITURE (2013-2014)

NON - PLAN

(Rs. in lakhs)

S.No.	Account Head	Revised Estimate 2013-2014	Progressive Expenditure 2013-2014
1.	Establishment Charges	588.00	581.70
2.	Travelling Allowances	3.50	3.50
3.	Recurring Contingencies (incl. equipment)	164.65	155.95
4.	Works		
	Major Works		
	Office Building		
	Residential Building		
	Minor Works		
5.	HRD		
	Total	**756.15**	**741.15**

PLAN

(Rs. in lakhs)

S.No.	Account Head	Revised Estimate 2013-2014	Progressive Expenditure 2013-2014
1.	Establishment Charges	0.00	0.00
2.	Travelling Allowances	13.95	13.95
3.	Recurring Contingencies (incl. equipment)	274.98	248.24
4.	Works		
	Major Works	31.51	31.50
	Office Building		
	Residential Building		
	Minor Works		
5.	HRD	3.56	3.55
	Total	**324.00**	**297.24**

RESEARCH ACHIEVEMENTS

AGRICULTURAL STRUCTURES AND ENVIRONMENT CONTROL DIVISION

Development of spectroscopic methods for detection and quantification of adulterants and contaminants in fruit juices and milk

S.N. Jha, Pranita Jaiswal and K. Mondal

The potential of Fourier Transform Infrared (FTIR) spectroscopy together with chemometrics was investigated as a rapid quality monitoring method for detection of soyamilk in milk. Spectral signatures of low value milk (soyamilk) mixed in varying combinations (10-40%) with mixed milk (cow and buffalo in 1:1) were acquired. Spectra revealed clear differences in the absorbance values of SM and PM supplemented with different levels of SM in wave number range of 1680-1058 cm^{-1} with a sharp peak at 1639-1613 cm^{-1} (Fig. 1).

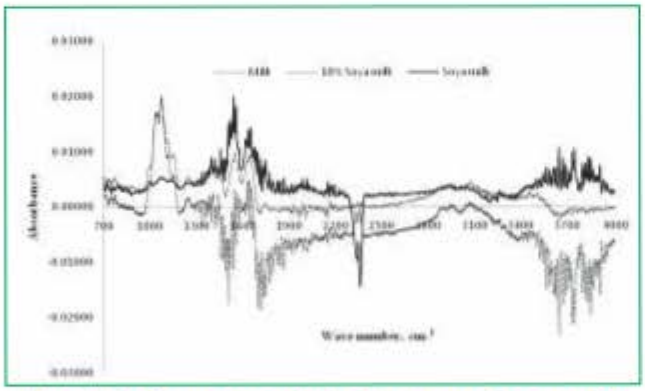


Fig. 1. Reference spectral signature of soyamilk (SM) and adulterated milk (10% soyamilk) in the wave number range of 4000-700 cm^{-1}

This region corresponds to absorption frequency of several soy-proteins. Principal component analysis (PCA) showed clear clustering of samples based on level of adulteration, at 5% significance level (Fig. 2).

The models developed using SIMCA approach, without any data treatment, could correctly (93%) classify the test samples into their respective class

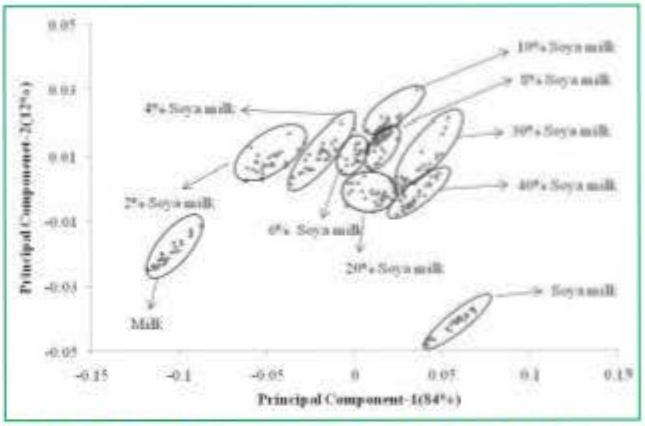


Fig. 2. Principal component score (PCA) plot for pure milk, adulterated milk (2-40%) and soya milk

except for 6% SM in the spectral range 1639-1635 cm^{-1}. Partial least square (PLS) and multiple linear regression (MLR) were carried out with and without data treatments. The soyamilk adulteration could be best predicted in the wave number range of 1472-1241 cm^{-1} using multiple linear regression (MLR) with coefficient of determination (R^2) of 0.99 and 0.92 for calibration and validation, respectively (Table 1). The results indicated that the FTIR spectroscopy has excellent potential for using dairy industry as a rapid method of detection and quantification of non-dairy ingredient in milk.

The potential of Attenuated Total Reflectance (ATR)-FTIR was also evaluated as a rapid method for detection and quantification of added urea milk. Spectra (4000–500 cm^{-1}) of milk adulterated with known concentration of urea (viz. 100 ppm, 500 ppm, 700 ppm, 900 ppm, 1300 ppm and 2000 ppm) were analyzed. The adulterated and non- adulterated milk showed clear differences in absorption values (Fig. 3)

Principal component analysis (PCA) showed clear clustering of samples based on level of adulteration, at 5% significance level (Fig. 4).

Table 1. Effect of different spectral windows on spectral data modeling for the best range of wavelength selected for the MLR at 20°C

Wave number range, cm^{-1}	Calibration			Validation		
	R^2	RMS	Bias	R^2	RMS	Bias
1639-1635 (SKTI)	0.78	13.32	0	0.77	13.77	0.13
1639-1613 (Beeta sheet)	0.92	7.63	0	0.91	8.50	0.09
1680-1631 (Amide-I)	0.91	8.25	0	0.87	9.96	0.04
1560-1533 (Amide-II)	0.69	15.69	0	0.62	17.43	0.21
1472-1239 (Amide-III)	0.99	1.66	0.01	0.92	7.56	0.02
1089-1058 (Vitamin-E)	0.98	3.85	0	0.98	4.36	0.01

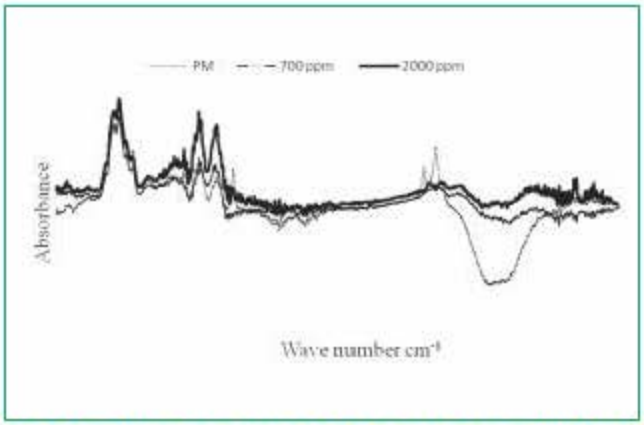


Fig. 3. Reference spectral signature of milk and adulterated milk (urea:700 ppm and 2000 ppm) in the wave number range of 4000-700 cm^{-1}

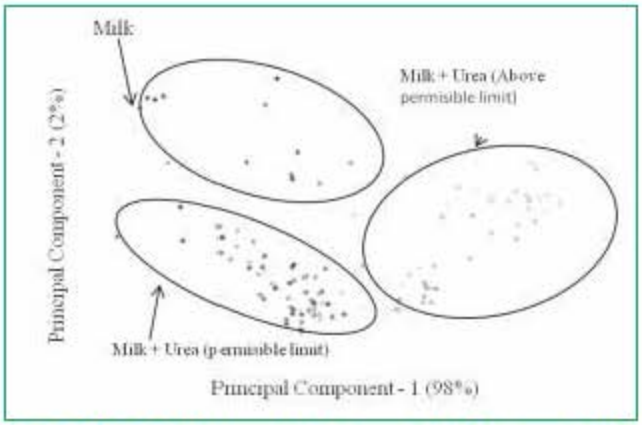


Fig. 4. Principal component score plot for pure milk, adulterated milk (above and below permissible limit)

Pattern recognition analysis by Soft Independent Modeling of Class Analogy (SIMCA) showed well-separated clusters of pure milk, milk adulterated with permissible limit of urea and those adulterated with above permissible limit of urea.

Spectral data of different concentration of *E. coli* in mango juice were created using FTIR in the wavelength range of 400-4000 cm^{-1} and UV-vis-NIR spectroscopy in the wavelength range of 200-1100 nm. Spectral data of different concentration of aflatoxin B1, M1 mixed in milk (cow and buffalo in 1:1) and *E. coli* in apple juice were created using FTIR in the wavelength range of 400-4000 cm^{-1}. Spectral library of different concentrations of aflatoxin B1 in water and lactose in milk in the wavelength range of 190-1100 nm were created.

Optimization of parameters for utilization of paddy straw, kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements

H.S. Oberoi

Solid state fermentation using pea pod waste (PPW) with *A. niger* HN-1 and Mandel Weber medium showed filter paper cellulase (FP) and β-glucosidase (BGL) activity of 30 FPU/g-ds and 270 IU/g-ds, respectively. Validation with the response surface optimized parameters (moisture content 65%, pH 6.0, temperature 33 °C, time 84 h) in a solid-state tray fermentation resulted in FP, BGL, endoglucanase (EG), cellobiohydrolase (CBH), xylanase, α-L-arabinofuranosidase, β-xylosidase and xylan esterase activity of 41.07±2.11 FPU/g-ds, 345.69±17.1 IU/g-ds, 480.3±21.5 IU/g-ds, 28.1±1.5 IU/g-ds, 2800.5±88.4 IU/g-ds, 88.1±9.3 IU/g-ds, 280.8±11.4 IU/g-ds, and 3321.7±14.8 IU/g-ds, respectively. Statistical optimization not only led to an increase in the enzyme production but also improved enzyme productivity. A high degree of correlation between the predicted and experimental values indicated the significance of the model. Enzyme was optimally active at temperature and pH of 55 °C and 5.0, respectively. Crude enzyme also demonstrated thermostability by retaining >95% activity for about 6 h. Zymogram analysis (Fig. 5) revealed that *A. niger* HN-1 produced cellulase with multiple forms of EG, CBH and BGL with molecular size ranging from 26 to 150 kDa.

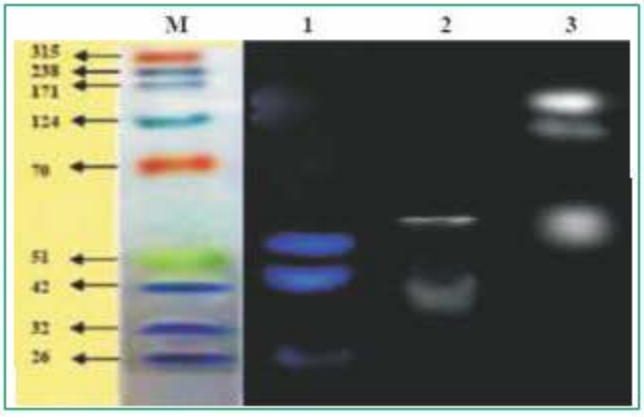


Fig. 5. Zymogram analysis of multiple cellulolytic enzymes produced by *A.niger* HN-1. Lane M, molecular weight markers; Lane 1, Endoglucanase; Lane 2, Cellobiohydrolase; Lane 3, β- glucosidase isoforms

Incorporation of the nickel-cobaltite nanoparticles ($NiCo_2O_4$ NPs) in the growth medium with newly isolated thermotolerant *Aspergillus fumigatus* NS (Class: Eurotiomycetes) led to a significant increase in the enzyme activity. Maximum production of endoglucanase (211 IU/gds), β-glucosidase (301 IU/gds) and xylanase (803 IU/gds) was achieved after 72 h without NPs (control), while in the presence of 1 mM concentration of NPs, endoglucanse, β-glucosidase and xylanase activity increased by about 49, 53 and 19.8 %, respectively after 48 h of incubation, against control, indicating a substantial increase in cellulase productivity with the addition of $NiCo_2O_4$ NPs in the growth medium (Fig. 6). Crude enzyme was thermally stable for 7 h at 80 °C in the presence of NPs, as against 4 h at the same temperature for control samples. Significant increase in the activity and improved thermal stability of cellulases in the presence of the $NiCo_2O_4$ NPs holds potential for use of $NiCo_2O_4$ NPs during enzyme production as well as hydrolysis.

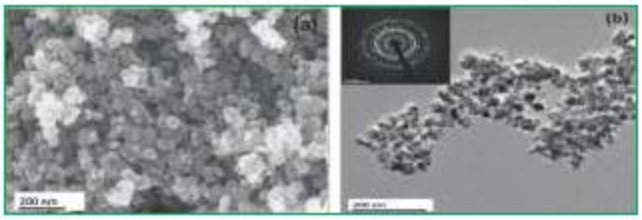


Fig. 6. FE-SEM micrograph of (a) $NiCo_2O_4$ NPs and (b)TEM micrograph of $NiCo_2O_4$ NPs [inset shows selected area electron diffraction pattern]

Micro-encapsulation methods for bacteriocins for their control release

K. Narsaiah, S.N. Jha and M.R. Manikantan

Process optimization for encapsulation of bacteriocin

Optimized process flow chart for encapsulation of bacteriocins is shown in Fig.7. Alginate (2% w/v) and guar gum (0.22 w/v) were mixed as dry powders.

This mixture was dissolved in distilled water and solution was autoclaved. Phosphatidylcholine (0.15% w/v) was added to bacteriocin solution and sonicated at 50% amplitude for 10 minutes to prepare nanoliposomes. Pediocin loaded nanoliposomes solution was filtered through 0.22µ filter. Filtered solution was added to alginate guar gum solution and stirred to get homogeneous solution. Mixed solution was atomized through autoclavable microencapsulator into calcium chloride (0.2 M) bath to generate microcapsules. Microcapsules were hardened for one hour. Hybrid microcapsules of alginate-guar gum with nanoliposomes loaded bacteriocin were retrieved from calcium chloride bath using muslin cloth. This process was optimized to yield about 60% encapsulation efficiency and good antimicrobial activity with controlled release of pediocin.

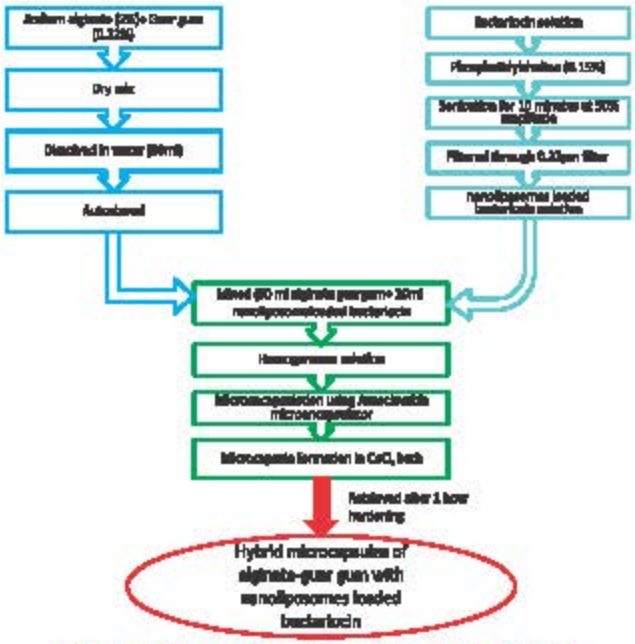


Fig. 7. Process flow chart for encapsulation of bacteriocin

Shelf life enhancement of minimally processed papaya coated with bacteriocin incorporated alginate

Papaya pieces were coated with bacteriocin (0, 20%) incorporated alginate (1, 1.5 and 2%). Coated papaya pieces and control (without coating) were analyzed for following quality parameters viz., colour, texture, weight loss, head space gas analysis, acidity, total soluble solids, and microbial quality for 21 days at an interval of 3 days.

Alginate coating on papaya pieces give them a glossy appearance (Fig. 8). Thickness of the alginate coating follows linear relationship ($y=138.5\ x$, $R^2=0.925$) with increase in concentration of alginate.

After 21 days of incubation, coated and uncoated

Fig. 8. Images of papaya (a) Fresh papaya pieces (b) Alginate coated papaya pieces (c) microscopic cross section view of papaya coated with alginate (2%)

samples showed decrease of O_2 level and acidity percentage, which was 1.8 and 2.7 times more in uncoated sample as compared to the coated sample. On the other side, level of CO_2 increased which was 1.7 times high in uncoated sample as compared to the coated sample. In uncoated sample because of high respiration rate the TSS value, firmness and weight loss were increased. On the other hand, alginate coating (with or without bacteriocin) acted as a barrier to water vapour transmission and gas exchange, which resulted in decrease in TSS value, firmness and weight loss in coated sample, which were observed 3.8, 8.7, 7.4 times lesser than the uncoated sample. Decrease in 'b' value and increase in 'a' value was more pronounced in case of control and become less prominent with alginate coating. Decrease in 'b' value and concomitant increase in 'a' value is due to the turning of yellow colour to reddish colour indicating ripening of papaya.

Microbial safety is the most important aspect of food quality owing to its direct effect on the health of the consumer. The limit of acceptance of fruit based products during storage, according to Institute of

Food Science and Technology (IFST) is 10^6 CFU/g. Bacteriocin incorporated in alginate coating significantly ($p < 0.01$) alleviated total plate count of minimally processed papaya (Fig. 9). In case of sample coated with 2% alginate (bacteriocin incorporated) CFU was only at 10^5 CFU/g, even till the end of storage period as compared to 10^7 CFU/g in case of control. The initial value of total plate count for all the samples was $1.6x10^3$ CFU/g and after storage period of 21 days it was increased to $7.5x10^7$, $1.9x10^6$, $5.5x10^4$, $3.4x10^4$ CFU/g for control, 1%, 1.5%, 2% alginate coated sample, respectively. On the other hand, total plate count for 1%, 1.5%, 2% bacteriocin incorporated alginate coated sample was increased from its initial value i.e. $1.6x10^3$ CFU/g to $1.1x10^4$, $3.8x10^3$, $5.5x10^2$, respectively. The growth rate was lower in bacteriocin incorporated alginate coated sample by the order of 2 log cycles compared to only alginate coated samples.

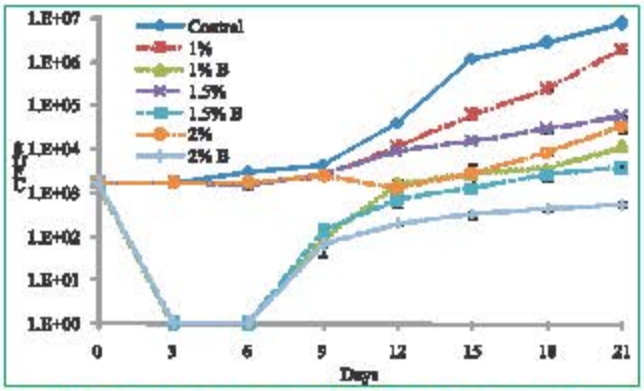


Fig. 9. Effect of concentrations of alginate coating on total plate count (Control-without alginate coating, 1.0%, 1.5%, 2.0%- alginate coating without bacteriocin, 1%, 1.5%, 2.0%- alginate coating with bacteriocin)

Development of animal handling and automated cooling systems for dairy farms

K. Narasiah, Sandeep Mann, Yogesh Kumar, Leena Kumari, Mukesh Bhakat and T.K. Mohanty

Deveopment of animal lifter for cow/buffalo

From ergonomic point of view the dimensions of animal lifter has to match the shape of the animal. Dimensions of adult cattle were measured for designing the animal lifter (Table 2). Dimensions of Murrah buffalo for animal lifter design were measured (Table 3).

Animal lifter of polyestser web sling was developed from M/s Ferreterro India Pvt. Ltd. in consultation with CIPHET, Ludhiana with following specifications (Fig. 10).

- Width and length of wrapping are 0.78 m and 2.5 m.
- The side sling legs are 3.2 m with adjustable self-locking buckle. The sling is made in such a way that sling legs will be almost vertical so that the stress in webbing straps is minimum.

Modified sling to have longer sling legs. This provides stability to the animal while lifting.

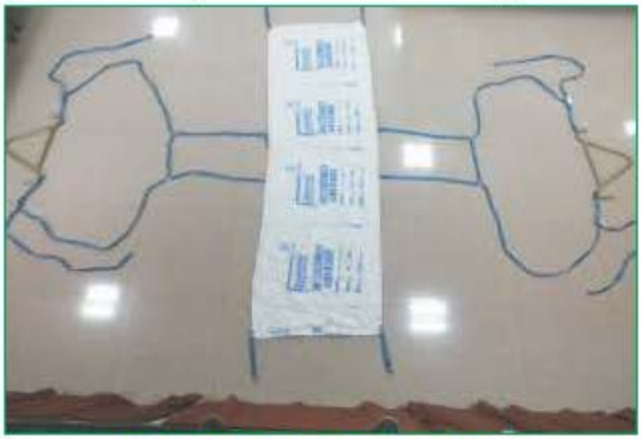


Fig. 10. Drawing of animal lifter

Table 2. Body measurement of Karan Fries

Effects	No. of Observations	HG (cm)	AG (cm)	BL (cm)	CR (cm)	DPN (cm)	DHK (cm)	DPH (cm)	HW (cm)	HH (cm)
Overall Mean	219	176.32 ± 0.89	201.82 ± 1.19	143.83 ± 1.10	203.64 ± 1.49	19.42 ± 0.18	40.58 ± 0.28	46.24 ± 0.33	128.60 ± 0.52	128.97 ± 0.57

HG = Heart girth; AG = Abdominal girth; BL = Body length; CR = Crown rump length; DPN = Distance between pins; DHK = Distance between hooks; DPH = Distance between pin and hook; HW = Height at withers; HH = Height at hook

Table 3. Body measurements of Murrah

Effects	No. of Observations	HG (cm)	AG (cm)	BL (cm)	CR (cm)	DPN (cm)	DHK (cm)	DPH (cm)	HW (cm)	HH (cm)
Overall	300	206.30	236.46	150.13	199.81	28.13	53.85	46.68	136.19	132.47
Mean		± 0.66	± 0.65	± 0.49	± 0.94	± 0.16	± 0.19	± 0.20	± 0.29	± 0.26

HG = Heart girth; AG = Abdominal girth; BL = Body length; CR = Crown rump length; DPN = Distance between pins; DHK = Distance between hooks; DPH = Distance between pin and hook; HW = Height at withers; HH = Height at hook.

Enhancement of shelf-life and microbial safety of meat and meat products applying high pressure, vacuum packaging and natural extract

Suresh Devatkal and Rahul K. Anurag

Bacillus amyloliquefaciens spores are currently described as the most high-pressure-resistant bacterial spores relevant to food preservation. The effects of two pressure treatments (200 MPa/20 min and 400 MPa/10 min at 27 °C) combined with 0.1% pomegranate peel extract (PPE) on dormant spores of *Bacillus amyloliquefaciens* were studied. An inactivation of only 0.6 and 0.90 logs of spores suspended in DW and PPE, respectively was observed for 200 MPa treatment. Further increasing the high pressure to 400 MPa for 10 min inactivated 2.6 and 2.92-log of spores suspended in DW and PPE. In contrast to inactivation results, germination of spores was significantly higher in spores treated with 200 MPa than 400 MPa. Germination level of 2.76 and 2.64- log was observed in spores suspended in DW and PPE and subjected to 200 MPa, respectively. Treatment of spores with 400 MPa inducted a germination level of 1.73 and 0.78 log of spores suspended in DW and PPE, respectively. Scanning electron microscopic studies indicated the average measured size of spores was about 2.2 by 1.2 µ. The control spores were in the intact oval shape with smoother surfaces, as compared to the treated spores. Both autoclaving and high-pressure treatments caused significant morphological damage, as the spores look like being squeezed. These results indicated that germinating effect of high pressure and PPE could be further explored for developing a natural method of food preservation.

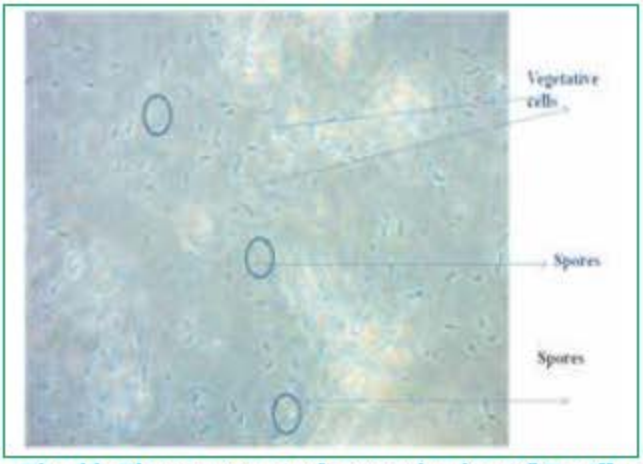


Fig. 11. Phase contrast microscopic view of *Bacillus amyloliquefaciens* spores

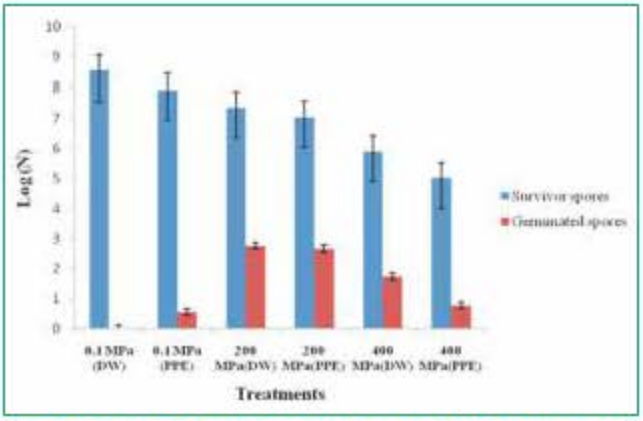


Fig 12. Survivals of *Bacillus amyloliquefaciens* spores after high pressure treatment

Inactivation of microbial pathogens and decontamination of shelled eggs using Ozone/O, (Divisional Activity)

Suresh Devatkal

Ozone is a natural antimicrobial agent which is effective against major pathogenic and food borne microbes. Ozone is very strong oxidizing agents and kills the bacteria by oxidation of cell membranes. The use of ozone in the processing of foods has been approved by the U.S. Food and Drug Administration. Experiments were conducted to know the antimicrobial efficiency of ozone against food borne bacterial pathogens like *Bacillus cereus* and *Salmonella typhimurium*. A domestic ozone generator capable of producing ozone concentration of 0.1 ppm (200mg/hr) was used in these studies for bacterial inactivation.

Pure cultures of *Bacillus cereus* and *Salmonella typhimurium* were grown overnight in nutrient broth incubated at 30°C and 37°C, respectively. Bacterial culture was centrifuged at 5000 rpm to obtain the pure bacterial pellet. This pellet was diluted appropriately to obtain a stock culture of ≈ 10^8-10^9 cells/ml. Bacterial inactivation studies were conducted on bacterial culture suspended in distilled water and phosphate buffer saline. An ozone treatment time of 16 min was used to assess the efficiency of ozone in killing the above bacterial pathogens. Average values of eight independent inactivation studies are presented in Fig. 13. These results showed that 16-min ozone treatment could able to inactivate 4.8-log of *Bacillus cereus* and 7.67-log of *Salmonella typhimurium* suspended in distilled water. When bacteria were suspended on PBS, inactivation level was 4.5 log for *Bacillus cereus and* 7.85-log for *Salmonella typhimurium*. Further these results showed that *Salmonella typhimurium* is more susceptible to ozone treatment as compared to *Bacillus cereus*.

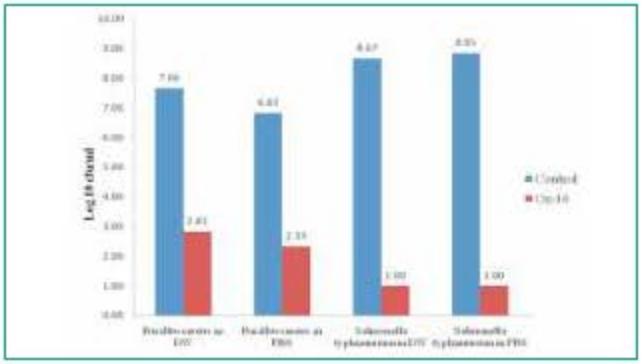


Fig. 13. Inactivation of *Bacillus cereus* and *Salmonella typhimurium* using aqueous ozone (0.1 ppm) (n=8. Detection limit: 1-log cfu/ml)

In another experiment, inactivation kinetics of *Bacillus cereus* vegetative bacteria subjected to ozone treatment was also studied. A stock culture of overnight grown *Bacillus cereus* (≈ 10^5-10^9cfu/ml) was suspended in sterile DW and subjected to 16 min ozone treatment using a domestic ozone generator (200mg/h capacity). Survival count was carried out at an interval of 0, 0.5, 1, 2, 4, 8 and 16 min. Kinetic parameters of inactivation of *Bacillus cereus* vegetative bacteria subjected to ozone treatment was studied using

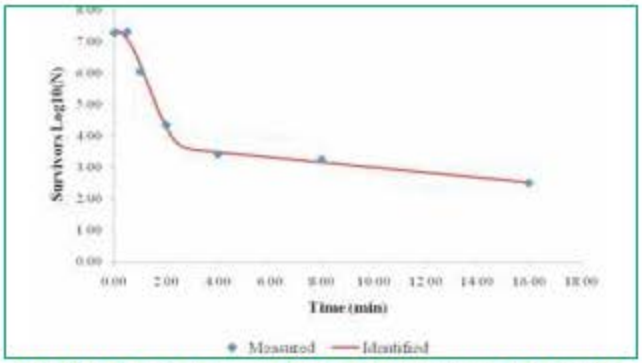


Fig.14.Survival curve of *Bacillus cereus* subjected to ozone treatment for different time interval. (Model: Biphasic +shoulder)

Gina-Fit tool. Different mathematical/statistical models namely: Log-linear, Log-linear Tail, Weibull, Double weibull and Biphasic +Shoulder were evaluated for best fit. R^2 values for respective models were 0.67, 0.91, 0.90, 0.95 and 0.99. Hence the best fitting models were "Biphasic

+shoulder" followed by Double Weibull. An important kinetic parameter 4D (time required to inactivate 4 log of viable cell) was also calculated. Calculated values of 4-D was 9.15±0.6 min and 9.31±0.61 min in Biphasic and Weibull double model respectively.

Development of continuous primary processing and shrink packaging line for cauliflower and cabbage

R. K. Vishwakarma, Leena Kumari and Ramesh Kumar

Cauliflower sold in the market usually contains part of stem as well as petiole portion of leaves, which covers the flower. The petiole and stem part is not utilized for human consumption. Therefore, a study was conducted to assess the physiological loss in weight (PLW) during storage of cauliflower with and without petiole portion. The fresh cauliflower was harvested from CIPHET, Ludhiana farm. Blade portion of the leaves of cauliflower was removed and stored at normal room temperature (8-16°C and 35-90% RH). Another sample was prepared in which the stem and complete leaves were removed and stored under same condition. Sample size for each experiment was 10 cauliflowers. The PLW was recorded at 2 days interval. The cauliflower harvested from field contains 62.6±5.9% by-product, which includes stem and leaves and remaining part is utilized for human consumption.

The effect of storage period on PLW of cauliflower samples is shown in Fig. 15. It may be observed from Fig 15 that the PLW of both cauliflower samples increased with increase in storage period. The PLW was more than 10% for both samples within 4 days of storage. It indicated the need of a barrier to reduce the loss. The PLW of samples of cauliflower having the stem and petiole part was 26.3±3.7% after 8 days of storage. Whereas, the PLW of samples of cauliflower without stem and petiole part was 27.3±4.3% after 8 days of storage. The PLW of cauliflower having no stem was slightly higher than that of cauliflower having stem, however the difference was not significant ($p<0.05$). Again the PLW of stem part, which was removed from the cauliflower, was 42.7±4.1% after 6 days of storage period. The petiole part of leaves attached with the cauliflower acts as barrier against loss of moisture. When the petiole is removed, flower surface is exposed resulting in higher moisture loss. Though the cover provided by the petiole helps in decreasing the PLW, it alone is not sufficient to check the high PLW.

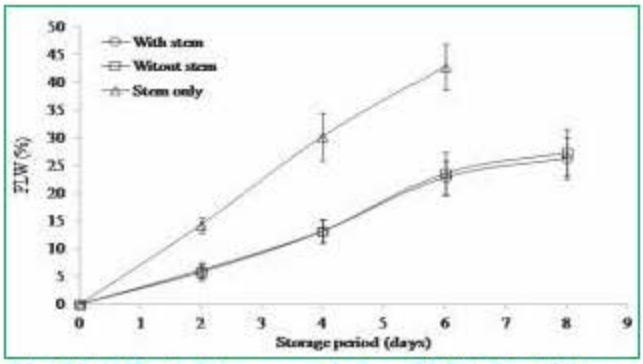


Fig. 15. Effect of storage period on PLW of cauliflower

Development of hybrid cold storage structure for onion and tomato

R. K. Vishwakarma and Leena Kumari

The use of desiccant cooling and evaporative cooling alone or in conjunction with refrigeration air conditioning may prove as less energy intensive method. Reduction in sensible heat load by the evaporative cooling and latent heat load by removal of water vapour (desiccation) may reduce the energy costs than cooling the same air with a refrigeration system alone. During winter, autumn and spring mornings, the evaporative cooling and desiccant alone will be able to meet the cooling load without energizing the refrigeration compressor. Therefore, a model of desiccant wheel was prepared and tested for its efficacy.

Wheat straw was taken as base material for preparation of desiccant material. The wheat straw was pulverised into powder using hammer mill. The balls of about 30-40 mm diameter were prepared using a binder. These balls were used as desiccant material. Two models of open ended desiccant wheel were prepared (Fig. 16). Length of desiccant wheels

was kept as 200 mm and 100 mm. Separators contain slotted opening for uniform air distribution. The desiccant material was filled in the hollow space.

The desiccant material was filled into the desiccant wheel and both ends were covered using wire mesh. This wheel was fitted on the front side of an evaporative cooler (Fig. 17).

Fig. 16. Model of desiccant wheel

Operation of the desiccant wheel having 200 mm length showed a drop in relative humidity of dry air, however the pressure drop was very high and air flow was almost restricted. Then the desiccant wheel having 100 mm length was evaluated. The process air generated by the cooler has temperature of 20°C and 90% RH. The dry air coming out of the desiccant wheel had temperature of 20.5°C and 78% RH initially. After 15 min of operation, the relative humidity of dry air started increasing and reached to 84% after 30 min of operation. The RH of air reached 89% after 75 min of operation. It indicated that the desiccant material had the capacity to absorb the water vapour from air of 90% RH up to 15 min only and thereafter the water vapour absorption capacity reduces. Thus the desiccant material should go for regeneration after 15 min. Further studies are in progress.The contributions of Dr. S. N. Jha and Er. Manpreet Kaur Grewal for this idea and formulation of this project and initial work on the aspects are acknowledged.

Fig. 17. Desiccant wheel fitted on the evaporative cooler

Makhana popping and decortication machine

S.N. Jha and R.K. Vishwakarma

A long felt demand of the *makhana* (Gorgon nut) popping machine was met at CIPHET, Ludhiana with the design and development of *makhana* popping and decorticating machine with 25-30 kg/h capacity of conditioned nut and more than 90% popping efficiency (Fig. 18).

The machine can be divided into two parts namely roasting unit and decortication/popping unit. The roasting unit is essentially a thermic heating system of specified length with a conveying mechanism to convey the roasted nuts towards outlet. Thermic heaters are used to heat the makhana seeds for specified time at 200-300 °C. Temperature and duration of roasting are controlled electronically

Fig.18. Commercial *makhana* roasting and popping machine

and feed rate is controlled mechanically. This unit is used for initial roasting for conditioning as well as final roasting to produce popped makhana.

The decortications/popping unit consists of a casing and impeller assembly with hard impact surface. When the hot roasted nuts strike to the impact surface, the shell breaks and due to sudden pressure drop, popping of the kernel takes place. This unit can also be used for decortication of conditioned makhana nuts to produce makhana flour for various food and industrial applications. The process parameters for conditioning, roasting, decortications and popping optimized earlier were used. The overall dimensions of machine are 1.5m × 0.75m × 2.0 m. Two electric motors of 1 hp each are required to run the machine. Thermic heaters of 6kW capacity were used in this machine. At optimum conditions, the popped makhana recovery was more than 90% with less than 3% undecorticated nuts. Most importantly, flattening of makhana does not take place in this machine and uniform shaped popped makhana is obtained. This machine gives better quality popped makhana and almost eliminates drudgery involved in present system of makahna processing. The same machine can be used for decortications of makhana seeds to produce flour for further value addition.

License for commercial production of the machine was given to M/s Jwala Engineering and Consultancy Services, Ambala in May 2013. The firm has already sold seven units of this machine. The machine was demonstrated to the farmers, entrepreneurs, scientists and other stake holders at Darbhanga and Saharasa in December 2013.

Shelf life extension of strawberry and plum fruits using active packaging in high barrier metal laminates

Rahul K. Anurag and Pranita Jaiswal

Active Packaging of Strawberry

Studies on respiration rate of strawberry were carried out in a closed system at two temperatures (5 and 10±1°C). Respiration Quotient (RQ) for strawberry *Chandler* variety was 0.72 at 5°C and 0.98 at 10°C. Strawberries stored in high barrier metal aluminium laminate, flushed with gaseous mixture (5 %O_2, 5% CO_2 and 90 % N_2) showed an RQ of 0.88 after 72 h.

Experiments were conducted to study the absorption kinetics of CO_2 gas using calcium hydroxide as carbon dioxide scavenging material. MAP gas flushing unit of Food Packaging and

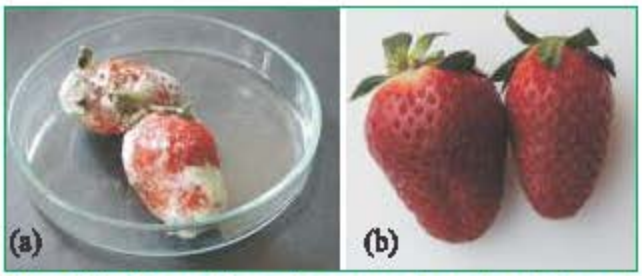


Fig: 19(a).Control Strawberry samples after 6 days of storage (b) Strawberries after 6 days of storage at 5% CO_2 + 15% O_2 active package

Fig. 20 (a). Empty active high barrier laminate package (b) Strawberry containing active high barrier laminate package with Carbon di-oxide scavenger and Oxygen gas bag

Transportation Laboratory was used to develop an active package with gaseous mixture of 5% CO_2 + 15% O_2 which was stored at 20°C; 85% RH. Results showed that calcium hydroxide reached its saturation level in 74 h. Based on the results of respiration rate and absorption kinetics, the dimensions (20×14.5×14cm) of the active package

were standardized for 500g weight of strawberry. Calcium hydroxide (12g, 15g and 18g) was bagged in muslin cloth and optimized for three selected levels of gaseous concentrations. Oxygen bags madeup of LDPE (84µm) thickness were kept inside the active package to prevent the anaerobic conditions. The changes in oxygen concentration inside the active package containing strawberry samples were monitored during storage. Oxygen gas permeability through the bag was also studied and efficacy of active package in maintaining aerobic condition was evaluated.

Active Packaging of Plum

Experiments were also conducted on plum fruits to extend their shelf life during storage. Five temperatures (5, 10, 15, 20 and 25°C) and three selected gas combinations were studied. Among all the samples studied, desirable quality parameters were observed in plum fruit stored at 5°C as TSS, TA, anthocyanin content, and colour values were similar to that of fresh plums upto 25 days of storage period. Textural parameters showed that firmness values decreased to (2.34N) from an initial value of (4.74N). Gas combination of 5% O_2 and 5% CO_2 at temperature of 5°C was found suitable for storing plums upto 25 days. Total plate and coliform count was found within the acceptable limit.

Development of RFID based quality tracing system

Leena Kumari, K. Narsaiah and Rahul Kumar Anurag

RFID system comprises tags, reader and software. A trial was conducted to check the potential of RFID technology for measurement of environmental parameter (temperature). In the trial RFID tag and reader were used to measure the temperature of banana. Unripe banana bunches were procured from local market of Ludhiana. After washing thoroughly, they were given the antifungal treatment. Then the bunches were packaged in the PP films of thickness 0.030 mm. The packaged banana bunches were placed inside cardboard boxes of volume 30x30x40 cm^3. The RFID tags were placed on the upper inside of the cardboard box. Temperature probe (Maxtech), IR (infrared) thermometer (FLUKE) was used for the measurement of temperature inside the cardboard boxes having banana. The cardboard box with bananas was placed inside the cold room at 13±1 °C for ripening. The bananas were stored for a period of three weeks.

The temperature of bananas was measured at regular intervals every day during its storage using the RFID tags, temperature probe and IR thermometer. The RFID reader connected to laptop through USB port was used to obtain the information of temperature from RFID tag. To study the effect of temperature variation on banana during storage, various physico-chemical parameters such as colour, TSS, texture etc. were also measured regularly. Texture was measured with peel and without peel.

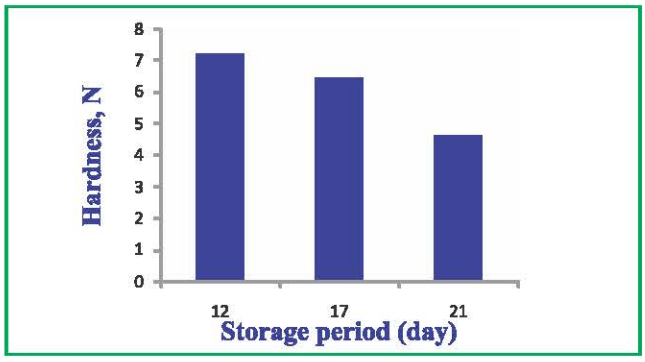


Fig. 21. Texture of banana samples (with peel) during storage in cold store

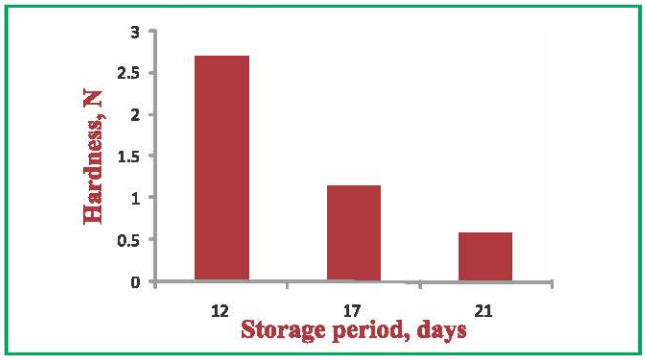


Fig.22. Texture of banana samples (without peel) during storage in cold store

Decrease in firmness of samples was observed with increasing storage period in both the cases (i.e. with peel and without peel) as shown in Fig 21 & Fig 22. Variation was observed in the temperature of cold store and temperature inside the boxes having banana. Although controller of the cold room showed the temperature in the range of 13°C, but many times actual temperature inside the cold room near the zone of banana box was found to be different as shown in the Table 4. Initial trials indicated that RFID technology can be used to monitor the environmental parameters inside cold storage room effectively and it can provide the information at faster speed.

Development of meat decontamination methods using pulsed light in conjunction with selected hurdle technology (Divisional activity)

Yogesh Kumar

Experiments have been conducted to identify possible hurdle interventions to be used in conjunction with pulsed light for enhancement of shelf life of different meat products. Thus, effect of pediocin, acidified sodium chlorite and benzoic acid was investigated to determine the effect of these natural antimicrobials on color, microbial and oxidative properties of goat meat during 10 day refrigerated storage period (GR1-pediocin+acidified sodium chlorite+benzoic acid, GR2-pediocin, GR3-

Table 4. Temperature recorded with RFID system and other means (Temperature probe, Infrared Thermometer)

Sr. No.	Temperature probe (^{0}C)	Infrared thermometer (^{0}C)	RFID system (^{0}C)
1	15.2	15.4	15
2	17.6	17.4	17
3	18	18.1	18
4	16.2	16.4	16
5	15.3	15.4	15
6	15.1	15.2	15
7	15.7	16.1	15
8	15.9	16.5	16
9	17.7	17	18
10	18	17.8	18
11	17.8	17.7	17
12	16.3	16.6	16
13	16.1	15.3	15
14	16.2	15.8	16
15	18	17.7	18
16	17.6	17.2	17
17	16.6	15.4	16
18	16.1	15.7	16
19	16.2	16.6	16
20	16.3	16.4	16
21	16.6	17.2	15
23	16.9	18.2	16
24	17.1	18.3	16

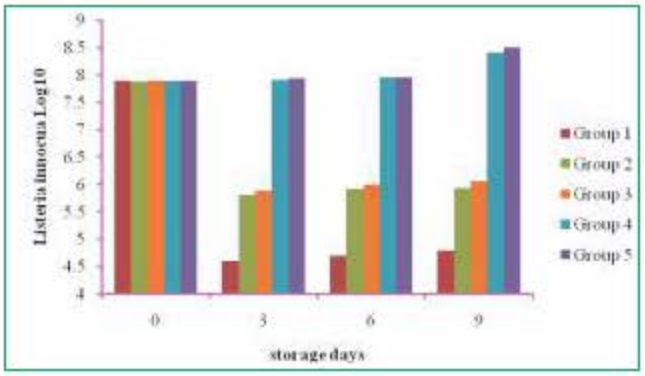


Fig. 23. Effect of different treatment on *Listeria innocua* count of refrigerated goat meat

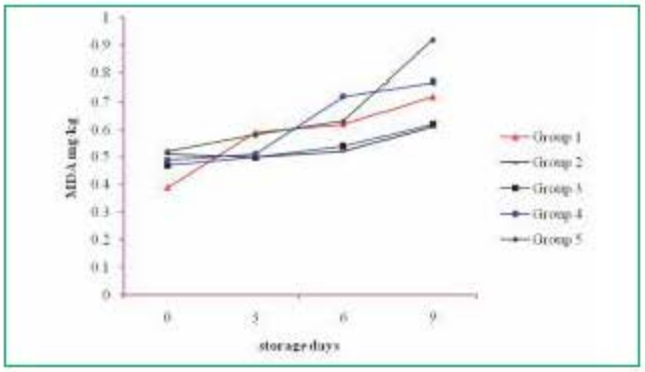


Fig. 24. Effect of different treatment on lipid oxidation of refrigerated goat meat

benzoic acid+acidified sodium chlorite, GR4-BHT and GR5-control). Moreover, inhibitory effect of these sources were also investigated on survival of inoculated *Listeria innocua sp.* in goat meat (10^8 concentrations). Results showed that pediocin with organic acids resulted in significant ($P<0.05$) inhibition of microbial growth and lowest microbial counts were obtained in the samples containing both pediocin and organic acid, indicating a possible synergistic effect. Pediocin and its combinations with organic acid, also showed the most strong antioxidative effect ($P<0.05$), at least when compared to BHT alone or the controls. Thus, the best antimicrobial and antioxidative effects were obtained from the combination of pediocin with the acids used in the study.

Development of nano-particle embedded biodegradable food packaging biopolymers

Dattatreya M Kadam, Pranita Jaiswal

Development of a new type of packaging materials to replace petroleum-based non-biodegradable plastics has become a growing field of interest since synthetic plastics lead to serious environmental concerns as a result of their non-biodegradability and depletion of natural resources. The packaging requirements of biological systems, including foodstuffs, are more diverse and complex than those for other products. In recent years, edible films and coating materials are increasingly used for food packaging to improve the food quality by serving as mass transfer barriers between food components and the surrounding environment. Food package should protect the products against physical hazards and environmental elements such as water vapor, gases, and odors; a combination of structural design and material selection should meet the requirements. An adequate selection of packaging materials can prevent food quality loss by providing barrier, or otherwise protective features, and enhancing food quality and shelf life.

Experimental set up using Response Surface Methodology was designed to carryout the optimum experiments and find out the different parameters.

Light transmittance measurements

Transmittance of the film forming solution was scanned in the range of 200-800 nm using a UV-spectrophotometer (Shimadzu, Kyoto, Japan). The variation of the transmittance (T) in % of the WPI films forming solution with or without silver nanoparticles in the 200-800 nm wavelength range is shown in Fig. 25. The film forming WPI solution has shown difference in transmittance after 400 nm wavelength. The addition of silver nanoparticles leads to increase in T. The T value at 800 nm was higher after addition of silver nanoparticles (Table 5). This phenomenon suggested that the UV absorption ability of WPI solution was modified with silver nanoparticles.

Table 5. Comparison of Transmittance (T) values of WPI solutions

Wavelength (nm)	Transmittance	
	With Silver Nanoparticles	Without Silver Nanoparticles
200	4	4
280	4	4
300	4	4
400	2.409	2.199
500	2.044	1.784
600	1.862	1.520
700	1.723	1.289
800	1.584	1.087

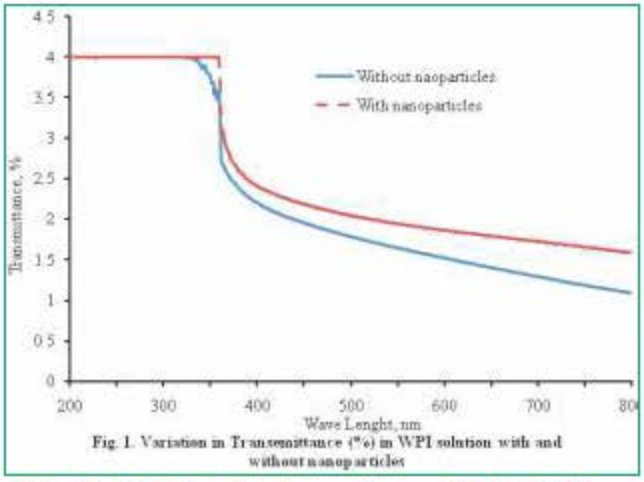


Fig. 1. Variation in Transmittance (%) in WPI solution with and without nanoparticles

Fig. 25. Variation in Transmittance (%) in WPI solution with and without nanoparticles

Development of Nano-bio-composite based Construction Material for Storage of Food Grains

Dattatreya M Kadam

Currently wide range of silo construction materials - including mild steel, stainless steel, galvanised steel, and dual metallic alloys are used. These materials are dense, heavy and costlier, which limits the farmers to go ahead with construction of such silos in their farm production areas. New lightweight, low-cost silo construction materials need to be developed using carbon fibers/ cellulose that could replace the currently used metals in silos manufacturing instead of using expensive petroleum-based carbon fiber. Developing the next-generation of renewable lightweight composites structural application materials will address the environmental concerns and add value to agricultural crops and ways to produce functional, affordable, and environmentally safe products from sustainable and bio-renewable sources.

Protocol for the synthesis of silver Nano formulation: Dissolution of silver nitrate in distilled water at 80°C at 550 rpm for 15 min. After this, addition of tri-sodium citrate (drop wise) was performed in the above solution. The reagent mixture was allowed for stirring at 80°C at 550 rpm for 45 min. The confirmation of the silver nanoparticles was done on the basis of visualizing the yellow colour of the solution. In the current study, synthesis of the silver nanoparticles has been done using chemical route. For the successful synthesis of silver nano formulations, silver nitrate

Fig. 26. Particle size analysis of silver nano-particles using zeta potentiometer

and tri sodium citrate have been used. Confirmation of synthesis of nanoparticles was done on the basis of the observation of yellow colour of the reagent solution used. In the study, size of the silver nanoparticles was 50 nm and polydispersity index (PDI) was 0.4, which confirmed the stability of the nano formulations.

Application of silver nano formulations

Chemically synthesized nanoparticles were investigated for the antimicrobial analysis against *E.coli*. Antimicrobial analysis was performed using zone of inhibition method, which represented the inhibition of *E.coli* up to certain extent. On the basis of antimicrobial analysis, it can be concluded that synthesized nanoparticles have antimicrobial applications, which can be further implemented in the food packaging containers in order to avoid food contamination effectively.

Development of multipurpose system for Grain storage silo

During grain storage, quantitative as well as qualitative losses occur due to insects, rodents, and micro-organisms. A large number of insect pests have been reported to be associated with stored grains. Almost all species have remarkably high rates of multiplication and, within one season, may destroy 10-15% of the grain and contaminate the rest with undesirable odors and flavors. Multipurpose system is used to trap the insect of stored grains. Multipurpose system is also used for fumigation and drying of stored grains. The system minimizes losses and increased shelf life of stored grains.

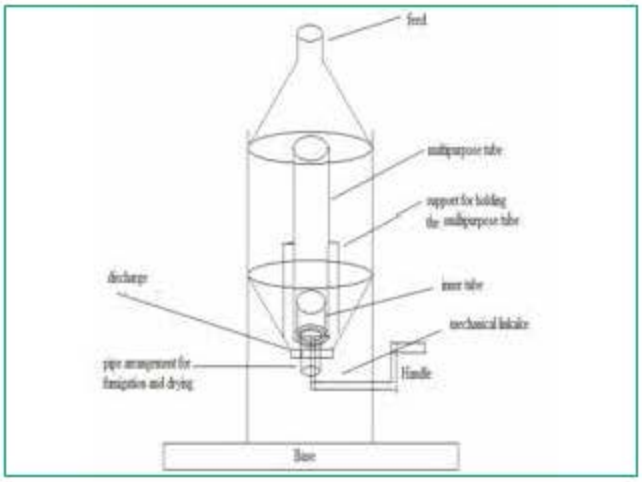


Fig. 27. 2-D view of silo with multipurpose system fitted in it.

Fig. 28. Multipurpose discharge system for silo

System for multipurpose use is developed and fitted with silo outlet (Fig 27). Developed system (Fig. 28) has advantages such as trap insects, aeration, drying of stored grains, fumigation of grains, controlled discharge of grains and reduce the wastage and maintain the quality of stored grains. Fabrication cost of multipurpose system is about Rs 2600/-.

FOOD GRAINS AND OILSEEDS PROCESSING DIVISION

Development of nutritive functional flour and food products

Mridula D., M.R. Manikantan, Anita Kochar (PAU, Ludhiana) and Monika Sharma

Multigrain based health food using extrusion technique

Food contains a wide range of nutrients but serves as a major source of few main nutrients only. Hence, a combination of different foods for product development is desirable for good nutritional profile and digestibility along with desired product attributes. In view of this, a study was carried out to standardize the process parameters for development of protein rich (>18% protein) extruded snack foods utilizing cereals (maize, sorghum, pearl millet), legume (defatted soy flour and soy protein) and sesame seeds. The feed material was extruded using twin screw extruder with two feed moisture (14% and 16%), die head temperature (100 and 120 °C) and three screw speed (275, 300 and 325rpm/s) at constant feed rate. Expansion ratio of extrudates developed at different extrusion conditions varied between 2.35 to 3.15 ($p<0.05$). Expansion ratio was significantly higher while bulk density was lower in samples developed at 120°C. Bulk density of extrudates developed at 100 and 120°C and 14 and 16% feed moisture ranged from 242 to 311 kg/m^3 and 189 to 275 kg/m^3, respectively. Water absorption index (WAI) and water solubility index of developed extruded products varied between 4.43 to 5.0g/g and 24.0 to 26.72%, respectively. WAI was not affected with feed moisture but die head temperature and screw speed affected the WAI significantly. Hardness and peak viscosity was lower in samples developed at 120 °C with 16% feed moisture. Overall sensory acceptability score for this sample was 8.64 at 9 point hedonic scale. This sample provided 382 kcal energy, 2.03g crude fibre, 2.49mg iron, 206mg calcium in 100g sample and 19.27% protein with 67.02% *in vitro* protein digestibility.

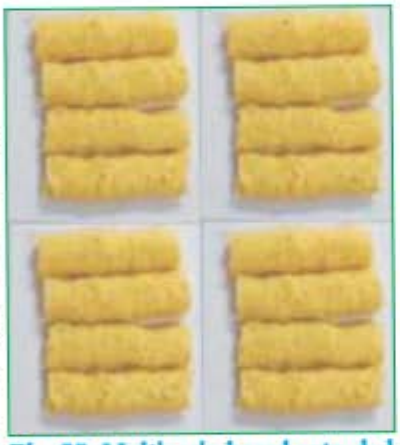


Fig. 29. Multigrain based extruded snacks

Development of high protein health mix for young children

Four types of multigrain based nutritious health mixes i.e. health mixes from sprouted grain (HMS),

Table 6. Physico-chemical properties of multigrain based health food

Parameters	Values (die head temperature, feed moisture)	
	100 °C (14 & 16%)	120 °C (14 & 16%)
Expansion in diameter	2.19 to 2.584	2.274 to 2.869
Bulk density, kg/m^3	230 to 441	219 to 317
WAI, g/g	4.27 to 4.69	4.43 to 4.61
WSI, %	25.05 to 26.25	26.19 to 26.92
Yellowness Index	44.98 to 48.60	44.68 to 48.59
Hardness, N	160.19 to 196.34	141.51 to 179.25
Peak viscosity, cP	128.25 to 272.75	112 to 152.25

sprouted and steamed grains (HMSS), using extrudates from un-sprouted grains (HMER) and extrudates from sprouted grains (HMES) were developed with vegetable powder and other important food materials. The bulk density of the developed health mix samples was ranged from 494 to 521kg/m^3. L, a and b values of all four kinds of weaning mix samples was similar. Yellowness index of health mix samples developed using unsprouted grain based extrudates was maximum. Peak viscosity was found in the range of 19.33 to 28.33 with minimum in HMSS sample. Nutritional quality of the all four kinds of developed health mix samples is given in Table 7. In general, the overall acceptability of health mix samples developed from extrudates was found higher than other samples. The developed health mixes were with high protein content (18.64 to 18.97%) and able to satisfy the daily protein requirement of 1-3 year old child. In general, the overall acceptability of mixes, developed using extrudates was found higher than other samples. The developed health mix was evaluated for protein efficiency ratio using 28 days old weaning albino rats. The health mix samples developed for young children with protein content >18% and control were used for this feeding trials. The study was carried out for 28 days following the standard methodology. The protein efficiency ratio of different samples of health mix was ranged from 1.91 to 2.31 as against 2.05 for control sample, which

Fig 30. Health mix (HMES)

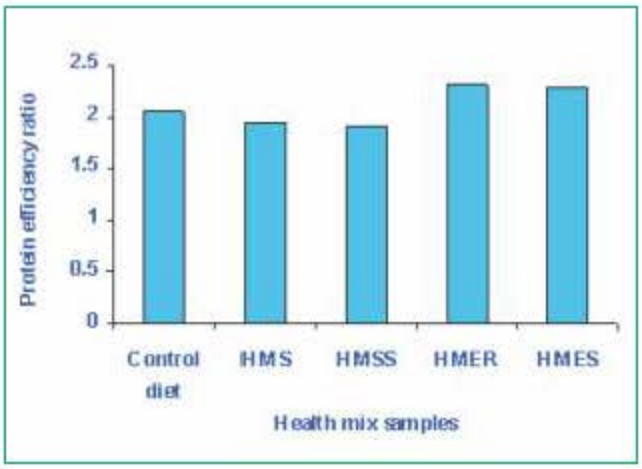


Fig 31. Effect of processing method on PER of health mixes

Table 7. Nutritional quality of health mixes

Particulars	Health mix samples			
	HMS	HMSS	HMER	HMES
Moisture, %	5.3	5.16	5.20	5.28
Protein, %	18.97	18.94	18.64	18.89
Fat, %	2.21	2.19	2.17	2.23
Crude fibre, %	2.40	2.44	2.49	2.51
Mineral content, %	2.97	2.92	2.88	2.94
Total carbohydrates, %	69.36	68.35	68.62	68.15
Calories, kcal/ 100g	373.21	368.87	368.57	368.23
Calcium, mg/ 100g	438.87	438.87	438.87	438.87
Iron, mg/ 100g	4.26	4.24	4.19	4.28

Table 8. Effect of processing method on sensory characteristics of health mixes

Sensory characteristics*	Health mix samples			
	HMS	HMSS	HMER	HMES
Appearance and colour	8.13 ±0.44	8.19 ±0.37	8.04 ±0.43	8.21 ±0.50
Sensory texture/ body	6.63 ±0.23	7.06 ±0.18	8.13 ±0.71	8.53 ±0.57
Odour	7.51 ±0.71	7.85 ±0.13	7.78 ±0.66	7.84 ±0.60
Flavour and taste	6.58 ±0.27	7.06 ±0.22	8.16 ±0.57	8.05 ±0.76
Mouthfeel	6.55 ±0.30	7.03 ±0.16	8.00 ±0.58	8.35 ±0.76
Overall acceptability	6.63 ±0.27	7.09 ±0.19	8.31 ±0.47	8.20 ±0.66

*on 9 point indoic scale

showed that method of processing affected the protein efficiency ratio of health mix samples.

Development of quick cooking multi-grain dalia

Quick cooking multi-grain *dalia* (MGD) was prepared utilizing sprouted wheat and mixer of three other grains (barley, sorghum and pearl millet) in the ratio of 100:0 (MGD-A), 75:25 (MGD-B), 50:50 (MGD-C), 25:75 (MGD-D) and 0:100 (MGD-E), respectively. The mixer of barley, sorghum and pearl millet was prepared using 50, 25, 25 parts of these grains, respectively. The recovery of grits/*dalia* (particle size 1.41 to 2 mm) from sprouted wheat and barley was 74.56 and 69.77%, respectively while sorghum and pearl millet yield 47.94 and 49.39% (particle size 0.954 to 1.41 mm), respectively. Sprouting brought a reduction in cooking time by about 50% as compared to un-sprouted studied grains. Cooking time for different MGD formulations ranged from 3.91 to 4.42 min, which was slightly increased with increasing proportion of mixer of barley, sorghum and pearl millet ($p>0.05$). Rehydration ratio of MGD samples varied from 3.12 to 3.45 with minimum in MGD-E sample. Though protein content was decreased with increasing proportion of mixer of three grains in MGD samples but *in vitro* protein digestibility (58.68 to 62.75%) was similar ($p>0.05$). The mean overall sensory acceptability scores for MGD samples ranged from 7.50 to 8.49 with 8.0 in samples having up to 75% grits of mixer of three grains. In view of very good overall sensory acceptability, rich in crude fibre,

Table 9. Nutritional quality of multi-grain *dalia*

MGD Samples	Moisture, % w.b.	Protein, %	Fat, %	Crude fibre, %	Minerals, %	Carbo hydrates, %	Calories, kcal/ 100g	*In vitro* protein digestibility, %	Calcium, mg/ 100g	Iron, mg/ 100g
MGD-A	6.28 ±0.02	10.26± 0.18^{a}	1.70 ±0.06^{e}	3.23 ±0.16^{a}	1.29 ±0.006^{a}	77.24± 0.26^{ab}	365.26± 0.93	62.75 ±1.00	45.33 ±1.15^{b}	1.18 ±0.11^{c}
MGD-B	6.32 ±0.04	9.68±0. 14^{b}	1.79 ±0.02^{d}	3.46 ±0.06^{ab}	1.22 ±0.008^{b}	77.53± 0.18^{a}	364.96± 0.45	62.58 ±1.99	52.00 ±2.0^{ab}	1.80 ±0.19^{b}
MGD-C	6.20 ±0.22	9.45±0. 06^{bc}	1.89 ±0.02^{c}	3.66 ±0.15^{b}	1.21 ±0.001^{b}	77.59± 0.11^{a}	365.19± 0.21	61.96 ±2.83	54.67 ±7.57^{a}	2.55 ±0.19^{a}
MGD-D	6.39 ±0.12	9.53±0. 11^{bc}	1.98 ±0.04^{b}	3.91 ±0.12^{a}	1.12 ±0.011^{c}	77.07± 0.13^{b}	364.25± 1.02	61.51 ±1.15	56.00 ±4.00^{a}	2.61 ±0.43^{a}
MGD-E	6.46 ±0.07	9.32±0. 22^{c}	2.11 ±0.03^{a}	4.06 ±0.15^{a}	1.07 ±0.025^{d}	76.99± 0.37^{b}	364.16± 0.70	58.68 ±1.75	58.67 ±2.31^{a}	2.68 ±0.11^{a}
F value	2.09^{ns}	16.84**	63.29**	18.16**	140.77**	4.19*	1.54^{ns}	2.35^{ns}	4.60*	22.70**
CD (0.05)	0.213	0.282	0.063	0.246	0.023	0.415	1.325	3.39	7.46	0.433

All values are mean ± SD (n=3); values with different superscript are statistically different; $^{*}p>0.05$, $^{**}p<0.01$

Table 10. Sensory characteristics of multi-grain *dalia*

MGD Samples	Appearance & colour	Sensory texture/ body	Odour	Flavour & taste	Overall acceptability
MGD-A	8.42 ± 0.47^{a}	8.33 ± 0.49^{a}	8.25 ± 0.45^{a}	8.42 ± 0.51^{a}	8.25 ± 0.62^{ab}
MGD-B	7.83 ± 0.54^{bc}	8.25 ± 0.58^{a}	8.04 ± 0.45^{a}	8.38 ± 0.43^{ab}	8.24 ± 0.50^{ab}
MGD-C	8.08 ± 0.42^{ab}	8.33 ± 0.44^{a}	8.25 ± 0.58^{a}	8.33 ± 0.49^{ab}	8.49 ± 0.48^{a}
MGD-D	7.50 ± 0.48^{c}	7.67 ± 0.49^{b}	8.08 ± 0.47^{a}	7.96 ± 0.54^{bc}	8.00 ± 0.56^{b}
MGD-E	7.04 ± 0.40^{d}	7.75 ± 0.45^{b}	7.50 ± 0.52^{b}	7.63 ± 0.57^{a}	7.50 ± 0.56^{c}
F value	15.81^{**}	5.33^{**}	4.60^{**}	5.34^{**}	5.64^{**}

All values are mean ± SD (n=9); values with different superscript are statistically different; $^{**}p<0.01$

calcium and iron content and low cooking time, 25:75 parts of sprouted wheat and mixer of studied three grains, respectively may be considered for preparation of acceptable quality quick cooking multi-grain *dalia*.

Development of functional pasta

Functional pasta, a popular ready to cook product was developed using different cereals (wheat, barley and sorghum) and legumes, and evaluated for important product quality parameters. Different formulations were developed with 100% wheat (PF-A) as control, 36% wheat and 64% other food material (PF-B), 33% wheat and 67% other food materials (PF-D), 30% wheat and 70% other food materials (PF-E), and 27% wheat and 73% other food materials (PF-F). The bulk density of the pasta formulations varied between 623 to 745 kg/m^3. Water absorption index of different formulations ranged from 2.89-3.39 g/g while water solubility index varied between 13.4 to 14.54%. The whiteness index of different formulations varied from 82.42 to 82.91 but the whiteness index was reduced when the formulations was extruded to pasta. The colour quality i.e. L, a, b, and whiteness index of pasta samples varied from 35.26 to 42.25, 5.68 to 7.15, 10.30 to 10.90 and 34.17 to 40.90 ($p<0.05$), respectively. Hardness and toughness of pasta (in raw form) was significantly higher in wheat based (control) samples than the multigrain based pasta. The optimum cooking time for multigrain based pasta samples varied from 4-5 min, which was lower than the wheat based samples. All the multigrain based pasta samples were well accepted during organoleptic evaluation with very good overall sensory acceptability (mean score 8.21) up to 30% wheat in the formulation. In view of this, 30% wheat, 23% sorghum, 13% barley with legumes may be considered for development of low glycemic functional pasta, which provided 17% protein, 5.9% crude fibre, 6.7mg/ 00g iron, 111.8mg/100g calcium and 74.45% in vitro protein digestibility.

Fig 32. Functional pasta

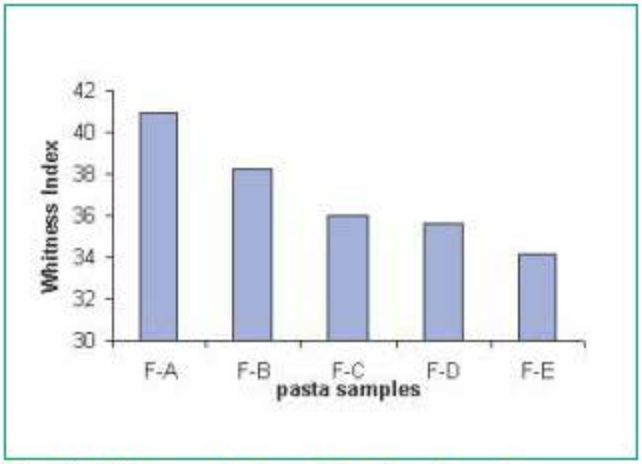


Fig 33. Whiteness index of functional pasta

Characterization, fortification, cooking and quality evaluation of soft rice

Mridula D., Deepika Goswami, N. Shobha Rani and Suneetha Kota (DRR, Hyderabad)

Development of calcium fortified soft rice

Calcium fortification of food products may be of vital importance to compensate for the inadequacies of calcium in the diet of the poor. In view of this, three soft rice genotypes (received from DRR, Hyderabad) namely *Agnoni Bora, Bogali Bora and Maju chokua,* and *pauna* rice (broken basmati as control) were considered for calcium fortification using calcium chloride (as a fortificant) and biopolymer coating namely hydroxypropyl methyl cellulose (HPMC) and methyl cellulose (MC). Calcium content in different calcium fortified soft rice premix of all three genotypes ranged between 25.22-25.41mg/g of premix. Coating of calcium fortified soft rice premix with HPMC and MC brought a significant reduction in the washing losses of calcium. Calcium retention in HPMC and MC coated calcium fortified soft rice, after second washing was more than 90%. The overall sensory acceptability scores for calcium fortified *Maju Chokua* and *Bogali Bora* genotypes of soft rice (calcium fortified soft rice premix: unfortified soft rice-6.25:100) were 7.09 and 7.45 as against 8.02 for *pauna* rice (control) Table 11. Increasing calcium concentration in the soft rice grain is expected to improve the calcium status amongst the soft rice consumers.

Fig. 34. Calcium fortified soft rice

Development of iron fortified soft rice

Three soft rice genotypes (obtained from DRR, Hyderabad) namely *Agnoni Bora, Bogali Bora and Maju Chokua,* and *pauna* rice (broken basmati as control) were considered for iron fortification using ferrous sulphate (as a fortificant) and biopolymer coating namely hydroxypropyl methyl cellulose (HPMC) and methyl cellulose (MC). The amylose content in *Agnoni Bora, Bogali Bora and Maju Chokua* genotypes of soft rice was 5.67, 5.12 and 12.64% while cooking time was 12.2, 11.5 and 13.1 min, respectively. Iron content in different iron fortified soft rice premix of these three genotypes ranged from 4.87 to 4.91mg/g of premix. Coating of iron fortified soft rice premix with HPMC and MC reduced the washing losses significantly; thus improved the iron retention during washing. Iron retention in iron fortified soft rice premix, after second washing ranged from 87.61 to 89.13%. The overall sensory acceptability scores for studied iron fortified soft rice (iron fortified soft rice premix: unfortified soft rice: 1:100) ranged from 6.91 to 7.02

Table 11. Sensory characteristics of calcium fortified soft rice and *pauna* rice in cooked form

Calcium fortified rice samples	Appearance & colour	Sensory texture	Odour	Flavour & taste	Overall acceptability
Control (unfortified rice)	8.09±0.38	8.18±0.40	8.05±0.35	8.5±0.39	8.55±0.42
Calcium fortified *pauna* rice	8.45±0.35	8.09±0.28	7.95±0.15	8.09±0.54	8.02±0.24
Calcium fortified soft rice					
Maju Chokua	7.59±0.49	7.45±0.47	7.68±0.46	7.09±0.2	7.09±0.20
Agnoni Bora	7.45±0.42	7.36±0.39	7.36±0.45	6.86±0.23	6.86±0.30
Bogali Bora	7.59±0.44	7.27±0.47	7.45±0.52	7.43±0.43	7.45±0.35

Fig 35. Iron fortified soft rice

as against 8.09 for iron fortified *pauna* rice (control) and 8.55 for unfortified *pauna* rice (Table 12). In view of iron content, retention of iron after washing and acceptability, all the studied genotypes may be considered for iron fortification to enhance the iron intake amongst the soft rice consumers.

Quality evaluation of soft rice genotypes for selected properties

Soft rice genotypes (71 No.) received from Directorate of Rice Research, Hyderabad (Table 13) were evaluated for physical, biochemical and cooking characteristics at initial moisture content of 9 to 11% (w.b.). Length, breadth and thickness of studied 71 soft rice genotypes were found in the range of 4.81 (SR-40) to 7.20mm (SR-26), 1.65 (SR-26) to 2.79mm (SR-20) and 1.40 (SR-53) to 1.93mm (SR-19), respectively. Geometric mean diameter, sphericity and porosity of studied soft rice genotypes ranged from 2.44 to 3.21, 0.37 to 0.55 and 27% to 39%, respectively. Bulk density was found minimum in SR-43 genotype and maximum in SR-40 genotype. The colour i.e. L, a and b values for whole milled soft rice genotypes ranged from 60.92 (SR-71) to 80.50 (SR-2), 1.31 (SR-38) to 4.72 (SR-59) and 8.83 (SR-73) to 12.59 (SR-26), respectively. Whiteness index was found minimum (58.42) for SR-39 and maximum (77.22) for SR-2 genotype. Studied genotypes were fair to good source of important minerals i.e. calcium and iron. Cooking time of different genotypes varied between 8.5 to 11.8 min with minimum for SR-1 and maximum for SR-3. Proximate composition of studied soft rice genotypes has been presented in Table 14.

Table 14. Proximate composition of soft rice genotypes

Nutrients	Nutritive value, per 100 g (w.b.)
Protein, %	6.60 (SR-74) to 12.61 (SR-5)
Fat, %	0.2 (SR-74) to 1.06 (SR-15)
Total minerals, %	0.17 (SR-46) to 0.98 (SR-10)
Amylose content, %	5.59 (SR-46) to 26.10% (SR-26)
Calcium, mg/100g	21.3 (SR-13) to 130.7 (SR-26)
Iron, mg/100g	0.55 (SR-31) to 3.92 (SR-8)

A value chain on composite dairy foods with enhanced health attributes

D. N. Yadav and Monika Sharma

Storage study of pearl millet-WPC extrudate and vegetable blended composite pasta

Storage study of pearl millet-WPC extrudate and

Table 12. Sensory characteristics of iron fortified soft rice and *pauna* rice

Fortified rice samples	Appearance & colour	Sensory texture	Odour	Flavour & taste	Overall acceptability
Unfortified rice (control)	8.09±0.38	8.18±0.4	8.05±0.35	8.5±0.39	8.55±0.42
Iron fortified pauna rice	8.0±0.50	8.05±0.47	7.91±0.2	8.09±0.3	8.09±0.3
Iron fortified soft rice					
Maju chokua	7.73±0.47	6.91±0.2	7.77±0.41	7.0±0.22	7.02±0.18
Agnoni Bora	7.59±0.32	6.91±0.38	7.73±0.26	6.95±0.27	7.0±0.19
Bogali Bora	7.36±0.23	6.86±0.21	7.82±0.25	6.93±0.25	6.91±0.28

Table 13. List of studied soft rice genotypes

Code	Name of soft rice genotypes	Code	Name of soft rice genotypes	Code	Name of soft rice genotypes
SR-1	Joha Bora	SR-26	Vasumathi	SR-51	Naldang Bora
SR-2	Ranga Bora		Vikas (not received)	SR-52	Helochi Bora 1
SR-3	Sungal Bora	SR-28	Jaya	SR-53	Helochi Bora 2
SR-4	Noldong Bora	SR-29	Agnoni Bora	SR-54	Aghoni Bora
SR-5	Tegori Bora	SR-30	Bogali Bora	SR-55	Bhogali
SR-6	Bongari Bora	SR-31	Abor bora	SR-56	KMJ Bora 56
SR-7	Kola Ampaki Bora	SR-32	Beji Bora 1	SR-57	KMJ Bora 53
SR-8	Bora-1	SR-33	Begun Bora	SR-58	KMJ Bora 51
SR-9	Dadhora Bora	SR-34	Boga Bora 1	SR-59	KMJ Bora 41
SR-10	Chokura Bora	SR-35	Boga Bora 3 (not received)	SR-60	KMJ Bora 36
SR-11	Sakoi bhanu Bora	SR-36	Bhat Bora (not received)	SR-61	KMJ Bora 49
SR-12	Kola Bora	SR-37	Bora 1	SR-62	KMJ Bora 74
SR-13	Misiri Chokua	SR-38	Bora 3	SR-63	KMJ Bora 5
SR-14	Boka Chokua	SR-39	Bora 5	SR-64	KMJ Bora 13
SR-15	Ch5-Bora Chokua	SR-40	Botia Bora	SR-65	KMJ Bora 21
SR-16	Kagori Chokura	SR-41	Bor Malbhog	SR-66	KMJ Bora 25
Sr-17	Kola Boka Chokura	SR-42	Chakkua Bora 1	SR-67	Boka Chakua 1 (not received)
SR-18	Haru Chokua	SR-43	Chansep Bora	SR-68	Boka Chakua 2
SR-19	Boga Chokua	SR-44	Chandra Bora	SR-69	Kojoli Chakua
SR-20	Lahi Chokua	SR-45	Danbori Bora	SR-70	Kalamdani Chakua
SR-21	Sam Chokua	SR-46	Fakkai Bora	SR-71	Lahi Chakua 1
SR-22	Maju Chokua	SR-47	Gela Bora	SR-72	Maju Chakua 1
SR-23	Ham Chokua	SR-48	Ghew Bora 1	SR-73	Maju Chakua 2
SR-24	Hampori Chokua	SR-49	Garu chakua Bora 2	SR-74	Misiri Chakua
SR-25	Kasturi	SR-50	Gomiri Bora	SR-75	Sam chakua

vegetable blended composite pasta packed in polyethylene (thickness 75μ) and stored at ambient conditions was carried out. The peroxide value (PV) for control, WPC (5%) blended pearl millet extrudate and carrot, tomato, turnip, spinach and control pasta at 0 day were 12.4, 11.0, 8.4, 10.0, 9.0, 10.2, 8.0 meq O_2 kg^{-1} fat, respectively and after 90 days 15.8, 13.2, 11.4, 13.5, 10.9, 11.8, 10.2 meqO_2kg^{-1} fat, respectively. The free fatty acids (FFA) values for control and WPC (5%) blended pearl millet extrudate after 90 days were 0.57 and 0.72%, respectively and for carrot, tomato, turnip, spinach blended and control pasta were 0.85, 0.81, 1.02, 0.97 and 0.76%, respectively. Total plate count for carrot, tomato, turnip, spinach blended and control pasta after 90 days were $27x10^2$, $20x10^2$, $15x10^2$, $29x10^2$ and $21x10^2$ cfu/ml, respectively whereas yeast and mould count was nil for all the samples. The samples were found acceptable after 90 days of storage at ambient conditions.

Barley water

Experiments were conducted to optimize ingredients and process protocols for barley water. Pearled barley grains and barley husk were used for extraction of barley solids in aqueous media at different water ratio (1:5, 1:10) and cooked for 20 min. Total solids in extract were 2.07, 1.85 for pearled barley grains and 1.71 and 1.44% for husk respectively. Level of other ingredients i.e. amchoor powder, spice mix and salt were used to improve its sensory quality. Lemon flavoured barley water was also developed with 5% lemon juice and sugar (2%) as optimum. Barley water with sugar had higher sensory acceptability.

Moisture dependent phase transition behavior of pearl millet flour

Pearl millet flour (12, 14, 16, 18, 20% mc) were analyzed for glass transition (Tg) and melting temperature (Tm) using phase transition analyzer. Tg values at 12, 14, 16, 18, 20 % m.c. were 77.1, 52.1, 49.2, 39.2 and 30.2°C and Tm values were 110.3, 89.2, 74.8, 63.2, 46.4°C respectively. It was observed that as moisture content increases glass transition and melting temperature decreases. Hence, at higher moisture less expansion of product is achieved during extrusion cooking.

Studies on cryogenic grinding for retention of flavour and medicinal properties of some important Indian spices.

P. Barnwal and D. N. Yadav

Performance evaluation of CIPHET developed cryogenic grinding system

The fenugreek, black pepper and coriander seeds were ground using CIPHET developed cryogenic spice grinding system. The fenugreek, black pepper and coriander seeds were ground at varying temperatures (10 and -50°C) with variable screw speed (5, 10 and 15 rpm). The particle size of fenugreek powder varied from 0.277±0.002 to 0.352± 0.009mm. The colour parameters i.e L, a, b, hue, chroma and browning index varied from 68.67±2.31 to 72.30±0.64, 4.28±0.26 to 5.57±0.51, 23.92±1.11 to 28.05±0.60, 75.53±1.04 to 77.99±0.53, 24.21±1.47 to 28.73±0.60 and 54.77±4.31 to 71.65±2.61, respectively (Table 15). The average particle size of coriander powder varied from 0.450±0.038 to 0.529± 0.005mm. The colour parameters i.e L, a, b, hue, chroma and browning index varied from 58.21±0.52 to 61.27±0.95, 5.20±0.46 to 6.76±0.28, 23.92±1.11 to 28.05±0.60, 75.53.±1.04 to 77.99±0.53, 24.21±1.47 to 28.73±0.61 and 54.77±4.31 to 71.65±2.61, respectively. The average particle size of black pepper powder varied from 0.313±0.007 to 0.369± 0.005mm. The colour parameters i.e L, a, b, hue and

chroma varied from 46.23±3.87 to 48.18±3.08, 2.47±0.31 to 2.98±1.20, 7.78±0.74 to 9.86±2.04, 8.19.±0.60 to 10.31±1.04 and 71.57±7.16 to 73.02±3.62, respectively. The particle size increased with increase in screw speed. The particle size of fenugreek powder, coriander powder and black pepper powder varied significantly with screw speed and temperature. However a bright light coloured powder and smaller particle size was obtained at -50°C for both seed crops. Higher value of volatile oil content, total phenols, flavonoid content and antioxidant content was found in coriander and black pepper powder ground at -50°C as compared to coriander powder ground at 10°C (Table 16, 17 & 18).

Table 15. Effect of screw speed on particle size (mm) of cryogenically ground powder (grade-1) of different spices at 10°C and -50°C.

Particle size (mm) at 10°C			
Screw speed	**Fenugreek**	**Coriander**	**Black pepper**
5	0.327±0.004[a]	0.469±0.029[a]	0.345±0.004
10	0.349±0.007[b]	0.523±0.019[b]	0.359±0.018
15	0.352±0.009[b]	0.529±0.005[b]	0.369±0.005
F- values	11.03*	8.97*	4.31[NS]
$CD_{0.05}$	0.01	0.04	0.04
Particle size (mm) at -50°C			
Screw speed	**Fenugreek**	**Coriander**	**Black pepper**
5	0.277±0.002[a]	0.450±0.038	0.313±0.007
10	0.294±0.010[a]	0.466±0.037	0.327±0.034
15	0.314±0. 011[b]	0.478±0.019	0.343±0.010
F- values	13.19*	1.10[NS]	0.73[NS]
$CD_{0.05}$	0.02	0.04	0.06

Table 16. Effect of screw speed and temperature on volatile oil, total phenols, flavonoid content and antioxidant content of coriander powder

Temperature (°C)	Screw speed (rpm)	Volatile oil (%)	Total phenols (mg GAE/g)	Flavonoid content (mg QE/g)	Antioxidant content (mg BHT E/g)
10	5	0.49±0.01	74.50±3.12	18.35±0.82	34.52±0.72
	10	0.49±0.01	77.32±1.89	21.82±1.40	35.30±0.91
	15	0.49±0.01	85.94±0.58	20.97±0.97	34.70±1.89
-50	5	0.66±0.01	79.32±6.74	19.96±2.84	37.24±1.44
	10	0.66±0.01	82.56±3.23	23.45±1.03	36.13±1.04
	15	0.66±0.01	85.27±7.32	24.78±0.88	38.56±1.67

Table 17. Effect of screw speed and temperature on volatile oil and oleoresin content of black pepper

Temperature (°C)	Screw speed (rpm)	Volatile oil (%)	Oleoresin content (%)
10	5	1.60±0.01	7.81±0.38
	10	1.60±0.01	7.80±0.07
	15	1.60±0.01	7.84±0.07
-50	5	2.0±0.01	8.31±0.27
	10	2.0±0.01	8.56±0.36
	15	2.0±0.01	8.27±0.04

Table 18. Effect of screw speed and temperature on volatile oil, total phenols, flavonoid content and antioxidant content of fenugreek powder

Temperature (°C)	Screw speed (rpm)	Volatile oil (%)	Total phenols (mg GAE/g)	Flavonoid content (mg QE/g)	Antioxidant content (mg BHT E/g)
10	5	3.42±0.80	54.55±0.14	21.23±2.16	22.38±3.52
	10	3.65±0.36	61.23±1.88	25.61±1.56	24.55±0.32
	15	3.55±0.28	67.29±6.16	24.87±4.51	24.27±0.59
-50	5	3.61±0.14	56.04±0.79	31.51±1.44	27.39±2.78
	10	3.88±0.13	68.29±4.4	48.48±3.43	33.98±1.04
	15	3.76±0.52	75.01±0.36	34.44±2.52	33.19±0.62

Technology for production of protein concentrate /isolate from commercial groundnut cake

D. N. Yadav, Mridula D. and R.K. Gupta

The commercial groundnut cake obtained from local market contained 35.2% protein, 15.5% crude fibre and about 15-16% impurities i.e. hulls and testa (Table 19). In order to remove the impurities, the cake was pulverized in hammer mill at 1400 rpm using three set of sieve openings (0.650, 1.190 & 4.760 mm) and passed through a set of 9 standard sieves (1.201 to 0.157 mm) (Table 21). Deoiled groundnut cake flour (without husk and testa) was prepared in the laboratory and used as control. Cake flour retained on different sieves along with control flour was analyzed for different physico-chemical properties. Based on similarity in physico-chemical properties with control, the cake flour was selected (Table 22). The groundnut

cake flour (pulverized in hammer mill with 1.190 mm sieve openings) and passed through 0.251 mm standard sieve contained 40.2% protein and 9.5% crude fibre, equivalent to the control cake as 39.6% & 10.6%, respectively (Table 20) and considered with no or minimum husk and testa. It indicated that physical method is quite useful in removing the hull and testa from commercial groundnut cake for its further utilization for food purposes. Purified groundnut cake flour incorporated extrudates (maize-rice-groundnut cake flour, 50:40:10) was prepared. It had higher protein (8.2±0.08%) content and excellent acceptability. The protein content was two times higher than extrudate produced from commercial extrudates of maize-rice blend (60:40).

Table 19. Proximate composition of commercial groundnut cake

Parameters	Content (%)
Moisture	9
Protein	35.2
Fat	0.45
Ash	5.9
Crude fibre	15.5

Table 20. Protein and crude fibre content of different groundnut cake samples

Samples	Protein, %	Crude fibre, %
Crude Cake	35.2±0.77	15.5±0.55
R20	30.4±0.12	26.3±1.62
R60	35.2±0.42	16.6±0.98
P60	39.6±0.21	10.6±0.07
R100	39.7±0.24	9.4±0.25
Peanut hull	-	65.7±0.65
Peanut testa	-	21.7±0.16
Deffated peanut kernel	40.2±0.52	9.5±0.21

Table 21. Sieve analysis of pulverized groundnut cake

Sieve Size (BSS)	Amount retained, % Width opening of sieves used in pulverizer		
	0.630 mm	1.190 mm	4.760 mm
10	-	-	12.6
14	11.80	12.00	24.8
20	16.80	18.20	14.0
30	15.80	18.20	12.40
40	10.00	10.40	8.80
50	13.20	14.60	9.40
60	3.60	3.20	2.60
85	8.30	9.80	5.30
100	2.80	3.80	3.20
Pan	18.20	15.60	7.20

Extraction of protein from purified ground nut flour was carried out at different cake water ratio (1:8, 1:10, and 1:12), shaking time 1, 2, 3 h at pH 8.0, 9.0, 9.5 followed by filtration, centrifugation and protein precipitation at pH 4.5. Protein isolate

Fig 36. Crude groundnut cake

Table 22. Different properties of groundnut cake samples

Sample	Total phenol mg (GAE)/100g	Color values			Bulk density g/cm³
		L	a	b	
Crude cake	0.090	58.74	4.79	16.75	0.56
Passed through 60 BSS	0.110	65.39	6.29	19.31	0.62
Collected in pan	0.125	67.71	5.58	20.12	0.64
Control	0.122	72.24	4.95	22.25	0.65

Fig 37. Cake flour passed through 60 BSS

(Protein 95.0%) from purified commercial groundnut cake was prepared and evaluated for different functional properties. The water holding, oil binding and foaming capacity was 1.12±0.75, 1.84±1.47, 1.1±0.76 ml/g respectively. Dispersibilty and wettebility was 26.9±5.63% and 11.9±1.9 s/0.1g, respectively. Protein powder from refined groundnut cake flour was prepared without centrifugation step. Double layered muslin cloth and 200 BSS (0.074 mm) sieve were used for alternate filtration. The prepared protein powder had 80.5 and 83.47% protein, respectively.

Development of non dairy based probiotic foods

Sangita Bansal, Satish K Sharma and Manisha Mangal

Probiotic peanut yoghurt

Process protocol for development of probiotic peanut yoghurt containing *Streptococcus faecalis* T110 has been standardized. Peanut milk was produced using equipment that are available in small scale industry for preparation of soymilk like soybean milk extractor. Milk was prepared by adding 1 kg of peanut in 6 l of water. The milk was found to have 3.93% protein, 1.83% fat, 0.2% ash and 91.2% moisture.

To develop probiotic peanut yoghurt, preliminary trials were conducted to optimize the probiotic strain (*Lactobacillus, Streptococcus*). Probiotic strain *Streptococcus faecalis* T110 culture (with Optical density 1) was selected after these preliminary trials. The inoculum concentration, incubation temperature and time were optimized by RSM.

Probiotic peanut yoghurt containing probiotic strain *S. faecalis* T110 was developed. The developed yoghurt has pH 4.5 and titratable acidity 0.14% (% lactic acid). Firmness of the yoghurt was 0.46 N. It exhibited syneresis of 46 ml/100ml and 47.5 cP peak viscosity. The probiotic count of yoghurt was found to be $\log_{10}$cfu 7.5. It can be stored for 7 days at 4±1°C.

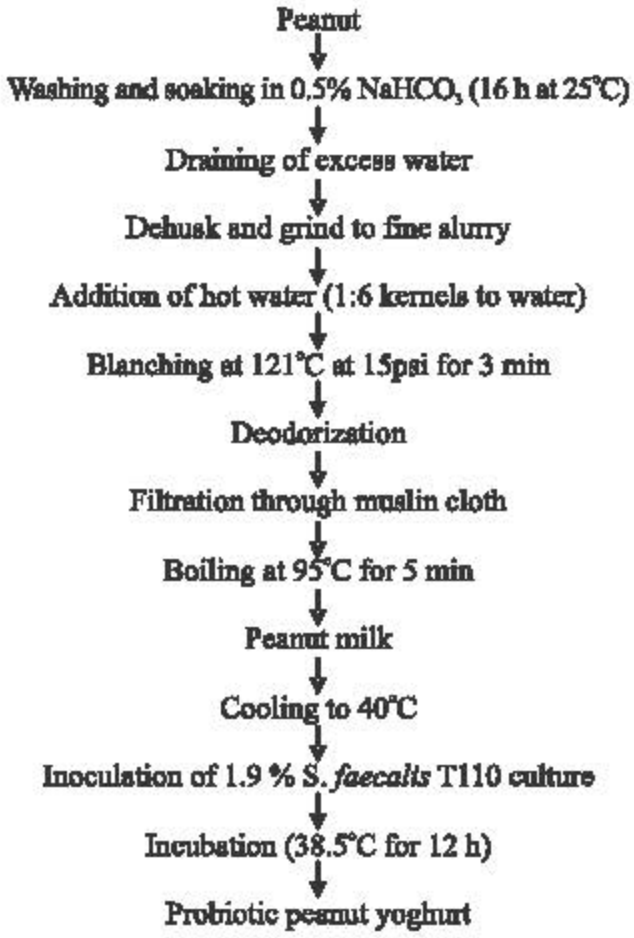


Fig. 38. Process flow chart for developing probiotic peanut yoghurt

Probiotic peanut yoghurt

Isolation and characterization of probiotic bacteria

Lactobacillus fermentum strains BBE4, BBE5, BBE6 and *Lactobacillus plantarum* strain BBE7 have been successfully isolated, and their 16S rDNA sequences have been registered with NCBI vide GenBank accession numbers KF974325 KF974328 KF974326 and KF974327given as under:

Table 23. List of cultures registered with NCBI

S.No.	Name	NCBI Genbank Accession Number
1	*Lactobacillus fermentum* BBE4	KF974325
2	*Lactobacillus fermentum* BBE5	KF974328
3	*Lactobacillus fermentum* BBE6	KF974326
4	*Lactobacillus plantarum* BBE7	KF974327

Development of PCR based diagnostic process for the detection of potential aflatoxin producing molds during post-harvest handling in rice

Manisha Mangal, Sangita Bansal, HS Oberoi and Surya Tushir

Process protocol for amplification omt-1 involved in aflatoxin biosynthesis

DNA was isolated from aflatoxin producing and non producing *Aspergillus* fungi following the method of Moller et al., 1992 by scaling it up to isolate DNA from 1 g of wet weight of submerged fungal culture. The genomic DNA was isolated from all the samples and was quantified using Nanodrop, starting with 2 µl of DNA samples. The primers of sterigmatocystin O-methyltransferase (omt-1), genes were used based on the published sequence for *A. flavus* and *A. parasiticus*. The PCR mix used for amplification of all the above genes included 1x Standard Taq Reaction Buffer, 200µM Deoxynucleotide solution mix, 0.2 µM Upstream Primer, 0.75 units of Taq DNA Polymerase/25µl PCR reaction, 100-125ng of DNA template and the volume was brought to 25µl with nuclease free water. PCR amplification was performed in 25µl of a reaction and PCR was carried out as 1 step at 94°C for 10 min and 35 cycles

of the three steps; 1 min 94°C, 90 at 62°C one final 5 min step at 72°C then hold at 4° C. PCR products were separated by electrophoreais on a 1% agarose gel with 0.5% ethidium bromide in 1x TAE buffer and visualized under UV light in a gel documentation system. A single amplification product of expected length *viz.* 1024 bp for *omt* gene, which could specifically differentiate aflatoxin producing i.e. *A. parasiticus* and *A. flavus fungi* from non producing *A. oryzae, A. fumigatus, A. niger* fungi was obtained.

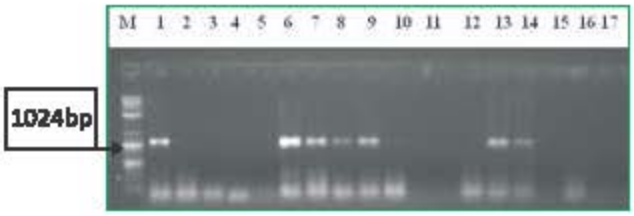


Fig. 39. Amplification of *omt* gene in various target samples

Lane no.M: 2-Log DNA ladder, LANE 1-17: *A. parasiticus (MTCC 2796), A.fumigatus, A. oryzae, A.niger, A. oryzae (MTCC 3107), A.flavus* (MTCC 2798), *A. flavus* (MTCC 2799), *A. flavus* (MTCC 2799), *A. flavus BBE5*, Rice, rice, *A. fumigatus, A. niger, A. parasiticus BBE4, A. flavu BBE5* , Groundnut, Groundnut

Process protocol for amplification nor-1 involved in aflatoxin biosynthesis

DNA was isolated from aflatoxin producing and non producing *Aspergillus* fungi following the method of Moller et al., 1992 by scaling it up to isolate DNA from 1 g of wet weight of submerged fungal culture. The genomic DNA was isolated from all the samples and was quantified using Nanodrop, starting with 2 µl of DNA samples. The primers of norsolorinic acid reductase (nor-1) were designed based on the published sequence of genes encoding for these in *A. flavus* and *A. parasiticus*. The PCR mix used for amplification of all the above genes included 1x Standard Taq Reaction Buffer, 200µM Deoxynucleotide solution Mix, 0.2 µM Upstream Primer, 0.2 µM Downstream Primer, 0.75 units of Taq DNA Polymerase/25µl PCR reaction, 100-125ng of DNA template and the volume was brought to 25µl with nuclease free water. PCR amplification was performed in 25µl of a reaction and PCR was carried out as follows: 1 step at 94°C for 10 min and 35 cycles of the three steps;1 min 94°C, 90 sec for 60°C for *nor-1*, one final 5 min step at 72°C then hold at 4°C. PCR products were separated by electrophoresis on a 1% agarose gel with 0.5% ethidium bromide in 1x TAE buffer and visualized under UV light in a gel documentation system. A single amplification product of expected size *viz.* 400 bp which could specifically differentiate aflatoxin producing i.e. *A. parasiticus* and *A. flavus fungi* from non producing *A. oryzae, A. fumigatus, A. niger* fungi was obtained.

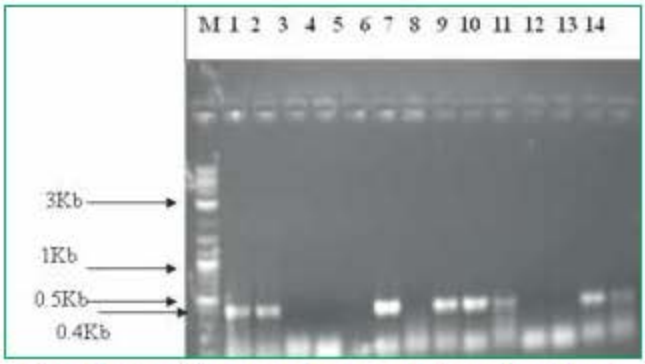


Fig. 40. Amplification of *nor* gene in various target samples

Lane no. M: 2-Log DNA ladder; LANE 1-14: A. parasiticus (MTCC 2796), A. parasiticus (MTCC 2797), A. fumigatus, A. oryzae, A. niger, A. flavus (MTCC 2798), A. oryzae (MTCC 3107), A. flavus (MTCC 2799), A.flavus(MTCC 2799), A. flavus BBE5, Rice, Groundnut, A. parasiticus BBE4 ,A. flavus BBE5

Process protocol for amplification apa involved in aflatoxin biosynthesis

DNA was isolated from aflatoxin producing and non producing *Aspergillus* fungi following the method of Moller et al., 1992 by scaling it up to isolate DNA from 1 g of wet weight of submerged fungal culture. The genomic DNA was isolated from all the samples and was quantified using Nanodrop, starting with 2 µl of DNA samples. The primers of apa proteins were designed based on the

published sequence of genes encoding for these in *A. flavus* and *A. parasiticus*. The PCR mix used for amplification of all the above genes included 1x Standard Taq Reaction Buffer, 200µM Deoxynucleotide solution mix, 0.2 µM Upstream Primer, 0.2 µM Downstream Primer, 0.75 units of Taq DNA Polymerase/25µl PCR reaction, 100-125ng of DNA Template and the volume was brought to 25µl with nuclease free water. PCR amplification was performed in 25µl of a reaction and PCR was carried out as 1 step at 94°C for 10 min and 35 cycles of the three steps; 1 min 94°C, 2 min at 57°C for *apa*, one final 5 min step at 72°C and then hold at 4°C. PCR products were separated by electrophoresis on a 1% agarose gel with 0.5% ethidium bromide in 1x TAE buffer and visualized under UV light in a gel documentation system. A single amplification product of expected size *viz.* 1032 bp for *apa* gene was observed which could specifically differentiate aflatoxin producing *i.e. A. parasiticus* and *A. flavus fungi* from non producing *A. oryzae, A. fumigatus, A.niger* fungi.

Fig. 41. Amplification of *apa* gene in various target sample

Lane no.M: 2-Log DNA ladder, LANE 1-15: *A. fumigatus, A. fumigatus, A. oryzae, A. niger, A. oryzae (MTCC 3107), A. parasiticus (MTCC 2796), A. parasiticus (MTCC 2797), A. flavus* (MTCC 2798), *A. flavus* (MTCC 2799), Groundnut, Rice, rice, Groundnut, *A. flavus BBE5, A. parasiticus BBE4*

Process technology for shelf stable millet flour and gluten free baked products

Deepika Goswami and R K Gupta

Enhancement of shelf life of barnyard millet flour using hydrothermal treatment

The barnyard millet (whole) sample (10–11% moisture, wb) was given hydrothermal treatment by soaking (up to 30% moisture content), steaming for different time period (1, 2, 3, 4, 5 and 6 min) followed by drying to 11-12% moisture (at 50-60°C) (Fig. 42).

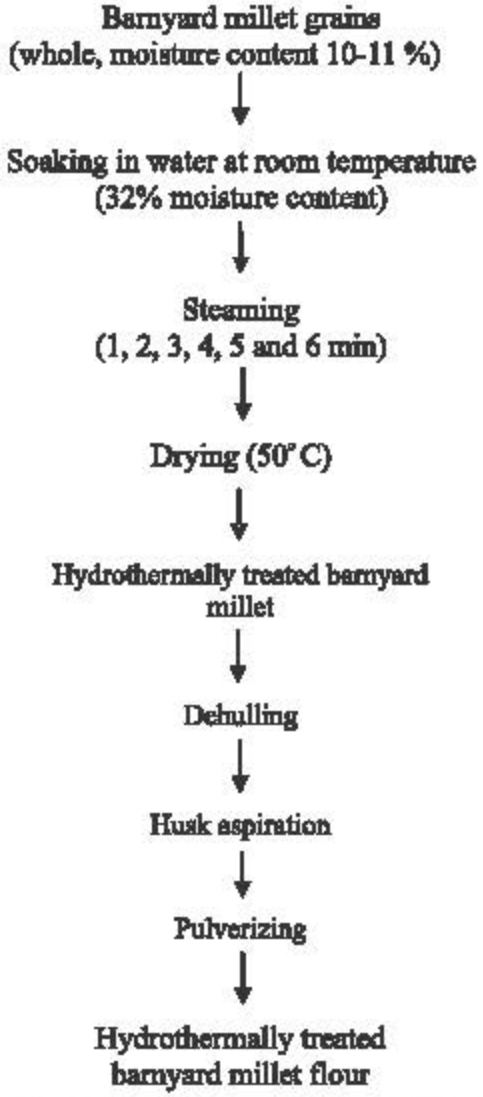


Fig. 42. Process flow chart for preparing barnyard millet flour with enhanced shelf life

The flour samples obtained from untreated as well as hydrothermally treated barnyard millet were analyzed for peroxidase activity (spectrophotometric method), pasting properties, water absorption index, water solubility index (WSI) and instrumental colour (L, a, b).

The effect of hydrothermal treatment on peroxidase activity, water absorption and water

solubility index and colour (L, a, b and YI values) are shown graphically in Fig. 43, 44, 45 and 46, respectively. It is observed that hydrothermal treatment decreased the peroxidase enzyme activity significantly from 0.323 (rate of change in absorbance per min) in the untreated sample to 0.011 in hydrothermally treated sample steamed for 1 min only. Further increase in steaming time decreased the peroxidase activity significantly from 1 min to 5 min. There was however, no significant reduction in enzyme activity when the steaming time increased to 6 min. Hence in the hydrothermal treatment the steaming time for 5 min may be selected based on the effect on enzyme activity.

Hydrothermal treatment increased the WAI with steaming time up to 2 min and then decreased. The WSI of samples increased with hydrothermal treatment. The pasting properties of the millet samples decreased with the hydrothermal treatment. Hydrothermal treatment of barnyard millet resulted into increase in darkness and increase in yellowness of the grains.

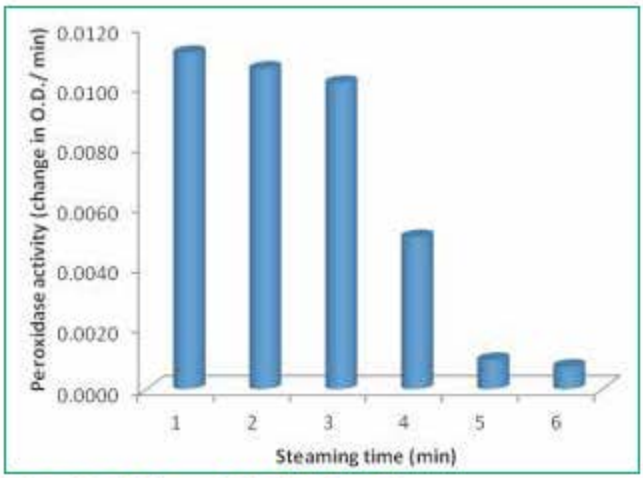


Fig. 43. Effect of hydrothermal pretreatment on peroxidase activity in barnyard millet flour

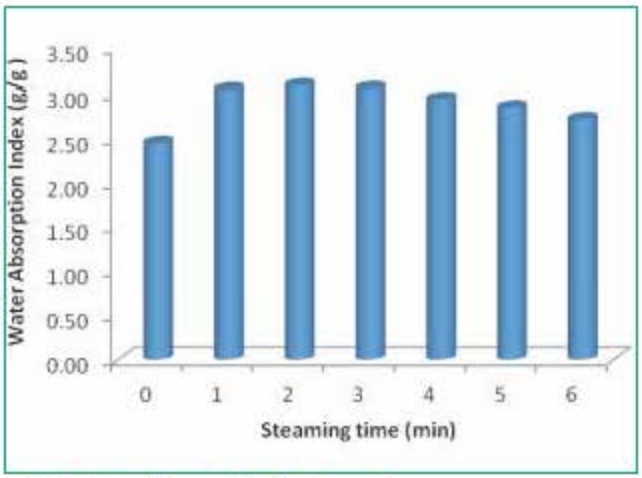


Fig. 44. Effect of hydrothermal pretreatment on water absorption index of barnyard millet flour

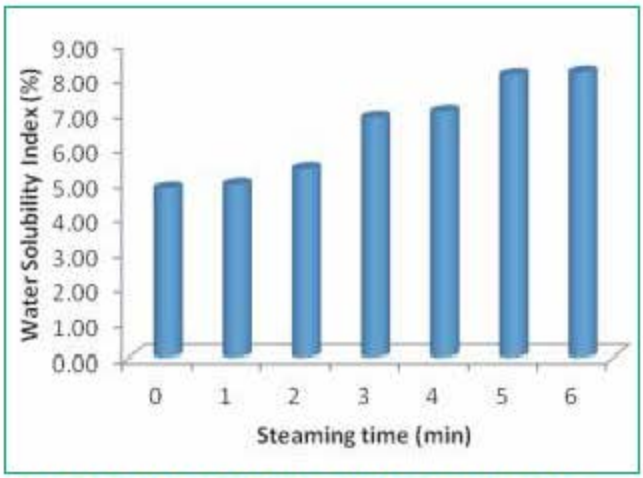


Fig. 45. Effect of hydrothermal pretreatment on water solubility index of barnyard millet flour

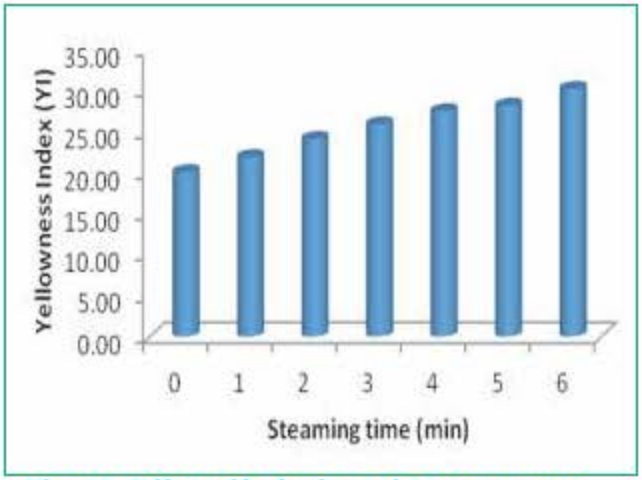


Fig. 46. Effect of hydrothermal pretreatment on yellowness index of barnyard millet flour

Development of functional & convenience foods based on maize & sorghum

Monika Sharma and Mridula D.

Coarse cereal based protein rich extruded snack food product

Extrusion is the process by which the starchy and/ or proteinacious materials are plasticized by combination of heat, mechanical shear and pressure. Extruded snacks were prepared from coarse cereals i.e. maize and sorghum along with rice and legumes viz. bengal gram and soybean chunks etc. Extrusion was performed on co-rotating twin screw extruder (7.5 HP motor, 400 V, 50 cycles, L-TSE model, Basic Technologies Private Ltd. Kolkata) with die opening of 3.55 mm. The process parameters viz. die head temperature (90–110°C), screw speed (330-350 rpm) and feed moisture content (14–18% wet basis) were optimized through central composite rotatable design (CCRD) for developing protein rich multigrain extruded snacks. The extruder was through feeder speed of 23 rpm and feed rate 10.5 kg/h. Steady state conditions we achieved in 20 minutes. Extrudates were collected and dried at 40°C for 30 min in a tray drier. Based upon the statistical analysis of the data, the optimized conditions with highest desirability level (=0.93) were 14% feed moisture content, 110°C die head temperature and 342.4 (342) rpm screw speed. This optimized solution was further validated by analyzing the dependent variables for the sample extruded at the above mentioned conditions. The protein content in the developed multigrain extruded snack were 15.50% with 72.11% *in vitro* protein digestibility. Also the calories in the extrudates are 377.01 kcal/100g, thus it can be concluded that the product has great potential in combating protein-calorie malnutrition. Also, the multigrain approach viz. combination of cereals and legumes is very successful for developing protein rich extruded snacks.

Protein rich complementary food mix

Complementary food mix was developed from extrusion processing of maize, sorghum and legumes. The process parameters viz. die head temperature (90–110°C), screw speed (330-350 rpm) and feed moisture content (14–18% wet basis) were optimized through central composite rotatable design (CCRD) for developing protein rich complementary food mix. Based upon the statistical analysis of the data, the optimized conditions with highest desirability level (=0.93) were 14% feed moisture content, 110°C die head temperature and 342.4 (342) rpm screw speed. The extruded sample prepared under the optimized extrusion conditions was powdered and carrot powder and whey protein concentrate were also added to increase the nutritional value. The optimized mix was analyzed for proximate composition and mentioned in Table 25. The developed mix contains more than 25% protein content and possesses good sensory acceptability, thus can be suitably used as complementary food mix. The developed mix can also be used as a protein supplement for children even above 3 years of age.

Table 24. Quality characteristics of coarse cereal based extruded products

Parameters	Values
WSI	20.92 to 45.37%
WAI	3.74 to 5.22g/g
Expansion Ratio	2.64 to 3.18
Bulk density	87.14 to 158.90g/cc
Hardness	23.27 to 68.17N
Breaking strength	1.063 to 5.94 N
L value	67.09 to 70.93
a value	4.27 to 5.45
b value	23.96 to 33.10
Hue	78.19 to 82.19
Chroma	24.54 to 33.44
Overall acceptability	7.1 to 8.2
Peak viscosity	94.5 to 234.5 cP

Table 25. Proximate composition of nutritious complementary food mix

Parameters (w.b.)	Values
Moisture, %	4.47
Ash, %	3.198
Protein, %	25.13
Fat, %	3.43
Carbohydrates, %	63.77
Crude fibre,%	4.83
Calcium, mg/100g	271.64
Iron, mg/100g	4.98
In vitro protein digestibility, %	87.11
Calories, kcal/100g	386.45

Fig. 47. Coarse cereal based protein rich extrudates

Fig. 48. Nutritious complementary food mix

Development of fat replacer & hydrocolloid from pearl millet and barley

Monika Sharma, DN Yadav & AK Singh

Process standardization for starch isolation from pearl millet

Starch isolation process has been standardized form HC-10 variety of pearl millet flour (60 BSS) at 4000 rpm with the 4-5 centrifugation cycles and the detailed process has been mentioned in Fig. 49.

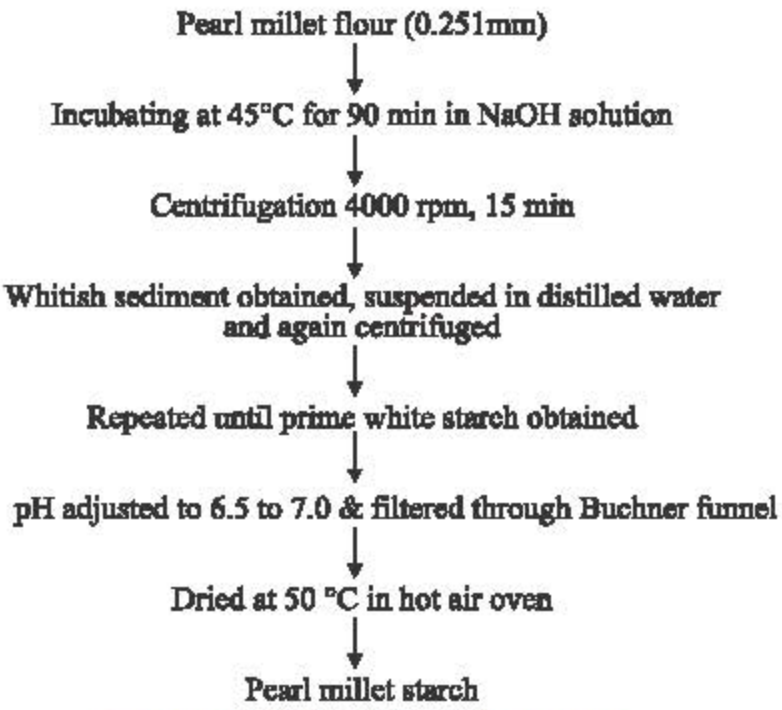


Fig. 49. Process protocol for starch isolation from pearl millet

Characterization of pearl millet starch

Characterization of pearl millet starch was done for physical, chemical, functional (like WAI, WSI, ES, EC and OAC index), structural (Scanning electron microscope), rheological (Loss modulus, storage modulus, pasting characteristics) and thermal properties (using differential scanning calorimeter). The isolated pearl millet starch was evaluated for its chemical composition and it contained 97.39% starch (db), 2.412 % ash (db), 0.182 % protein (db) and 0.016% fat.

Functional properties of native pearl millet starch

Properties	Mean value
Resistant Starch (RS)	2.41 %
Dextrose Equivalent (DE)	0
Water Absorption Index (WAI)	208.66 %
Water Solubility Index (WSI)	5.96 %
Oil Absorption Capacity (OAC)	1.31
Emulsion Capacity (EC)	94.0
Emulsion Stability (ES)	100.0

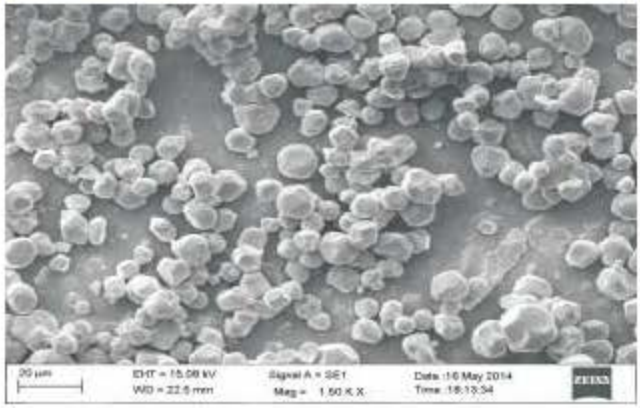


Fig. 49. SEM scan of pearl millet starch

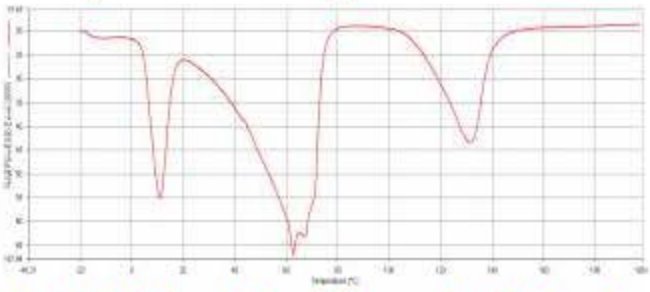


Fig. 50. DSC graph for native pearl millet starch

Primary processing and value addition of pseudocereals

S.K. Alakula Kudos, Mridula D. and R.K. Gupta

Determination of physicochemical properties of buckwheat

Buckwheat is a pseudocereal crop, belonging to the genus Fagopyrum of the family Polygonaceae, which is produced all over the world. In India, buckwheat is a traditional crop of the high altitude Himalayan region having multifarious utility. It is highly nutritive and is also important as a pharmaceutical plant. Physical properties of these buckwheat (*Fagopyrum esculentum*) seeds have been determined as a function of seed moisture content, varying from 9.89–20.48% (db). Length, width, thickness and geometric mean diameter of buckwheat seeds increased significantly ($p<0.01$) from 5.29 to 6.02mm, 3.69 to 4.16mm, 3.34 to 3.71mm and 4.02 to 4.52mm, respectively with increase in moisture content. Sphericity had significant differences with moisture content of the seed. The values ranged from 0.75 to 0.79. Thousand seed weight increased linearly from 24.26 g to 26.61 g. A linear significant increase of seed surface area (S) from 51.04 to 64.57 mm^2 was observed at the studied moisture range. Bulk density (ρ_b) and true density (ρ_t) decreased linearly ($p<0.01$) from 669.10 to 615.38 kg/m^3 and 1136.88 to 1111.11 kg/m^3, respectively. But the porosity increased significantly ($p<0.01$) from 41.15 to 44.62%. The experimental results of angle of repose showed a significant increase of 25.45° to 28.78°. At all moisture content levels, the static and dynamic coefficient of friction were maximum on mild steel surface and minimum on glass surface. The coefficient of internal friction increased linearly from 0.753 to 0.891. These properties determined at the studied moisture content would be helpful in designing the equipment for handling, transportation, processing and storage of buckwheat.

Cleaning and grading of buckwheat

Sorghum cleaner was adopted for cleaning the buckwheat seeds and the efficiency of the machine was determined as 78%. Perforated metal screens of round openings having 4.5mm and 1mm diameter were used for cleaning and grading of buckwheat seeds. The pedal cum power operated screen cleaner cum grader was adopted for the purpose of grading buckwheat seeds. The capacity and the efficiency of the grader were determined as 20kg/h and 84%, respectively by manual (pedal) operation.

Dehulling of buckwheat

Buckwheat dehulling was carried out using lab model abrasive dehuller (single abrasive disc) at different moisture content and residence time. Maximum dehulling efficiency of 56.34% was obtained at 9.89% moisture content at the residence time of 60s. Sorghum dehuller (single abrasive

roller) and millet pearler (multiple abrasive discs) were also adopted for buckwheat dehulling. Reduction in dehulling efficiency of sorghum dehuller was observed with increase in moisture content. The dehulling efficiency was 55.70% at 8.6% mc. and reduced to 52.76% at 11.25% mc. The millet pearler with multiple abrasive discs gave 45.92% dehulling efficiency at 11.4% mc.

Dehulling of hydrothermally treated buckwheat

The effect of hydrothermal treatment of buckwheat seeds on its hullability was determined. Duration for soaking and steaming of buckwheat seeds were kept as 0min, 15min and 30min, 5min, 10min and 15min, respectively for this study. The results showed the maximum dehulling efficiency of 70.1% for the seeds soaked for 30min and steamed for 15min. The dehulling efficiency of completely parboiled seeds (T10) was determined as 70.6% (Table 26).

Effect of hydrothermal treatments on the antioxidant properties

The effect of hydrothermal treatments on the antioxidant properties namely total phenolic content, flavonoids and radical scavenging activity were determined. The results showed that the individual effects of soaking, steaming and the interactive effect of soaking and steaming were significant on the antioxidant properties of buckwheat flour. The total phenolic content of the treated buckwheat flour ranged from 363.06 to 523.71 mg gallic acid equivalent/100g dry matter, the flavonoid content ranged from 188.48 to 419.65 mg/100g dry matter. Total phenolics and flavonoids were found to increase with the duration of steaming. The radical scavenging activity in terms of 2,2-diphenyl-1-picrylhydrazyl (DPPH) of the treated samples were found to be in the range of 52% - 70%.

Design and development of oat dehuller

S.K. Aleksha Kudos and Anil Kumar Dixit

Experiments were conducted to evaluate the performance of sunflower dehuller (impact type) for dehulling of oats at 8.12 % and 13.33% moisture content. The dehulling efficiency was found higher (67.76%) at 8.12% mc than at 13.33% mc (37.94%). The overall efficiency of the dehulling system was also found higher at reduced moisture content. The values were 59.52% and 20.97% at the mc of 8.12% and 13.33%, respectively. The dehulling efficiency as a result of hydrothermal and kilning treatment of oats was 46% and 45.8%, respectively.

Table 26. Effect of hydrothermal treatments on dehulling of buckwheat

Treatments	Colour quality of flour			Dehulling efficiency,% based on Kupritz formula			Overall efficiency of dehulling system,%
	Lightness	Hue	Chroma	Coefficient of hulling	Coefficient of wholeness of kernel	η,%	
T1 (0/5)	83.61	1.48	8.18	94.98	0.37	35.23	61.60
T2 (0/10)	85.27	1.47	8.69	95.47	0.43	41.17	64.28
T3 (0/15)	89.36	1.47	8.66	95.36	0.38	36.10	61.35
T4 (15/5)	87.64	1.46	10.01	92.41	0.29	26.39	53.44
T5 (15/10)	86.78	1.50	10.5	94.51	0.58	54.90	64.12
T6 (15/15)	86.56	1.47	11.08	95.83	0.46	44.32	59.38
T7 (30/5)	87.63	1.47	10.68	92.96	0.3	27.54	52.92
T8 (30/10)	87.32	1.43	10.29	94.55	0.5	47.02	57.75
T9 (30/15)	84.1	1.46	11.01	96.69	0.68	65.49	70.10
T10	80.24	1.39	13.48	98.45	0.59	58.25	70.58

HORTICULTURAL CROPS PROCESSING DIVISION

A value chain on commercial exploitation of underutilized fruits of tribal zones of Rajasthan

P. C. Sharma and Ramesh Kumar

Optimization of method for extraction of *jamun* pulp

Different pulp extraction techniques (hot and cold process) were tried to assess the quality and recovery of pulp from *jamun* fruit. In hot extraction method, *jamun* fruit were heated for 5 min. to separate the pulp from the seed and then passed through the pulper to extract the pulp while in cold extraction, the fruits were directly passed through the pulper without any heating. Hot extraction was found most appropriate as it resulted in higher pulp recovery (68%) with deep purple colour. Cold extraction method, on the other hand gave 63% pulp yield (Table 27). The quality parameters in hot and cold extracted jamun pulp were found to be 12.0 and 12.8°B TSS, 1.18 and 1.33 % acidity, 3.35 and 2.27 pH, 0.718 and 0.881 OD at 632 nm (Phenols), respectively. Total antioxidant capacity of hot extracted pulp was higher (0.213 OD at 517 nm) as compared to cold extracted pulp (0.211 OD at 517 nm).

Fig. 51. Extraction of *jamun* pulp in process

Table 27. Physico-chemical properties of *jamun* pulp

Pulp quality parameter	Pulp extraction techniques	
	Hot extraction	Cold extraction
Pulp recovery (%)	68	63
TSS (°B)	12	12.8
Acidity, %	1.18	1.33
Colour value L	14.57	17.73
a	87.85	102.13
b	- 5.28	- 6.56
pH	3.35	2.27
Phenol (OD at 517)	0.718	0.881
Total antioxidant capacity (OD at 632)	0.213	0.211

Storage stability of *jamun* RTS beverage

Mint based *jamun* RTS beverages were prepared with 12°B TSS, 0.25 % acidity and 5.0% mint extract. The end product was evaluated for sensory quality and shelf life under ambient condition. Both TSS and acidity did not change much upto second month of storage thereafter increased gradually and reached a maximum value of 12.6°B for TSS and 0.28% for acidity after six month of storage (Table 28). Vitamin C decreased while browning increased during storage. Though, there was progressive decrease in sensory quality of the product yet the beverage was still highly acceptable upto four months of ambient storage.

Fig. 52. Mint based *Jamun* Beverage

Effect of 1-MCP and chitosan coating on keeping quality of *ber*

Ber fruits harvested at mature green stage were treated with 1-MCP at 600 nl L^{-1} for 12 hours and 2 %

Table 28. Effect of storage period on quality of *Jamun* RTS beverage

Storage period (months)	TSS (°B)	Acidity (%)	Vitamin C (mg/100g)	NEB (OD at 420 nm)	Mean sensory score
0	12.0	0.25	8.13	0.018	8.66
1	12.0	0.26	7.74	0.021	8.56
2	12.1	0.26	7.09	0.028	8.12
3	12.2	0.27	6.91	0.039	7.65
4	12.4	0.27	6.40	0.047	7.14
5	12.6	0.28	5.25	0.061	6.41
6	12.6	0.28	4.34	0.084	5.37

chitosan solution alone or in combination of both. The treated fruits were stored under ambient condition. The result showed that both 1-MCP and chitosan coating were quite effective in delaying the fruit softening and ripening. Maximum extension in shelf life of ber fruit was noticed when the fruits were treated with the combination of both. However, 1-MCP alone doubled the shelf life (14 days) of ber as compared to control sample, which lasted only for 7 days. Biochemical parameters were better maintained in the fruits treated with either treatment as compared to untreated fruits. The storage life of chitosan treated fruits increased by 5 days and enhanced further to 8 days when the fruits were treated with the combination of both (Fig. 53). 1-MCP delayed the degreening process but did not control the decay loss. Whereas, chitosan coating reduced fruit spoilage as compared to all other treatments.

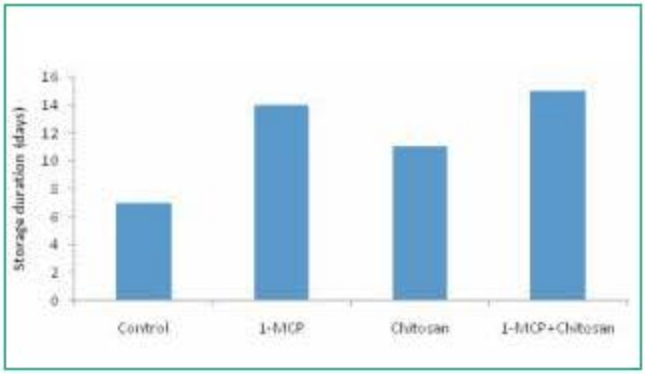


Fig. 53. Shelf life of ber as affected by 1-MCP and chitosan coating

Evaluation of compact fruit grader for oblong and round fruit

Compact fruit grader was designed and evaluated for its performance by grading *ber* fruit variety Umran. The machine was operated continuously by running at three different speeds (16, 24 and 32 rpm) for 2h. The machine consists of rotating disc at a specific inclination with four grading boards. The grading efficiency of the machine decreased with the increase in the speed of the rotating disc and the highest grading efficiency of about 90% was observed when the machine was operated at a speed of 16 rpm (Table 29). This machine has the capacity of 303, 375, and 460 kg/h with grading efficiency of around 90, 74 and 65 %, respectively. The machine grades the fruit in four different grades viz. <25 mm, 25-30mm, 30-35mm and >35mm diameter. The machine is most suited for both oblong and round fruits and is operated by 1hp electric motor.

Table 29. Performance of compact fruit (ber) grader at different speed.

Speed (rpm)	Capacity (kg/h)	Efficiency (%)
16	303	89.72
24	375	73.56
32	460	65.06

Fig. 54. Compact fruit (*Ber*) grader

<25mm 25-30mm 30-35mm >35mm

Fig. 55. Ber fruits graded by the developed machine

Development of process technology for browning inhibition, novel product development and by product utilization of pear

Ramesh Kumar, P. C. Sharma and Sunil Kumar

Effect of ripening stage on browning and tissue firmness of fresh cut pear

Ripeness of pear fruit was assessed for mechanical slicing and subsequent storage of slices with least browning. For this, pears were placed at 20°C for varied length of time to obtain the different ripeness stage and then were sliced after attaining three level of maturity viz. no ripening (75 N), ripened to an average firmness of 59 N and over ripened to a firmness of 43 N (Table 30). Both sweetness and browning index increased while vitamin C decreased with the advancement of fruit ripening. Pear sliced at 43 N taste good but it was too soft to withstand the mechanical slicing. Browning index at this stage was found to be highest (61.24) among all other ripening stages. Slicing at higher firmness (75 N) resulted in least browning of slices but texture was unacceptably hard for fresh eating with poor flavour. Firmness of 59 N was found more appropriate for slicing of pear. Pear at this firmness sliced well and had acceptable colour, flavour and sweetness.

Mechanical slicing of pear

Table 30. Effect of ripening stages on quality of pear

Fruit properties	Ripening stage for slicing		
	Mature green	Partially ripe	Fully ripe
TSS (°B)	13.23	13.89	14.60
Acidity (%)	0.34	0 .31	0.29
pH	4.07	4.13	4.32
Vit. C (mg/100g)	7.11	4.30	3.23
Browning index	56.38	58.53	61.24
Firmness (N)	74.84	58.57	42.64

Optimization of blanching method for inhibition of PPO activity in pear

Heat stability of polyphenol oxidase enzyme of pear was investigated using steam, hot water and microwave blanching with respect to total inactivation of polyphenol oxidase activity for subsequent drying. Relative colour changes and PPO activity were studied after different blanching time. The results showed that the enzyme activity decreased with increase in the blanching time (Fig. 56). Among different methods, microwave blanching was found most effective in inhibiting the PPO activity. There was complete inactivation of PPO after 2 min of microwave blanching compared to hot water blanching, which took almost 6 min to reach the stage of total enzyme inactivation. Steam blanching for 10 min resulted in 3.8% residual activity of PPO and was least effective. Conventional water blanching resulted in more loss of water soluble vitamins. Microwave blanching was more effective in retaining the maximum nutrients except vitamin C. The results also suggested that yellowness (b value) and brightness (L value) contributed more to the browning index compared to the redness (a value).

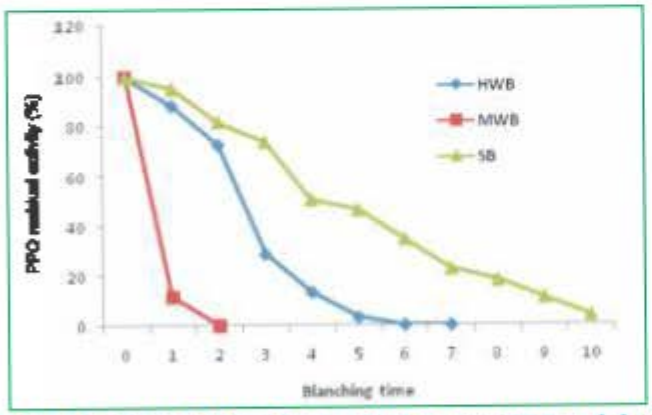


Fig. 56. Effect of blanching method on pear PPO activity

Inhibitory effect of various anti-browning agents on pear browning

Enzymatic browning impairs the sensory quality of fresh cut pear. Study was conducted to determine the effectiveness of different anti-browning agents for inhibition of enzymatic browning in fresh cut pear. The pear slices were dipped in solution containing different concentration of ascorbic acid, citric acid (0, 0.25, 0.50, 1.0) and cystein (0, 0.05, 0.25 0.50%). It was observed that antibrowning treated slices had significantly less cut surface browning compared to untreated slices. However, the effect of citric acid was only temporary and sample showed the sign of browning within 8 hr of slicing. Treatment with ascorbic acid and cystein significantly reduced enzymatic browning but the slices treated with 0.5% cystein (Fig. 57) prevents cut surface browning for a much longer period as compared to 1.0 % ascorbic acid treatment, which showed high enzyme activity within two days of storage.

Effect of onion and garlic extract on pear browning and PPO activity

Onion and garlic extract was prepared by extracting the onion juice with equal quantity of water and its effects were determined on pear polyphenol oxidase. Heated extract was obtained by boiling the extract for various times at 100°C. The browning of pear slices was retarded by both fresh and heated onion extract but it had the maximum inhibitory effect when heated extract was used for

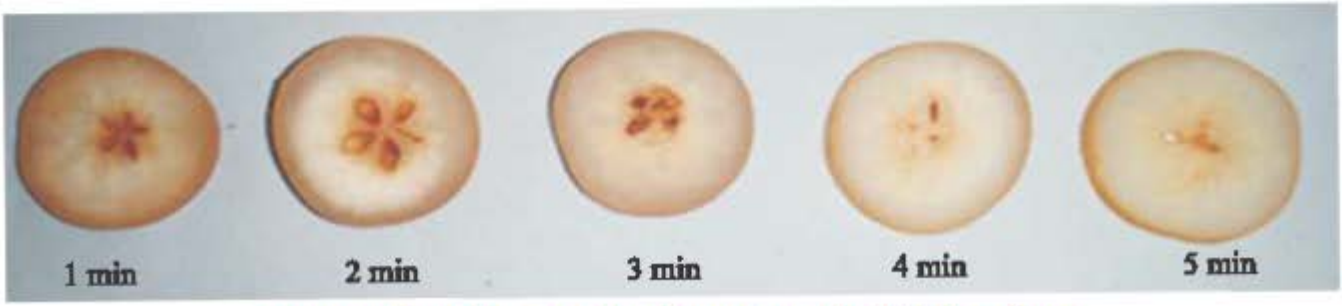


Fig. 57. Effect of hot water blanching on browning inhibition of pear

Fig. 58. Browning of pear as influenced by cysteine treatment

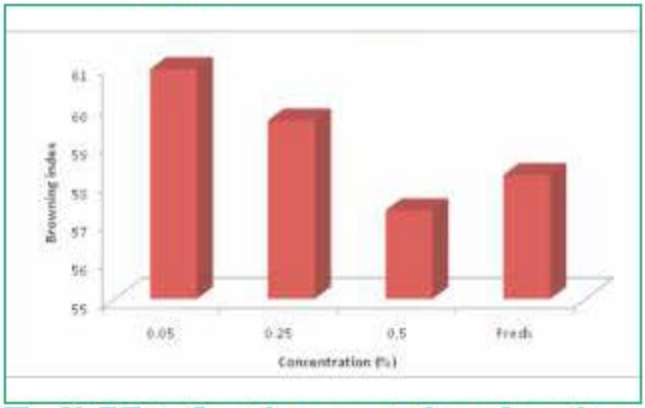


Fig. 59. Effect of cysteine concentration on browning inhibition of pear

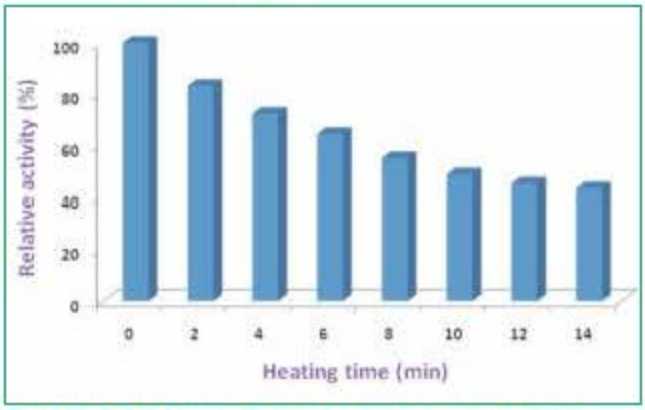


Fig. 60. Inhibitory effect of onion extract on PPO activity of pear

dip treatment. Addition of onion and garlic extract that had been heated at 100°C caused a stronger inhibitory effect on pear PPO than the fresh one. The polyphenol oxidase of pear was inhibited by onion extract and this inhibitory effect of polyphenol oxidase increased with the increase in the temperature and time of heated extract (Fig. 60). The extract heated for 10 min reduced the PPO activity by 43% and further increase in heating time had little or no effect on enzyme inhibition. Though dipping of slices in the extract impaired the sensory quality of the fruit but it could be a partial substitute for inhibiting pear browning by synthetic anti-browning agent.

Effect of firming agent on quality of fresh cut pear

Pear fruit discs were used to determine the efficacy of various chemical treatments ($CaCl_2$ and calcium lactate each at 0.25, 0.5 and 1.0 %) to reduce enzymatic browning and excessive tissue softening. Firmness of the pear discs proportionally increased as the level of both firming agent increased. Addition of $CaCl_2$ prevented textural deficiencies such as mealiness and loss of firmness and 1.0 % $CaCl_2$ treated slices had the highest flesh firmness value of all the treatment levels tested (Fig. 61). However, this treatment resulted in off flavour at this concentration. Although $CaCl_2$ resulted in maximum flesh firmness but 1% calcium lactate dip was found best to retain flesh firmness of pear disc while minimizing the potential for off flavours caused by use of $CaCl_2$.

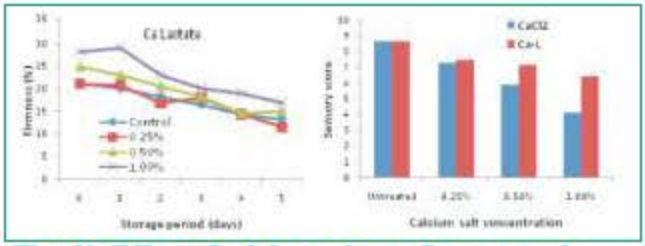


Fig. 61. Effect of calcium salts on firmness and sensory quality of fresh cut pear

Shelf life of fresh cut pear treated with anti-browning agent

Effects of various treatments were evaluated for extending the shelf life of fresh cut pears. The pear slices were dipped in a solution of 0.5% cystein (Cys) alone or in combination with 1.0% calcium lactate (Cal) for 5 min and then stored at 5°C for 10 days. Colour changes during storage was significantly influenced by the storage period. Browning of stored sample in terms of brightness, hue and chroma

decreased with the increase in the storage duration (Table 31). Substantial changes in colour were mostly observed during the first few days of storage. At the end of storage, the brightness value of fresh cut pear treated with both cystein and calcium lactate was significantly higher (67.76) compared to the slices treated with cystein alone (63.48). It was also noticed that both brightness and whiteness index equally describes the changes in fresh cut pear. Thus, the combined treatment of cystein and calcium lactate can provide 5 days shelf life when the pears were sliced at a partially ripe stage of 55N firmness.

EDP on processing of aonla for value addition

One EDP was conducted on processing and utilization of aonla into novel value added products during December 2013. Entrepreneurs from Punjab and Gujarat participated in this training programme. The training was organized in order to commercialize the technology developed for processing of aonla into different value added products like aonla candy, mouth freshener, laddoo, ready-to-serve beverages, jelly and murabba. Participants were given hand on experience for preparation of these products and were evaluated through their simulation exercise for manufacturing diversified products from aonla and other similar fruits. The participants were also exposed to machinery and tools required for establishing small scale processing units for aonla fruits.

Shelf-life enhancement of fresh-cut fruits using enzyme technology

Sunil Kumar, Ramesh Kumar and V. Eyarkai Nambi

Standardization of method for enhancing shelf-life of pomegranate arils

The experiment was conducted on pectin methyl esterase (PME) and Ca^{2+} treated arils using response surface methodology. The containers, utensils and probable surfaces likely to come in contact with the fruits/arils as well as pomegranate fruits were thoroughly washed and sanitized with 0.01% NaOCl. The experimental arils extracted manually were first washed with distilled water and then dipped in 0.01% NaOCl for 1 min. The arils were dipped in 0.05 M acetate buffer (pH 4.0) containing

Table 31. Changes in colour value during storage of fresh cut pear

Storage period (days)	Cysteine Brightness (L*)	Cys+Cal Brightness (L*)	Cysteine Hue°	Cys+Cal Hue°	Cysteine Croma	Cys+Cal Croma
0	76.47	78.47	46.19	46.03	30.74	29.33
1	71.33	75.24	45.98	46.48	31.83	28.73
2	68.12	73.61	44.97	45.36	32.80	30.86
3	70.22	72.05	45.40	46.88	32.16	30.88
4	66.30	69.51	45.77	44.70	34.14	31.77
5	63.48	67.76	44.80	46.02	34.03	32.09

food-grade PME and $CaCl_2$ and the dip treatments were performed in a water bath having 35±2 °C temperature. To overcome the problem of fungal attack, sodium benzoate (0.07%) was also added along with enzymatic treatment. Finally, a solution was prepared by mixing all ingredients (PME, $CaCl_2$ and sodium benzoate in 0.05 M acetate buffer, pH 4.0) and the arils were treated with this readymade solution to reduce reaction time and minimize leaching losses. The control arils were simply washed with chlorinated water. After treatment, pomegranate arils (treated as well as control) were drained and dried under shade with forced air. The treated and untreated arils were packed in 25 µ LDPE perforated bags. The perforation was provided by piercing 8 uniform pin holes to avoid anaerobic growth during storage. The samples were maintained under low (5°C; relative humidity 90%) and ambient (25°C with 60% RH) temperature conditions for evaluating the shelf-life. By applying optimized treatment; 249.33 units of PME along with 1.70% $CaCl_2$ for 24.93 min, the shelf-life of treated pomegranate arils could be extended by 28 d compared to control having shelf-life of 20 d under low temperature storage conditions. The shelf-life under ambient condition was 2 and 3 d, respectively, for control and treated arils.

Changes in physico-chemical parameters were assessed during low temperature storage of pomegranate arils. The changes in color values of pomegranate arils are given in Table 32. The brightness (L value) of fruit decreased with the increase in storage period, though 'L' value decreased more for treated arils compared to control, but after the lapse of considerable storage period. Similarly 'a' value which represents the red color of the fruit decreased during storage. The 'b' value, however, first increased and then decreased during storage.

The firmness of pomegranate arils decreased with the advancement of storage period (Fig. 62). The firmness of low temperature stored arils was found to be 0.511 N on 20th d for control, while the corresponding value for treated was observed to be 0.630 N on 20th d and reached at the stage of control sample (0.519 N) after 28th d of storage. So, the enzyme assisted calcium chloride treatment was found to extend shelf-life by more than 8 days compared to control. The changes in PLW were less for treated (1.20%) samples as compared to control

Table 32. Changes in colour scale (L, a, b values) of pomegranate arils during low temperature (5 °C and 90% RH) storage

Day(s) after storage	Colour scale					
	'L'		'a'		'b'	
	C	T	C	T	C	T
0	40.39±3.165	40.39±3.165	40.43±5.284	40.43±5.284	6.31±0.978	6.31±0.978
4th	37.19±4.796	38.46±3.631	41.03±1.311	41.82±2.282	15.73±5.550	16.55±2.510
8th	33.50±4.181	37.81±1.209	42.08±14.364	43.15±3.585	17.58±3.924	17.77±2.591
12$_{th}$	32.48±1.815	37.31±4.015	40.89±3.069	42.32±11.310	14.05±1.242	15.39±1.605
16th	31.64±2.419	37.63±8.879	35.98±3.247	36.12±1.111	12.59±4.215	14.25±0.514
20th	31.07±1.764	37.90±1.684	35.04±8.799	35.70±7.386	12.46±4.635	13.17±3.390
24th	32.10±0.605	36.91±2.165	28.74±2.559	31.70±0.779	13.66±2.789	13.20±1.068
28th	-	29.69±4.182	-	31.85±8.693	-	11.28±4.922
32nd	-	26.34±1.828	-	29.86±6.394	-	6.63±1.448

L, a, b represent the color scales for pomegranate arils; C= Control; T= Enzyme treated arils; Scale value±SEm; n = 3

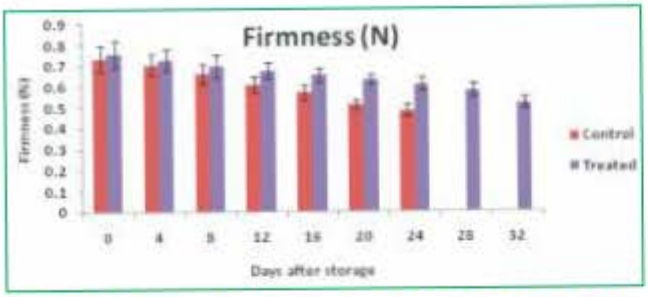


Fig. 62. Changes in firmness of pomegranate arils during low temperature (5 °C and 90 % RH) storage

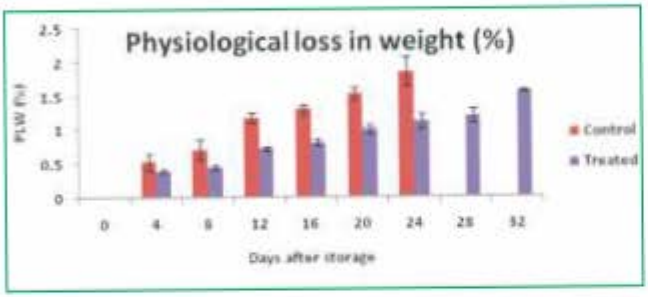


Fig. 63. Changes in physiological loss in weight of pomegranate arils during low temperature (5 °C and 90 % RH) storage

(1.53%) (Fig. 63). Thus, the physico-chemical data of the low tempearature stored pomegranate arils suggested that the simultaneous application of PME and calcium chloride was capable of making the cell wall/pomegranate arils tissue firmer enough to prevent weight losses for longer times and extended the shelf-life by 8 d compared to control under similar conditions. Sensory evaluation of the control and treated samples showed a sensory score of 7.5 and 8.0, respectively, for control and treated at 12th d of storage, while the respective coressponding values were 5.5 and 7.5 at 20th d of storage. The value decreased to 5.25 at 28th d of storage for the enzyme treated samples. So, on the basis of sensory score, the pomegranate arils could be said acceptable up to 20th d. The respective data for ambient storage have been elaborated in Table 33.

Microbial quality and biochemical parameters

No *Salmonella*, *Staphylococcus* and coliforms were present in fresh as well stored pomegranate aril samples during storage. However, total plate count increased sharply for control samples (from initial TPC of $13x10^2$ to $63x10^5$ cfu/g at 24th d) while it reached the corresponding value to control for treated samples ($62x10^5$cfu/g) on 32nd d under low temperature storage. Overall total antioxidant capacity (TAC) increased during low temperature storage for control as well as treated samples (Fig.64a). The TAC protected the control samples up to 20th d, but the treated samples survived up to 28th d of storage, though the respective increase in TAC from initial value (3929.59 nmols of ascorbic acid equivalents/g f.wt.) was 4518.91 (control) and 4918.87 (treatment) nmols of ascorbic acid equivalents/g f.wt. (Fig. 64). Ferric reducing antioxidant power (FRAP) also corroborated with TAC and increased during storage, though the increase was more in treated samples compared to control, thus, suggesting less shelf-life of control fruits in comparison to treated ones (Fig. 64b).

The surface browning of fruits is invariably attributed to enzymatic oxidation of polyphenols by polyphenol oxidases (PPOs) in the presence of atmospheric oxygen. The actvity of PPO increased continuously during storage both in control as well as treated arils, though the increase was more pronounced in control. The PPO activity increased from an initial value of 162.25 nmols of purpurogallin produced/min/g fruit weight to 512.04 on 24th d in control fruits while the corresponding value for treated arils was 404.59 nmols (Fig. 65a). The lipoxygenase (LOX) enzyme causes oxidative degradation of unsaturated fatty acids to conjugated dienes. The LOX activity also showed the similar trend during the storage period (Fig. 65b). It increased from a minimum value of 89.92 to 370.11 and 374.49 nmols of conjugated dienes produced/min/g, respectively, for control and treated pomegranate aril samples after the end of their storage period. The respective data for ambient storage have been enumerated in Table 33. From these results, it may be suggested that the simultaneous effect of PME and calcium ions might be responsible for the decreased and delayed LOX and polygalacturonase (due to improved tissue firmness) and PPO (due to prevention of enzymatic

Table 33. Physico-chemical, microbiological and biochemical profile of pomegranate arils during ambient (25 °C and 60 % RH) storage

Parameters		Control			Treated		
		0 d	2nd d	4th d	0 d	2nd d	4th d
Color	L	40.39±3.16	32.44±1.61	36.78±4.84	40.39±3.16	48.79±5.82	37.04±6.71
	a	40.43±5.28	42.77±1.94	48.82±7.78	40.43±5.28	45.08±0.46	50.50±1.50
	b	6.31±0.98	8.97±1.76	9.42±4.74	6.31±0.98	13.31±5.73	14.45±4.03
Firmness (N)		0.734±0.06	0.608±0.06	0.526±0.04	0.756±0.07	0.682±0.05	0.585±0.05
PLW (%)		-	2.56±0.04	4.66±0.22	-	1.49±0.15	1.75±0.08
TPC (cfu x10^5/g)		13±0.58	47±1.15	89.33±3.28	13±0.58	42±1.15	81.67±1.86
TAC (nmols of ascorbic acid eq/g f.wt.)		3929.59±33.56	4075.67±21.88	4672.49±16.78	3929.59±33.56	4139.01±27.74	4685.25±11.05
FRAP (nmols of Fe^{2+} eq/g f.wt.)		273.43±3.23	330.80±5.32	366.20±2.12	273.43±3.23	341.78±5.32	383.29±3.23
PPO (nmols of purpurogallin produced /min/ g f.wt.)		162.25±0.41	315.73±1.00	533.17±0.75	162.25±0.41	293.47±4.40	462.80±0.66
LOX (nmols of conjugated dienes produced/min/ g f.wt.)		89.92±5.90	192.72±5.79	420.48±3.79	89.92±5.90	186.15±3.79	383.25±5.79

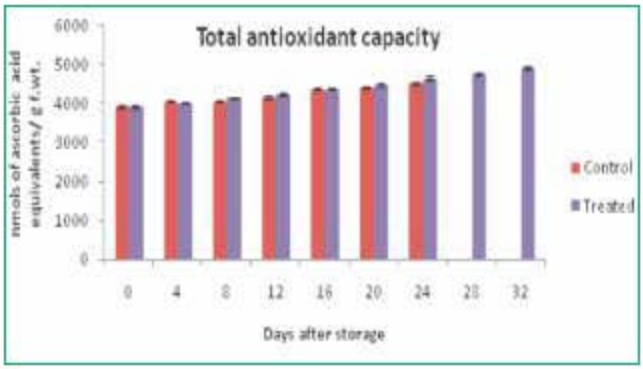


Fig. 64a

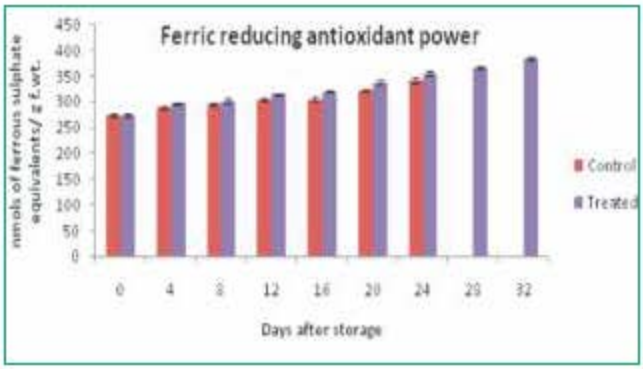


Fig. 64b

Fig. 64. Total antioxidant capacity (64a) and ferric reducing antioxidant power (64b) of pomegranate arils during low temperature (5 °C and 90 % RH) storage

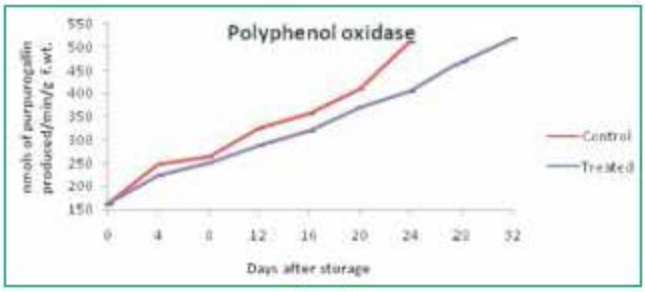


Fig. 65a

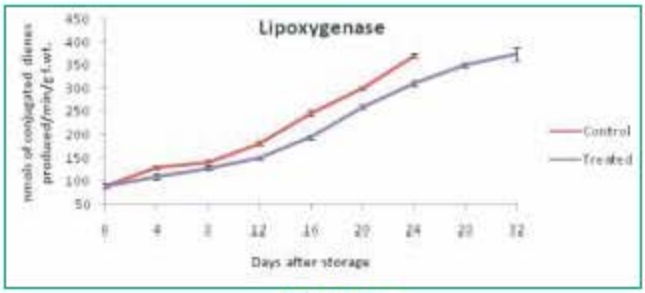


Fig. 65b

Fig. 65. Changes in polyphenol oxidase (65a) and lipoxygenase (65b) activities of pomegranate arils during low temperature (5 °C and 90 % RH) storage

browning) enzyme activities in treated pomegranate arils compared to untreated ones. It may be inferred that by applying 249.33 units of PME along with 1.70% $CaCl_2$ for 24.93 min, the shelf-life of treated pomegranate arils could be extended by 28 d compared to control having shelf-life of 20 d under low temperature (5 °C; relative humidity 90%) storage conditions (Fig. 66). The shelf-life under ambient condition was 2 and 3 d, respectively, for

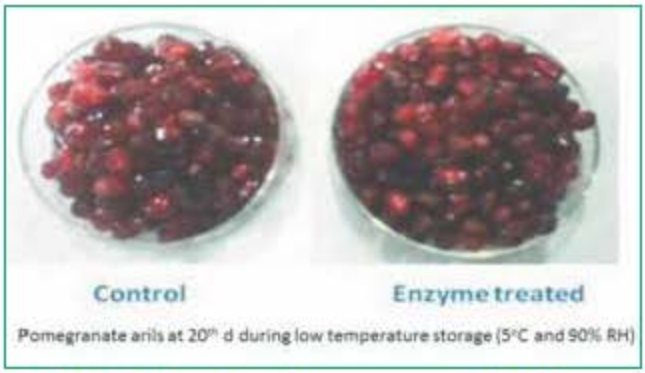


Fig. 66. Quality of stored pomegranate arils at low temperature

control and treated arils. A readymade solution has been prepared, the treatment of which (for respective standardized time), can prolong the shelf-life of pomegranate arils. The solution contains all the ingredients as unified mixture, thus, making the application process simple, user friendly, cheap, less time requiring and preventing leaching losses.

Development of process protocol for de-bittering of kinnow juice

Sunil Kumar, Ramesh Kumar and PC Sharma

Extraction and estimation of limonin and naringin

For extraction of limonin from seeds and peel of kinnow, 2.0 g each of seeds and peel, were homogenized with 50 ml of Tris buffer (0.1 M; pH 7.0). The broth was incubated at 40°C in a shaker (150 rpm) for 24 h. After 24 h, the resulting extract was filtered through two layers of muslin cloth; acidified to pH 2.0 using 5 N HCl and kept undisturbed for 15 min. To the acidified extract, added 50 ml of chloroform, mixed vigorously and allowed to stand for 30 min in a separatory funnel. For kinnow juice, 50 ml of juice was mixed directly with 50 ml of chloroform and allowed to stand for 30 min. Since limonin is fat soluble, it comes in chloroform portion while other water soluble debris comes in water (Fig. 67). The decanted chloroform was used as limonin extract. Limonin was estimated using Burnham reagent with slight modifications (Vaks and Litshitz, 1981).

Fig. 67: Phase separation between water soluble and fat soluble fractions of kinnow seed

For extraction of naringin from seeds and peel of kinnow, 2.0 g each of seeds and peel, were homogenized with 50 ml of Tris buffer (0.1 M; pH

7.0). The broth was incubated at 40°C in a shaker (150 rpm) for 2 h. After 2 h, the resulting extract was filtered through two layers of muslin cloth and centrifuged at 7000 rpm for 30 min. However, kinnow juice was filtered directly (by omitting homogenization and incubation steps) through two layers of muslin cloth and centrifuged (Eltak, India) at 7000 rpm for 30 min. The resulting aqueous extract was used as naringin extract and for estimation of total soluble protein. Naringin content was estimated colorimetrically using the method of Davis (1947). The values of various portions of kinnow (*viz.* seed, peel and juice) are given in Table 34. The data showed that limonin (6845.24 ppm/g) and soluble protein (53.86 mg/ml) were reported highest in kinnow seeds while naringin (15825 ppm/g) was reported highest in kinnow peel.

Extraction and estimation of limonoate-D-ring-lactone hydrolase (LDLH)

Kinnow seeds were extracted from kinnow fruits after their juice extraction, washed, dried under shade at room temperature, packed in LDPE bags and stored at ambient and dried place until their intended use. The enzyme was extracted by doing slight modifications of the method adopted by Breaka III and Manners (2004). The seeds were ground in 0.1 M tris (pH 8.0) extraction buffer containing 1% NaCl and 3% polyvinylpyrrolidone (omitting use of sodium dodecyl sulphate). The resulting broth was placed for 2 h in a shaker (150 rpm) and filtered through two layers of cheesecloth afterwards. The extract was centrifuged in a refrigerated centrifuge at 7000 rpm for 30 min and then

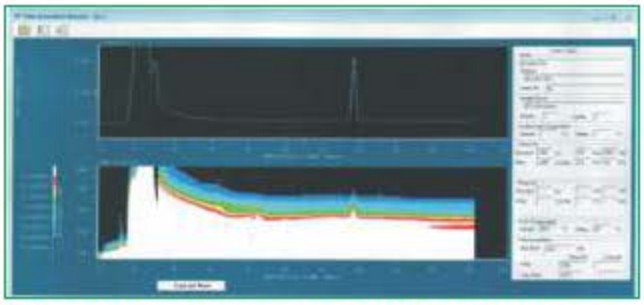


Fig. 68. Fig. showing a run for LDLH estimation by HPLC

supernatant was filtered through grade-4 filter paper. The resulting extract was then filtered through 0.45 µ nylon membrane and used for further analysis (Fig. 68).

High pressure liquid chromatography/HPLC (Model: D-2000 Elite; Make: Hitachi, Japan) consisted of reverse phase C18 column and diode array detector. For LDLH enzyme, 525 µl of tris buffer (0.1 M; pH 8.0), 350 µl of 30% acetonitrile, 100 µl of 1 mM limonin and 5 µl of enzyme extract were mixed thoroughly and incubated at 37°C in a water bath for a defined time. After completion of reaction, 20 µl of 0.25 M EDTA was added to the reaction mixture. A blank containing the above 530 µl of tris buffer (0.1 M; pH 8.0), 350 µl of 30% acetonitrile, 100 µl of 1 mM limonin and 20 µl of 0.25 M EDTA was also run simultaneously and 80 µl of each (blank and reacted) fed for HPLC analysis. The decrease in limonin concentration was monitored at 210 nm at a flow rate of 1 ml/min through diode array detector (DAD). The peak and area were quantified (Fig. 69a, b) and converted to ppm using limonin standard curve and expressed in ppm of limonin degraded/min. The control

Table 34. Biochemical analysis of various parts of kinnow

Kinnow tissue	Seed (ppm/g)	Peel (ppm/g)	Juice (ppm/ml)
Limonin	6845.24	1720.00	38.92
Naringin	2578.10	15825.00	229.92
Total soluble protein (mg/g)	53.86	8.65	*0.402

reaction mixture contained 138830 AU (absorbance unit) (Fig. 69a) and a 5 min incubation of LDLH (5 µl enzyme) could degrade the limonin to 42532 AU and the residual limonin was recorded as 96298 AU (Fig. 69b). The rate of LDLH reaction was found to be 58.8 ppm of limonin degraded/min/ml enzyme extract.

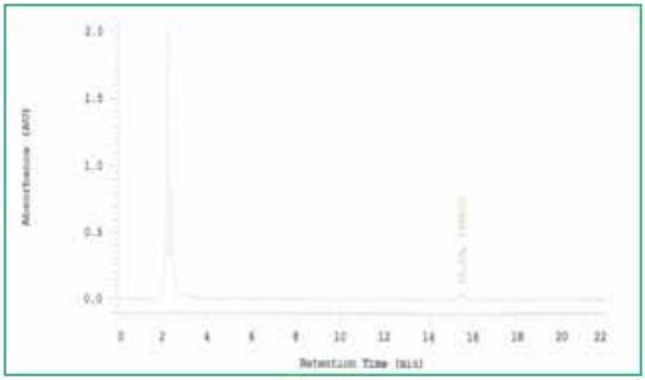


Fig. 69a

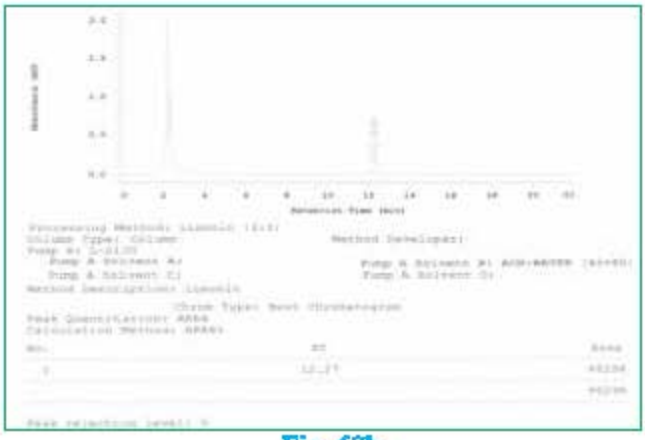


Fig. 69b

Fig. 69. Concentration of limonin fed initially (69a) and degraded by LDLH (5 µl of crude enzyme, 5 min of incubation at 37°C) (69b)

Purification of limonoate-D-ring lactone hydrolase

Total soluble protein from a lot of 1.5 kg of kinnow seeds was found to be 60440.6 mg for crude extract and 4485.7 mg for 25-85% ammonium sulphate fraction Table 35. During purification, the 25-85% ammonium sulphate fraction contained maximum LDLH activity with a fold purification of approx. 3.0 times. The specific activity for crude extract and 25-85% ammonium sulphate fraction was 7.644 and 19.671 units/mg soluble protein, respectively. The above obtained enzyme was concentrated by osmosis and dialyzed against same buffer (Tris buffer, 0.1 M; pH 8.0) for further purification and characterization (Fig. 70) using molecular exclusion chromatography.

Fig. 70. Showing process of osmosis

Extraction and estimation methods of limonin, naringin and LDLH have been standardized. The data showed that limonin (6845.24 ppm/g) and soluble protein (53.86 mg/ml) were reported highest in kinnow seeds while naringin (15825.00 ppm/g) was reported highest in kinnow peel. The rate of

Table 35. Summary of purification of LDLH

Purification step	Total volume (mL)	Total protein (mg)	Total activity (units)	Specific activity (units/mg protein)	Fold purification	Yield
Crude extract	7800.0	60440.6	458640.0	7.644	1.0	100.0
Ammonium sulphate saturation (25-85%)	1026	4485.7	88236.0	19.671	2.57	19.24

LDLH reaction was found to be 58.8 ppm of limonin degraded/min/ml enzyme extract

Shelf life enhancement and quality improvement of litchi fruit by controlling pericarp browning using enzyme technology

Bharat Bhushan and PC Sharma

Phospholipase D is a key enzyme involved in initiation of membrane deterioration. Inhibition of its activity prevents the destabilization of the membranes and accumulation of neutral lipids which increases the longevity of the crop products. Standardization of phospholipase D (PLD) enzyme extraction and estimating activity assay in the litchi related class of fruits like pomegranate arils has been completed. Enzyme inhibition studies of PLD enzyme in presence of selective reagents have been started and preliminary trials have been successful using chemical mediated inhibition technology to control the enzyme. For example, inositol, glycerol and isoamyl alcohol (methyl-butanol) treatments have been used at a concentration of one percent and fruit samples were immersed in the solution for 15 min. The dip treatment have proven them as potent inhibitors of the activity of this enzyme. The immersion method has been chosen because it is easy to perform and effective.

Development of poly-house structure using earth air heat exchanger for mushroom cultivation in semi-arid region

Jitendra Singh and Bharat Bhushan

A specific poly-house structure of 8 x 4 x 3 m size was constructed. Whole poly-house structure was covered by two layers of the black polythene (250μ) and in between polythene layers 12" thick straw material (farm waste) was sandwiched to insulate and create suitable microclimate inside the poly-house. PVC pipes of 20 feet length and 63 mm dia were assembled in a serpentine manner and buried in 1.5 m depth from earth surface to allow exchange of under-ground heat. One end of the assembled pipes was connected with electric blower (450 W) while other end was protectively opened inside the poly-house to allow continuous exchange of prevailing under-ground temperature. Mushrooms being sensitive to the biotic and abiotic (climatic) conditions, its cultivation requires many adjustable facilities, which must provide the appropriate environment required for mushroom growth. Mushroom cultivation under poly-house conditions in semi-arid region was found quite feasible with certain seasonal modifications.

Fig. 71. (a) Compost pasteurization unit (b) Passage (c) Mushroom production unit

Developed poly-house structure (Fig. 71) can be used for round the year mushroom production. During summer months (April-Sep) *Pleurotus* (spp.) mushroom such as, *P. ostreatus* and *P. sajor-caju* were grown successfully on wheat straw compost (substrate) under poly-house conditions. Evaporative cooling and exhaust ventilation for 8-10 hrs in day time was found sufficient to maintain temperature between 25-32°C, relative humidity 70-98% and optimum O_2 and CO_2 concentrations. Similarly, optimum growth of button mushroom (*A. bisporus*) can be achieved during winter months (November-March) using 6-8 h exhaust ventilation for gaseous exchange in day hours. Low tunnel poly-house or earth air heat exchanger was found useful for warming of the poly-house to maintain temperature 18-26°C. Comparatively, low tunnel polyhouse was found more useful, in terms of energy consumption for warming and improved performance in compost pasteurization.

A. bisporus should be spawned during first fortnight of the November month for maximum yield due to temperature variations from November to March, which is incidently required for mushroom growth and development. Among the cultural

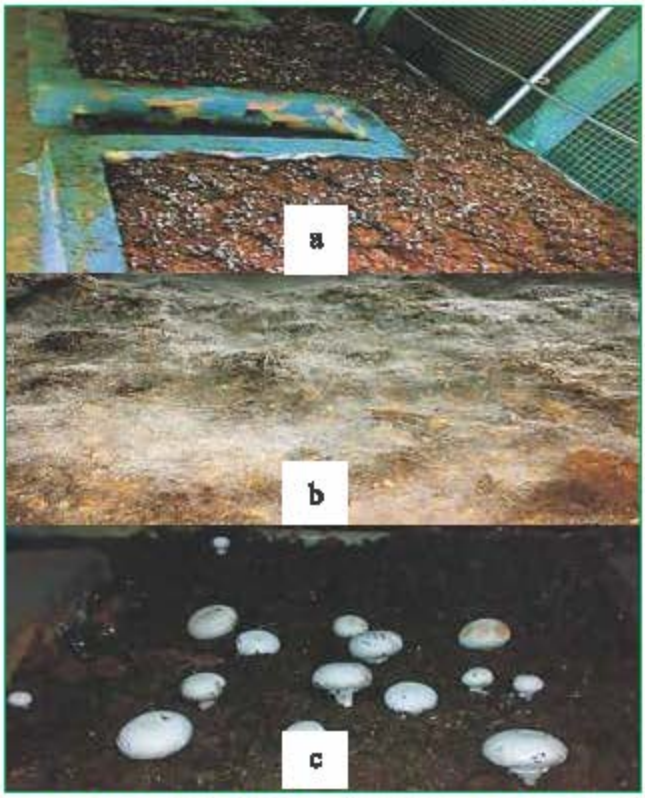


Fig. 72. (a) Spawning (b) Spawn run and (c) Fruit body formation of *A. bisporus* (first flush)

Fig. 73. (a) Polybags (b) Spawn run in crates (c) Fruit body formation

practices, such as use of quarries (Fig. 72 a, b and c), polybags and crates (Fig. 73 a, b and c), crates were found more convenient and suitable for spawn run and gaseous exchange and optimum growth of fruiting body.

Temperature during standard weeks of the winter months (Nov-Jan) were compiled in average ranges and comparative results were evaluated (Table 36-38). Earth air heat exchanger was used to raise temperature inside the polyhouse during winter season. Conceptually, it was only installed for warming of the polyhouse in night hours i.e. 09:00 PM to 09:00 AM. Outlet temperature of the earth air heat exchanger was found static between 26-27°C throughout the year. Temperature of the polyhouse was recorded before starting of EAHE. During month of November inside temperature of the polyhouse ranged from 20-25.5°C at 09:00 PM i.e. before starting of EAHE and application of EAHE for 12 h was found applicable to raise inside

Fig. 74. Growth of *P. sajor-caju* under polyhouse

Fig. 75. Growth of *P. ostreatus* under polyhouse

temperature up to 26°C during first and second week of November *viz.*, equal to the outlet temperature of the earth air heat exchanger at 09:00 AM. But in third and second week of November, use of EAHE could not be much more effective to enhance the inside temperature upto the outlet temperature of EAHE. However, temperature varied from 24.0-26.0°C inside the polyhouse in day hours (11:00 AM to 5:00 PM) without use of EAHE, which was more than the open field (Table 36). These temperature ranges of night and day hour were found quite suitable for mushroom (*A. bisporus*) mycelium growth.

Table 36. Average temperature (°C) inside polyhouse using earth air heat exchanger, EAHE (night and day hours) and open field during November 2013

Standard weeks	Outlet air temp of EAHE	Polyhouse temp (night hrs) using EAHE		Polyhouse temp (day hrs) without EAHE		Open field temp°C	
		Night (09:00 PM)	Morning (09:00 AM)	Forenoon (11:00 AM)	Evening (5:00 PM)	Min	Max
First week	27.0	25.5	26.0	24.8	26.6	13.7	30.3
Second week	27.4	25.3	26.0	25.4	26.6	13.0	29.2
Third week	26.6	21.0	23.5	25.2	25.0	11.6	29.0
Fourth week	26.5	20.5	22.0	25.0	24.0	10.3	29.0

Table 37. Average temperature (°C) inside polyhouse using earth air heat exchanger, EAHE (night and day hours) and open field during month of December 2013

Standard weeks	Outlet air temp of EAHE	Polyhouse temp., night hrs using EAHE		Polyhouse temp, day hrs without EAHE		Open field temp°C	
		Night (09:00 PM)	Morning (09:00 AM)	Forenoon (11:00 AM)	Evening (5:00 PM)	Min	Max
First week	27.5	17.0	21.0	20.0	18.4	8.2	23.3
Second week	27.0	16.0	20.2	20.4	17.6	7.4	22.6
Third week	26.0	17.0	20.0	18.2	18.0	5.2	21.0
Fourth week	26.0	14.5	19.2	17.5	17.0	3.2	19.0

Table 38. Average temperature (°C) inside polyhouse using earth air heat exchanger, EAHE (night and day hours) and open field during January 2014

Standard weeks	Outlet air temp of EAHE	Polyhouse temp., (night hrs) using EAHE		Polyhouse temp (day hrs) without EAHE		Open field temp°C	
		Night (09:00 PM)	Morning (09:00 AM)	Forenoon (11:00 AM)	Evening (5:00 PM)	Min	Max
First week	27.0	14.0	19.5	17.0	17.4	3.5	18.3
Second week	27.0	16.3	18.0	16.0	18.6	6.0	21.2
Third week	26.7	19.5	20.7	17.2	22.0	12.6	24.0
Fourth week	26.0	21.0	22.2	22.0	23.0	13.9	26.6

Comparatively, low temperature range 14-17.0°C was recorded inside the polyhouse during December at night hours, before starting of the EAHE. Application of EAHE was also found moderately effective in December to increase temperature only up to 2-3°C (Table 37). Temperature between 15-20°C was found favourable for the primordial and fruiting body formation (reproductive growth) of *A. bisporus*.

Oyster mushrooms and *P. sajor-caju (P. ostreatus)* (Fig. 74, 75) can be cultivated under polyhouse conditions in summer months and similarly, button mushroom (*A. bisporus*) should be best grown in crates during winter season. Thus, round the year mushroom production can be carried out under polyhouse conditions.

Optimization of suitable coloured plastic mulch for the repulsion of insect pests in vegetable crops

Jitendra Singh and Bharat Bhushan

Suitability of coloured plastic mulch was evaluated for the repulsion of insect-pests in capsicum field (Fig. 76). The seedlings of capsicum (Indra hybrid) were transplanted on raised beds (1 x 5

m) at 50 x 50 cm plant to plant and row to row spacing under drip irrigation. Six types of different coloured plastic mulches (black ordinary, black reflective, blue, green, red and yellow) along with unmulched (control) were used in three replicates. Highest aphid (550-620 aphid/plant) attack was found in yellow plastic mulched plots and in control (350-400). Whereas, least number of aphid counts were found in green (30-50), blue (30-50) and black plastic (70-85) mulched plots. In terms of plant growth, more number of branches and leaves were found in green mulched plots, followed by blue and black plastic mulched plots. Similarly, in yellow and red colour mulched plots more weed density was observed. Whereas, no weed growth was found in black, green and blue plastic mulched plots. In control plots, stunted plant growth with more pest infestation and weed growth (dry weight ~1.8kg/plot) were observed. Earliest flowering and fruiting were found in green plastic mulched plots, which were followed by red and black mulch treatments. Monthly average temperature of the black ordinary poly-films (surface) was found highest (30-50°C) from Dec-March, whereas, reflective black poly film indicated similar temperature as in red, green and blue poly films (15-43°C). On the other hand lowest surface temperature was observed in yellow poly-film i.e. 14-41°C (Dec-March); while in control plots, it was 16-40°C. Similarly, during winter (Dec-March), more soil temperature (13-25°C) was achieved under different plastic mulches as compared to control (11-21°C).

Fig. 76. Different coloured plastic mulching in capsicum field

Almost similar and maximum yields were found in silver black (3.8 kg/plant) and green (3.4 kg/plant) plastic mulched plots, followed by black (3.2 kg/plant) blue (2.9 kg/plant) and red (2.8 kg/plant). This study indicated that the silver black, green, blue and ordinary black plastics can be recommended for mulching in capsicum field.

Effect of over tree sprinklers, foggers and colour shade nets to reduce heat stress to pomegranate crop in semi-arid region of Punjab

Jitendra Singh and Bharat Bhushan

Pomegranate fruit damage due to sunburn and fruit cracking have been reported upto 40-50%, which leads to less attraction in market and finally economic losses. To overcome this problem, coloured shade nets, over tree sprinkler, fogger, borax and kaolin were evaluated in pomegranate orchard (Fig. 77). Three colour shade nets of green (35% & 50%), red (50%), black (50%) and an insect net of 50 mesh size were installed over the four plants of pomegranate at 3 m height, using bamboo frame.

Fig. 77. Pomegranate plant growth and yield under different treatments

A. Effect of shade net on plant growth

B. Open field

C. Sprinkler treatment

Fig. 78. Pomegranate plant growth and yield under different treatments

Other treatments such as over tree sprinkler and fogger were installed at 2.5 m height to create humid and cool microclimate.

Symmetrically, four plants were treated by kaolin (4%) and borax (0.4%) to protect the fruit peel against excessive solar radiation. During first year of experiment, highest fruit set and lowest sunburn and fruit cracking was achieved under black shade net house. Similarly, lowest temperature of pomegranate peel and leaves was observed under black shade net conditions i.e. 31.6°C and 32.0°C, respectively. Whereas, peel and leaf temperature was found highest in open conditions *viz.* 36.1°C and 36.4°C, respectively.

All the shade net houses remained installed throughout the year *viz.* reduced sunlight could be available for the plants, which indicated prolonged dormancy of the plants under shade nets conditions. As light intensity increased in April month, emergence of new leaves was also observed under shade nets. But comparatively there was proliferated plant growth with almost negligible flowering and fruiting under all the shade nets (Fig. 78). Among the treatments, overhead sprinkler was found quite suitable to reduce sunburn and fruit cracking. Therefore, it has been concluded that sunburn and fruit cracking can be reduced by installation of black shade net house during May month or when complete fruit set takes place. This net should be necessarily removed after harvesting to attain tangible plant growth. On the other hand use of overhead sprinkler from May to August or up to harvesting can be recommended to reduce sunburn and fruit cracking in pomegranate in semi-arid region of Abohar.

TRANSFER OF TECHNOLOGY DIVISION

Mobilizing mass media support for sharing agro-information

Indu Karki and Jitendra Singh

The year 2013-14 witnessed linkages developed with All India Radio, Jalandhar and private channels for dissemination of information and for coverage of various institute's events and technological stories. More than 100 news-clippings in leading regional and national dailies were published. You tube channel on video films prepared under the NAIP Mass media project was started for wider dissemination of films. Besides, these films were exhibited during different farmers' fairs across the country to motivate farmers and entrepreneurs. Achievements at a glance may be seen in Table 39.

Coverage in print media

As many as 102 news-items were published during this period, which included the success stories of innovative farmers, transfer of technology events, training programmes, institute activities, visits of the important personalities and new technologies etc. (Fig. 79) Coverage appeared in leading regional and national dailies and generated considerable impact.

Radio Programmes

All India Radio (AIR) station Jalandhar covered the 13 radio programs organized at the Central Institute of Post Harvest Engineering and Technology, Ludhiana under the rural program named 'Do Dooni Chaar'. The various topics were covered like Business Planning and Development, Turmeric processing, Marketing of agricultural produce, Bajra processing, Value addition of maize and sorghum, Probiotics, Hygienic poultry processing, Better method of fish processing, Pork processing, Agro processing and related health hazards, Fish processing, Evaporative cooled room and Tomato processing. The programmes were

EDUCATION

CIPHET develops low-cost cryogenic grinder

लुधियाना-चंडीगढ़, बुधवार, 11 सितंबर 2013 www.businessbhaskar.com 5

सीफेट रेडियो के माध्यम से देगा किसानों को जानकारी

Fig. 79. News items related to Post-Harvest technology

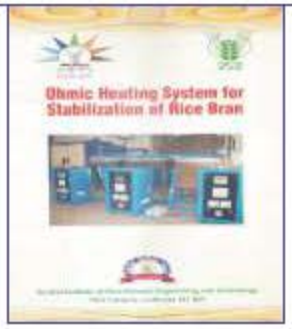
broadcasted through a powerful 300 kW of transmitter on medium wave frequency at 873 KHz and covered whole state of Punjab, while programme could also be listened in parts of Haryana, Himanchal Pradesh, Uttarakhand, J&K and Rajasthan.

Brochures of Technologies : Brochures of 12 technology belongs to CIPHET as well as develop funded project were printed and are shown below :

Publication of technology brochures

Makhana popping machine

Sunflower dehuller



Ohmic heating system for rice bran stabilization

Autoclavable microencapsulation system

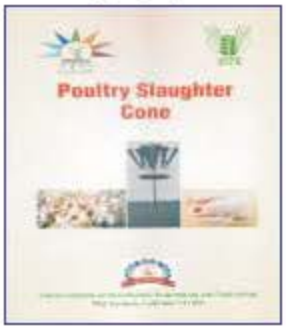
Automatic litchi peeler

Automatic custard apple pulper

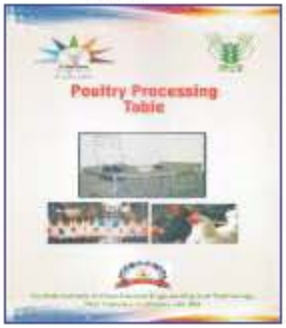
Mobilizing mass media support for sharing agro information

Animal feed with potato waste

Air powered sausage filler



Poultry slaughter cone



Poultry processing table

Value added convenient meat products

Table 39. Achievements at a Glance

Activities	Achievements
News clippings	102 news clippings were published in leading regional and national dailies
Radio programmes	13 radio programmes on various CIPHET technologies were aired.
Visit of media persons	5
Feature stories/articles	12
Online news item/stories	30 news items were published in cityairnews.com, fnbnews.com, YahooNews, Scottrade.com, Webindia123.com, Newsoneindia.com, Newkerala.com, India4u.com, Cypee.com
Printing of technology brochures	Brochures on 12 different technologies of CIPHET and externally funded projects were published. Total 2400 copies were printed.

CIPHET media on YouTube

"CIPHET Media" was created on YouTube. Through this video of various technologies can be viewed on www.youtube.com. Hits by visitors to the technologies' videos are given below:

S. No.	Name of Video/technology	Website hits
1	Evaporative cooled room	112 views
2	Grass root entrepreneur-a success story of CIPHET trained entrepreneur Kailash Chowdhary	111 views, 5 likes
3	Shaping a new tomorrow	48 views
4	Cattle feed	221 views
5	The net house of net profit	4625 views, 9 likes
6	The change maker	75 views, 10 likes
7	Sultan of fisheries	453 views, 8 likes
8	Bachittar Singh-soyabean processor	156 views, 6 likes
9	Potato seeds for prosperity	44 views
10	Saffron revolution in Kashmir	355 views, 3 likes
11	Parivartan ki lahar	2444 views
12	CIPHET green chilli powder	203 views

Impact Assessment of Entrepreneurship Development Programmes (EDPs) conducted by CIPHET

Anil Kumar Dixit and Indu Karki

The objectives of the study were to find out the benefits of EDPs and licensing of CIPHET technology to the beneficiaries and to identify and prioritize the constraints hindering adoption. Primary data from 127 persons (49 EDP participants and 78 licensees) were collected with the help of Schedule-I and scientists response on EDPs were ascertained with Schedule-II. Multiple regression analysis and Garrett's ranking technique were applied. It is evident from the survey that 27.55 percent of licensee and EDP participants have either already adopted CIPHET technology or in process of adoption. The mean score (on the scale of 1 to 5) with respect to awareness creation (4.55), improvement in technical knowledge (4.33) and confidence building (3.98) revealed participants satisfaction level between highly agree to agree. The economic benefits accrued to an entrepreneur from soya processing and green chilli power were estimated to the tune of 5.8 and 1.5 lakh per annum, respectively. Some intangible benefits such as product diversification, exploring market channels, quality consciousness, and participation in training at abroad were also observed. Market is found to be the key driver for adoption of technology as it established positive and significant ($p< 0.01$) relationship. Other factors favoring adoption are innovativeness in technology and participation in trainings, exhibitions and innovators meet. Further, non availability of market for final product as far as demand of final product, competition among entrepreneurs and private companies is concerned, rated as top most constraint (Garret score 76.35) as shown in Table 40. The entrepreneurs have also expressed their concern that the price of raw material is high particularly in case of peanut and green chilli. Participants suggested for more hands on practices during EDP/training programmes, as they have rated this III[rd] most influential constraint. In addition, non-availability of credit and non-availability of precise

Table 40. Ranking of constraints faced by entrepreneurs

Factors	Garrett mean score	Rank
1. TECHNO-ECONOMIC CONSTRAINTS		
Less Technical skill	22.00	VII
Technology non-availability (full package or a component)	26.87	VI
Hands on experience during EDP	39.24	III
2. FINANCIAL CONSTRAINTS		
Non-availability of credit	35.11	IV
Higher interest rate	18.62	VIII
MARKETING RELATED CONSTRAINTS		
Market (In terms of demand, timeliness and competition)	76.35	I
Non-availability of raw material at reasonable price	43.36	II
Higher packing and packaging cost	10.37	
Commission and taxes	14.49	IX
Market information (price, demand and supply, and intelligence)	30.99	V
3. PHYSICAL AND INSTITUTIONAL CONSTRAINTS		
Power	18.62	VIII
Communication	10.37	X
Quality control laboratory	6.25	XI
Social capital least developed (farmer organization, NGOs, and other public and private institutions)	2.12	XII
Franchising model- not exist	14.49	IX

Interaction with guava processing entrepreneur, Abhor

Product diversification based on EDP on guava processing (Village Muajgarh)

and timely market information were rated as IV and V position, respectively. Some physical (such as non-availability of power, communication, and quality control) and institutional constraints (i.e., least developed social capital and franchising model) were also reported but ranking is less. Undoubtedly, these constraints limit the adoption and success of processing technology. Hence, there is a need to develop comprehensive strategies by government, research institutions and other line departments in an integrated manner to deal with these constraints so as to accelerate the growth of processing sector. Finally, need base EDP considering socio-economic and geographical dimensions, resources availability, and willingness to pay and acceptance of intended beneficiary, need to be promoted.

Assessment of occupational health hazards among workers in agro processing units

Karki Indu and Gaikwad Nilesh

Fifteen units which included flour mills and rice mills were selected. In a flour mill, the average number of wheat milling machines was one to two with milling capacity of 15, 20, and 30 qt/day. All had about 3-6 workers who were working for 8-12 hrs work shift. Questionnaire based data were collected from the workers of APCs and rice mills regarding working hours, type of shift, work related illnesses, health hazards etc. The environmental parameters like temperature, relative humidity (RH), noise and dust were also studied with regard to APCs. The guidelines of Canadian Centre for Occupational Health and Safety (CCOHS) were followed during the noise & dust survey. Layout

Fig. 80. Grid formation on the floor of Agro Processing Units

showing location of various machines and workers in the mills were prepared. Grids of specific size (i.e. 0.5 m^2, 1 m^2, 2 m^2) was made on the layout based on the size of the unit and to get the representative data for the unit (Fig. 80).

Environmental conditions

The environmental conditions i.e. average temperature, RH, air velocity and ambient noise during the period of investigation were found to be 33.1°C, 63%, 4.6m/s & 67.1 dBA respectively in the milling unit 1, 36.6°C, 59%, 4.6m/s & 68 dBA respectively in unit 2, and 31.9°C, 82%, 5.3m/s & 69

Table 41. Sound intensity related to different work units and corresponding maximum exposure limit according to NIOSH and OSHA at unit 1

Noise sources	Grid point location	Sound intensity (dBA)	Average sound intensity (dBA)	NIOSH max. exposure limit (hrs)	OSHA max. exposure limit (hrs)
Milling machine	21	90.3	91.4	2.35	7.67
	22	87.9		4.09	10.7
	23	88.2		3.81	10.26
	26	88.8		3.32	9.44
	27	94.5		0.89	4.28
	28	86.5		5.65	12.99
	31	93.6		1.89	4.85
	32	98.5		0.35	2.46
	33	94.3		0.93	4.4
Motor	38	92.2	92.3	1.51	5.89
	39	89		3.17	9.18
	43	95.5		0.7	3.73
	44	92.8		1.31	5.42
Power transmission unit	32	98.5	95.1	0.35	2.46
	33	94.3		0.93	4.4
	37	96.1		0.61	3.43
	38	92.2		1.51	5.89
	42	94.5		0.89	4.28
Weighing balance	14	82.6		13.92	22.31
Wheat storage section	11	90	89.5	2.51	8
	16	89		3.17	9.18
Flour bags storage section	1	81.8	82.6	16.75	24.93
	6	83.4		11.57	19.97

dBA respectively in milling unit 3. In unit 4, the average temperature, relative humidity, air velocity and ambient noise were found to be 30°C, 54%, 4.6m/s & 66.9 dBA respectively. Likewise, in all the flour mills data were collected.

Source of noise and the maximum exposure limit according to NIOSH and OSHA

In unit 1, highest sound level was generated at power transmission unit varying in the range of 92.2 dBA and 98.5 dBA and the average sound intensity of 95.1 dBA which was highest among all noise sources. Power transmission unit causes highest sound intensity due to improper power transmission mechanism. Sound generated by wheat milling machine is caused due to the milling action of stone mills. The lowest noise level was recorded at flour bags storage section with 82.6 dBA.

In unit 2 also, highest sound level was recorded at power transmission unit varying in the range of 91.1 dBA and 94.2 dBA with the highest average sound intensity (92.6 dBA). The lowest noise level was recorded at wheat storage section with 83 dBA. The details are given in table 41.

Fig. 81. Collection of data on dust

Dust Concentration standards

ACGIH recommends a TLV-TWA of 0.5 mg/m^3 for occupational exposure to inhalable flour dust to protect against sensitization and other respiratory symptoms.

Dust concentration at different grid points of wheat milling units

For dust, PM 1 & PM 2.5 indicate respirable fraction and PM 10 indicates thoracic fraction. In unit 1, total suspended particulate (TSP) at some points near all the workplaces were above the recommended value of 0.5 mg/m^3 (ACGIH 2004). The highest measured TSP TWA value was 17.941 mg/m^3 at the wheat feeding section which was much greater than the prescribed limit. This might be due to dust dispersion during the task of feeding wheat into the hopper. TSP TWA values near the milling machine found to be 2.522 mg/m^3, 1.052 mg/m^3, 1.067 mg/m^3 and 1.056 mg/m^3 which were again more than the limit. The reason behind this may be that these points were near the hopper and vibrating screen where dust get suspended due to pouring of wheat and to and fro motion of the screen respectively. Near the wheat storage section TSP values were 6.568 mg/m^3 and 7.910 mg/m^3 owing to flour collection area and milling machine. TSP value near the weighing balance was 0.532 mg/m^3 which was also found higher due to flour compensation done during weighing process and also due to the dust emitted by the bagging operation which was carried out near the balance (Fig 81).

In unit 2, highest measured TSP TWA value was 4.435 mg/m^3 at the flour collection area which was much greater than the prescribed limit. TSP value at the wheat feeding section was 4.283 mg/m^3. The reason may be the dust dispersed during the task of feeding wheat into the hopper. Likewise, data were collected for all the units.

The highest TSP TWA among all units was 17.941 mg/m^3 in unit 1. In other units, highest TSP was found in the range of 1.146 mg/m^3 to 4.283 mg/m^3. The unit 1 had small size, poor ventilation and was most congested among all the units. It indicates that the dust particles get more concentrated due to smaller size and poor ventilation.

Development of national database on post-harvest technologies

Indu Karki, Tanbir Ahmad and S K Nanda

Commodity wise data were collected on post-harvest management and processing. The commodities like cereals (wheat, rice, maize), pulses (red gram, pigeon pea), oil seeds (soybean and ground nut), vegetables (potato, onion, tomato, peas), fruits (pomegranate, banana, litchi, pineapple, custard apple, mango, citrus), plantation crops (cashew nut, coconut, arecanut) were covered. Information was collected on aspects like maturity indices, harvesting season, equipment and gadgets required for postharvest processing which included data collection on destoning, pre-cleaning, cleaning, sorting/grading, storage, etc. Besides, manufacturers of machines, their complete address along with the approximate. cost of machines, suppliers addresses, phone numbers, emails, photographs of machineries etc were also collected. A proforma/survey schedule was prepared for collection of data and sent to 833 manufacturers associations all over India. Information were also collected on secondary processing like value addition and product development, extraction of possible bio-active compounds, packaging, storage and cold chain management, equipment & machines required and their approximate cost, suppliers addresses, phone numbers, emails, photographs of machineries etc. The information is being collected in the following format:

Table 42. Format for Database Management System (DBMS)

S.No	Name of the equipment for post harvest management of crop	Specification (Capacity of the gadget/machine)	Approximate cost (Rs.)	Photograph of machine	Name and address (including mobile no., fax no., website and e-mail) of manufacturer/supplier

Other activities undertaken / achievements by TOT Division

Trainings imparted

a) Farmers Training

- Organized a training programme on 'Post-Harvest Technologies for Rural Catchment' for 20 farmers during October 10-14, 2013 for 17 farmers from Namakkal, Tamil Nadu sponsored by Agriculture Technology Management Agency (ATMA), Namakkal, Tamil Nadu.
- A training on 'Handling and Processing of Turmeric' was conducted for the 30 farmers from Maharashtra during January 13-16, 2014. It was sponsored by ATMA, Wadgaon, Chandrapur, Maharashtra.
- A four days training on 'Post- Harvest Technologies for Rural Catchment' was organized for 26 farmers from Gondia (Maharashtra) sponsored by ATMA, Gondia during February 24-27, 2014.
- A three days training on 'Post-Harvest Technologies for Rural Catchment' was organized for 30 farmers, Nagpur (Maharashtra) sponsored by ATMA, Nagpur during February 27-March 01, 2014.

- Three days training on 'Post-Harvest Management of Fish' under TSP programme was organized by CIPHET, Ludhiana in collaboration with College of Fisheries, Raha, Nagaon, Assam (Assam Agricultural University, Assam) from March 26-28, 2014.

b) Officers Training

- An exposure visit of 30 foreign executives from Kenya, Liberia and Malawi under US-India-Africa Triangular International Training on 'New Dimension in Agricultural Extension Management' for extension functionaries in collaboration with PAMETI, PAU Ludhiana and MANAGE, Hyderabad was organized at CIPHET, Ludhiana on October 31, 2013.

- An exposure visit cum interaction programme for 30 Punjab state govt. officials was held at CIPHET, Ludhiana. The officials were apprised about CIPHET activities, technologies and trainings under a workshop on "Capacity building for WDC members under IWMP" organized by PAMETI, PAU Ludhiana on December 12, 2013.
- A training program on 'Soybean Processing for Milk and Tofu' was conducted during Feb. 3-5, 2014 for two participants from district Ludhiana and Sangrur.
- A training program on 'Post Harvest Management' was conducted for the 21 agricultural marketing officers from Maharashtra during Feb. 17-21, 2014. It was sponsored by MACP, Maharashtra.

c) Entrepreneurs Training

- A training program on 'Soybean Processing for Milk and tofu' was conducted during Feb. 3-5, 2014 for two participants from district Ludhiana and Sangrur.

d) Students Training

- CIPHET organized training for five B.Tech students from Tamil Nadu Agricultural University, Kumulur during Jan. 2 to 31, 2014.
- CIPHET organized training for 13 B.Tech

students from SKUAST, Srinagar during Feb. 5 to March 01, 2014.

- One month training was organized by CIPHET, for B.Sc. (Agril.) students from D.A.V. College, Abohar during Feb. 24 to March 23, 2014.
- In-plant training was organized by CIPHET for 24 B.Tech students from Chhattisgarh Agricultural Engineering College, Risali (Bhilai) during March 04 to April 01, 2014.

Exhibitions

- CIPHET participated in National Agriculture Fair Cum Exhibition Krishi Vasant 2014 for showcasing its post-harvest technologies during February 09–13, 2014 held at Central Institute of Cotton Research, Nagpur.
- CIPHET coordinated for making ICAR pavilion for display of technologies from CIPHET, CIRB, Hissar, CSSRI, Karnal and NDRI, Karnal at

Progressive Punjab Agricultural Summit organized at Chapparchiri, Mohali, Chandigarh during Feb. 16-19, 2014. Dr. R. K. Gupta, Director, Dr. S. K. Nanda, I/C Head TOT, Dr. Indu Rawat, Scientist and Mr. Ajay Agrawal, Business Manager, BPD along with other CIPHET scientists attended the exhibition and made the farmers aware about the technologies and incubation facilities available at CIPHET. Many farmers, entrepreneur and business persons visited stall and took keen interest in CIPHET developed technologies.

- CIPHET participated in Pusa Krishi Vigyan Mela, IARI, New Delhi during Feb. 26-28, 2014. One of the farmers nominated by CIPHET was selected for ICAR innovative award 2014 on this occasion.
- CIPHET showcased its technologies in two days Training cum Exhibition at Katihar, Bihar during March 3-4, 2014. It was inaugurated by Shri Tariq Anwar, the Chief Guest on this occasion in the presence of Dr. Vishal Nath, Director NRC, Litchi, Dr. B.K. Gupta, Head & I/C, NRC Makhana Centre at Darbhanga, Dr. Manoj Nath, Head & I/C CPRI Centre, Patna, Shri Anirudh Singh, Deputy-Director, NIFTEM and Mr. Sanjeev Rai, Director, Entrepreneurship and Training Institute, Katihar.

- CIPHET participated and displayed its technologies in Kisan Mela at PAU Ludhiana, during March 14-15, 2014.

AICRP on Post-Harvest Technology

Food Grains Sector

Medium capacity millet dehuller (Almora centre)

VPKAS Almora centre has developed a medium capacity millet dehuller considering the requirement of small and marginal farmers especially of hilly areas. An aspirator type single phase 2 hp electric motor driven millet dehuller (capacity of 15-20 kg/h, weight 70-80 kg) was designed and developed with cleaning unit for threshing and de-husking of barnyard, proso, kodo, little and foxtail millets. The machine was tested for de-husking of barnyard millet, kodo, little millets and threshing and pearling of finger millet at different moisture content. The speed of the drum is adjustable up to 900-1200 rpm by changing the pulley combination for different operations. The test results of the machine for threshing of millets and de-husking/pearling of millets are given in Tables 43 and 44.

Medium capacity millet dehuller

Table 43. Test result of the millet dehuller for threshing of millets

Name of crop	M.C. of grain (%)	Clearance (mm)	RPM of cylinder (No.)	Threshing Capacity (kg/h)	Efficiency (%)
Finger millet	15-18	5-6	900-1000	100-120	99
Barnyard	15-18	5-6	900-1000	180-200	99
Foxtail	15-18	5-6	900 -1000	150-160	99
Little millet	15-18	5-6	900-1000	180-200	99
Proso	15-18	6-7.5	900-1000	160-180	99
Kodo	15-18	6 -7.5	900 -1000	150-160	98

Table 44. Test result of the machine for de-husking/pearling* of millets

Name of crop	M.C. of grain (%)	Clearance (mm)	RPM of cylinder (No.)	Threshing/ *pearling capacity (kg/h)	Efficiency (%)
Barnyard	11-12	3	1100-1200	20-25	99
Foxtail	10-11	3	1100-1200	30-35	99
Little millet	10-11	3	1100-1200	30-35	99
Proso	10-12	5-6	1100-1200	25-30	98
Kodo	10-12	5-6	1100-1200	20-25	98
Oat	11-12	10-11	1000-1100	50-75	98
Barley	11-12	10-11	1000-1100	150-200	98
Finger millet pearling	10-12	3	1100-1200	140-160	99

*Pearling in case of finger millet only, M.C. Moisture Content

Exploitation of underutilized crops of J&K for development of extruded snacks (Srinagar centre)

For the development of extruded snacks, corn (variety C-8) and water chestnut were ground to pass through 200 μ sieve using lab mill and were blended in the ratio of 90:10, 80:20, 70:30, 60:40 and 50:50 respectively. 2, 4 and 6% of salt, sugar and spice mix respectively were added to each blend at 10% moisture content and were packed in LDPE packets and stored at ambient conditions till further use. A co-rotating and intermeshing twin-screw extruder Model BC 21 (Clextral, Firminy, France) was used for extrusion. Temperature of the first, second and third zone of the extruder was maintained at 40, 70 and 100°C respectively throughout the experiments, while the temperature at fourth zone (compression and die section) was varied according to the experimental design. The bulk density of extrudates ranged from 0.08 to 0.45 g/cc, whereas the water absorption index (WAI) and water solubility index (WSI) were found in the range of 5.18 to 5.86 g/g and 5.32 to 18.98%, respectively.

Development of hook (*kundi*) for minimizing the pilferage losses during handling/lifting of bags (Ludhiana centre)

Seven (7) mm hook made of MS material was developed and adjudged to be the best for minimizing the pilferage losses during handling/lifting of bags in markets/warehouses/ godowns for both wheat and milled rice. In comparison to the 10 mm hooks already in practice, the developed hook can reduce the pilferage losses to the tune of 34% in case of milled rice bags and 39 % in case of wheat bags. The size of hole created by the developed hook is 8-8.5 mm in comparison to 12-13.5 mm hole created by the 10 mm hooks.

Hook (7 mm)

Testing of developed hook

Horticulture sector

Development of process technology and pilot plant for cherry/tutty-fruity from pumpkin (Akola centre)

Akola centre has developed the process for preparation of cherry/tutty- fruity from raw pumpkin and a pilot plant (100 kg/day capacity), which includes Peeler, Hand cutter, Slicer and Cuber. The developed peeler, cutter and slicer can also be used for fruits such as papaya, potato, carrot, etc. From 100 kg of pumpkin fruits, 65 kg cherry/tutty-fruity can be prepared. The pilot plant requires shade of 20 x 20 ft. and the approximate cost is Rs 1.30 lakh. The estimated benefits are to the tune of Rs. 4,79,573 (per annual net profit), break- even point 23.95% and return on investment is 66.32%. The cost of production of cherry/tutty-fruity is about Rs. 14 per kg. The employment generation is to the tune of 600 man days per year. The plant can be used alternatively for making cherry from papaya or other fruits.

PDKV fruit peeler

Pilot plant (handcutter, slicer and cuber)

Pumpkin cherry/tutty-fruity

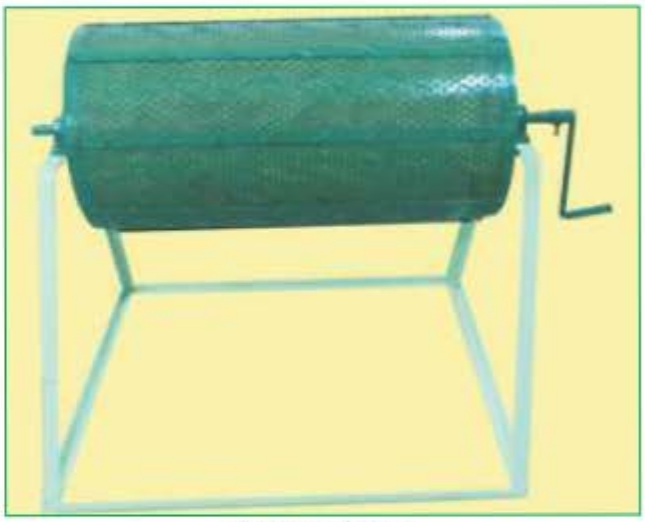
Portable evaporative cool chamber for retail storage of vegetables (Bhubaneswar centre)

A portable evaporatively cooled retail vegetable storage chamber having dimension of 75 x 72 x 132 cm has been developed. Three sides of the cooler are provided with khas khas padding material and the door is made up of perplex transparent sheet. It is fitted with a small water pump (18 W) to lift water from the storage tray to the overhead tank placed above the chamber. The water is distributed throughout the padding material attached to the side walls of the storage unit. A small blower of 15 W is attached at the top for sucking of air to increase the cooling efficiency. The storage chamber is provided with three perforated trays (62 x 60 x 6.5 cm size each) for storage of vegetables inside it with a capacity of 30kg. The system reduced the temperature inside the chamber by 4 to 8 degree and increased the RH by 10 to 20% depending on ambient condition. The unit was tested for storage of vegetables like okra, pointed gourd, bitter gourd, brinjal and tomato and the shelf life extended by 2 to 4 days more than that of the control samples. It also reduced the spoilage by 55 to 65% compared to the control sample.

Evaporative cool vegetable storage cabinet

Manual operated sapota cleaner (Junagadh Centre)

Harvested sapota fruit surface have scurf, which is to be removed. The developed cleaner removes the scurf as well as gives shining to the sapota fruit surface. The main parts of the machine are perforated metal sheet drum, jute cloth, frame, and handle. The efficiency of sapota cleaner is found to be 98 to 99% and damage of only 2% sapota fruits is reported. The unit cost of machine is Rs. 7000 at current prices of 2013-14.



Sapota Cleaner

Production of probiotic fruit juices using free probiotic cells (Ludhiana centre)

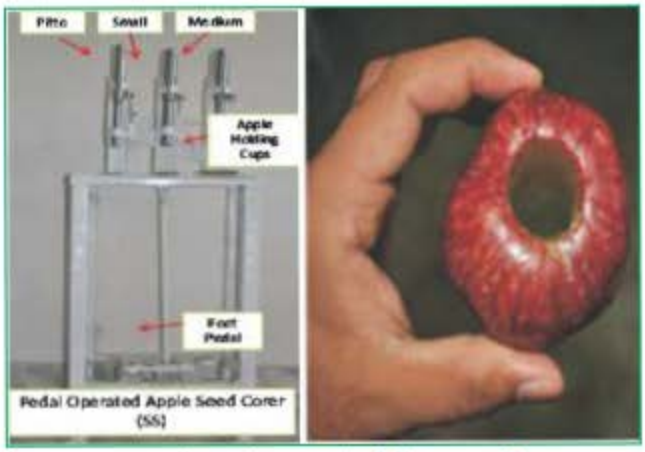
Technology for production of probiotic fruit juices using free probiotic cells from guava, kinnow and mango was developed and patent was filed. The

Probiotic fruit juices

probiotic guava, kinnow and mango juices were successfully formulated, with stable and viable beneficial bacteria content in the recommended dose (106 cfu/ml) with a shelf life of one month. The best combination was of *L. acidophilus* and *L. casei* being added together without microencapsulation in case of kinnow, guava and mango juice and the average count ranged from 6-14x10^{6} cfu/ml which is the therapeutic level for a probiotic product.

Apple corer (Solan Centre)

A stainless steel corer was designed and fabricated with three core tubes of sizes 16mm, 18mm and 22mm provided with three fruit holding cups with 60mm, 65mm and 75mm fruit sizes, respectively. To make both hands free for holding the fruits, the foot pedal was provided for operating the machine along with core collectors. The efficiency of machine is 100kg fruits/h compared to 14kg/h fruits manually. The remaining sound core can be used for further processing.



Apple seed corer (pedal operated)

Apple seed extractor (Solan Centre)

Apple seed extractor with stainless steel contact parts and operates with 1 hp motor has two chambers; one is for milling the cores and another for separating the seeds. Milling chamber is provided with five knives and water jets. Cores of the fruits are fed in the hopper and milled in milling chamber and then the milled mass is passed to the seed separating chamber with the help of lever, which comprises of seven knives and six shafts with water jets on all the sides. The seeds are separated from milled mass with the movement of knives, shafts and pressure of water. The seeds are collected in seed receiving trays while left over mass is drained from waste receiving end. The efficiency of machine is 180kg core/h in comparison to manually seed extraction of 1 kg core /h.

The technology standardized and machineries developed under the project will be a boon to the economy of nursery growers of Himachal Pradesh as well as other apple growing states of the country.

Development of intermediate moisture product from plum fruits (Solan centre)

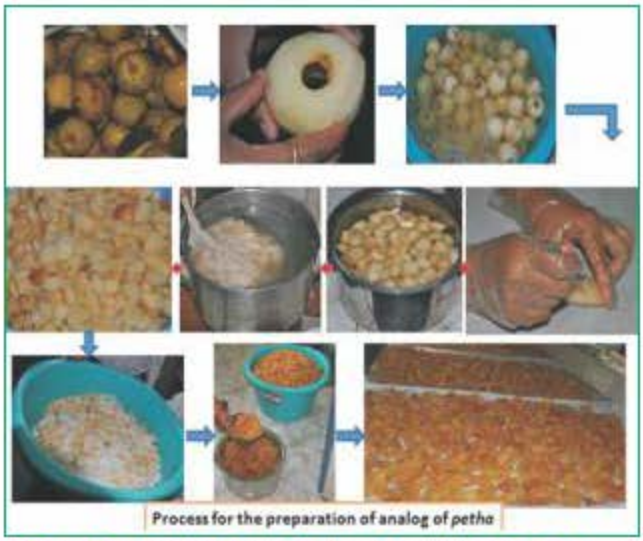
Technology for development of osmotically dried plums and utilization of left over syrup for development of various value added products was developed. The plum fruits are rich in ascorbic acid (50mg/100g) having antioxidant activity of 56.85% and a rich source of anthocyanin can be utilized for development of IMF products. The fruits were blanched in 0.5% NaOH solution for 30 s; followed by washing in cold water and water containing citric acid (0.2%) for the complete removal of lye. The lye peeled fruits were dipped in the hypertonic sugar solution of 70°B, drained, destoned and dried mechanically at 55±3°C. The technology is useful for

Value addition of plum fruits

development of nutritionally enriched osmo-dried plums. The left over syrup possessed an appreciable amount of vitamin C (18.75 mg/100g) and antioxidant activity (35.83%) thus utilized for the preparation of appetizer and RTS drinks.

Standardization of technology for development of sand pear (Patharnakh) candy (Solan centre)

The technology for development of sand pear (patharnakh) candy has been standardized. The fruits after peeling and coring were made into cubes and dipped in a solution of CaO (0.3%) for 30 minutes. The drained fruits were pricked, blanched in a boiling solution of 2% alum for 25s. The blanched pear cubes were washed and then the sugar was added by the layering method. On the consecutive day the total soluble solids was observed as 38°B, which was raised to 55°B on the alternate day. Finally the TSS was raised to 70°B, and the fruits were dipped for a day in the syrup followed by draining and drying in a mechanical/poly tunnel drier. The sand pear candy prepared by following the developed technology is



Complete technology for development of sand pear (patharnakh) candy

an analogue of *petha*.

Development of banana peeler-Model 2 (Tavanur centre)

The banana peeler, which was fabricated earlier (Model 2) was of a single peeler unit for a fixed sized banana. In order to make it more easy, effective and more human friendly, a machine was fabricated to peel 3 grades of banana (small, medium and large) using three peeling units of different sized blades. The average capacity of the machine is 35kg/h, peeling efficiency 88% and material loss 9%.

Banana Peeler-Model 2

Development of vanilla oleoresin plant (Tavanur centre)

A process technology for extracting vanilla oleoresin was developed and based on this an extractor was fabricated. For the preparation of

Vanilla oleoresin plant

vanilla oleoresin, hot extraction method with isopropanol as solvent was selected as this yields higher vanillin and other volatile constituents. The process parameters like concentration of solvent and time were standardized and found that the flavor components were maximum at 100% concentration for 7 h extraction. Based on this standardized process parameters, a vanilla oleoresin plant of capacity 3kg of cured vanilla was designed and fabricated.

Development of GMP and HACCP protocol for pepper industry (Tavanur centre)

The existing process line in the pepper industries was analyzed. HACCP protocols by modifying the process lines and human intervention for maintaining the quality of final products of pepper viz., garbled pepper, white pepper, dehydrated green pepper and pepper in brine were prepared. The HACCP worksheet describing measures for prevention of hazard for a particular stage in the process line was prepared. With these details, the importance in control of hazard in that particular stage of operation was examined and accordingly it was considered as 'critical' or 'non-Critical'(CCP). Similar CCP's were identified for the other pepper products. The modified flow process lines in the industries after incorporating HACCP analysis included a) conveying system for process automation b) sterilizing unit to reduce microbiological contamination c) metal detector to remove metals incorporated with the product during processing d) automated packing unit to reduce human intervention while packing. These safety management principles can trim down human intervention during pepper processing for safe and good quality end products.

Development of ginger peeler (Udaipur centre)

Peeling of ginger is labour intensive and time consuming. Ginger peeler was developed by Udaipur centre to overcome the problems of existing ginger peeler (already developed by Udaipur centre). The developed ginger peeler works satisfactorily at 115 rpm roller speed and for peeling time conscimes . The

Ginger peeler

peeling efficiency and net loss at optimum operating parameters were observed to be 81.25 per cent and 2.8 per cent, respectively.

Livestock sector

Bio-protection of meat using metabolites of beneficial bacterial cultures (Chennai centre)

Pure culture of *Pediococcus* was propagated in MRS broth. The antibacterial activity of the prepared cell free supernatant of *Pediococcus* against *Staphylococcus* was demonstrated by Agar well diffusion method. A clear zone of inhibition was appreciable. Trials were conducted to standardize the spraying of the prepared cell free supernatant of

pediococcus on chicken carcasses. Arbitary value for the pediocin produced was determined. Two trials were conducted to study the effect of pediocin and Pediocin with EDTA on the shelf life of chicken carcasses. Physico-chemical parameters viz, pH, WHC, ERV, TBA and TV, microbial parameters viz., TVC and sensory evalutation viz, odour score were also assessed.

Fish patties (Mangalore centre)

The process protocol for development of fish patty has been developed. Fish patty is a convenience, ready-to-cook/ready-to-eat product, which can be directly eaten or used in fish burger as a base material. Fish patty is prepared from ground

Ready-to-Eat Fish patty

fish meat and a mixture consisting of mushroom, starch, salt, sugar, vegetable oil, seasoning together with permissible preservatives for proper blending of meat and to improve and enhance gel strength and taste, respectively. The ingredients are fish minced meat (650 g), mushroom (150 g), soya protein (40 g), sodium tri polyphosphate (2 g), potato (50 g), sun drop oil (20 g), bread crumbs powder (10 g), salt (9 g), sugar (5g), chilli powder (8 g), cardamom (1 g) and chilled water (30 g). The steps for preparation of fish patty are: first remove scale, eviscerate and wash thoroughly, boil the fish for 6 to 8 minutes and then cool to room temperature. Afer cooling, separate muscle from skin and bone and make muscle into a fine paste by squeezing by hand, add all ingredients and mix properly. When paste become very hard then add chilled water, again mix thoroughly by hand. Thereafter take 25g of paste and make into round/ rectangular shape of 1cm thickness. Shaped products are put in the deep freezer for an hour and when products become frozen, packed into synthetic casing with required quantities, seal it and market.

Preservation and handling techniques for porcine skin for production of biological bandages (Mumbai centre)

The trial to evaluate the viability of porcine skin grafts has been started by using Humby's knife. Porcine skin has been collected from freshly slaughtered pigs at Pig Slaughter Unit of Deonar Abattoir, Mumbai. The uneven skin grafts have been removed by Humby's knife and assessed its viability by TTC assay. Subsequently, the viable skin grafts were preserved in 40 °C and - 200 °C temperatures and viability is being tested by TTC assay at one day interval during storage. The grafts removed by the Humby's knife were uneven size and shape therefore dermatome is needed to get the proper grafts from the pig skin.

Jaggery sector

Evaluation of vacuum and modified atmosphere packing for storage of granular jaggery (Anakapalle centre)

Granular jaggery samples packed with vacuum and MAP were kept under storage during July–December 2013 to study the shelf life. The samples were analysed for bio-chemical changes. Under MAP, 0.3% decrease in sucrose and 0.3% increase in reducing sugar content were observed whereas the decrease in sucrose was 0.6% & 1.0%, increase in reducing sugars 0.3% & 0.6% and increase in total non sugars was 0.3% & 0.4% under vacuum packaging and control, respectively. Slight increase in moisture (0.05-0.2%) was observed in all the packaging methods.

Enrichment of jaggery with carotenes and beta carotene for dietary allowance (Anakapalle centre)

Enrichment of granular jaggery for carotenes and betacarotene was taken up during April 2013 and stored to monitor the changes in the biochemical properties. Carrot paste or moringa leaf paste was added @1, 2, 4, 6, 8 and 10g/kg of juice to enrich jaggery for carotenes and beta carotenes. As the addition of paste increases, the corresponding increase in total carotenes in jaggery was not observed. The increase was noticed only with addition from 1 to 2 g/kg of juice. Due to incremental addition of carrot or moringa leaf paste, reduction in sucrose % was observed from April to December 2013. The reduction ranged from 1.4 to 2.4% in carrot and 1.6 to 3.0% in moringa leaf paste. Increase in percent reducing sugars ranged from 0.6 to 1.2% in carrot and 0.8 to 1.3% in moringa leaf paste. Total nonsugars increased from 0.8 to 1.2% due to carrot and 0.8 to 1.8% due to addition of moringa. These changes can be attributed due to slight increase in moisture content in the enriched granular jaggery.

Assessement of harvest and post-harvest losses of major crops and commodities in India (Ministry of Food Processing Industries sponsored project)

R. K. Gupta, R. K. Vishwakarma, Anil K Dixit, SK Aleksha Kudos and RE/PI of all AICRP on PHT centres

Around 85 percent work on primary data collection by enquiry and obsevation by the cooperationg centres has been completed. Data entry by all centres in data entry software (already provided to cooperating centres in CD) is expected to be completed by June 2014.

FCI sponsored project on 'Study on storage losses of food grains in FCI and CWC warehouses and to recommend norms for storage losses in efficient warehouse management

R. K. Gupta, Anil K Dixit, SK Aleksha Kudos and RE/PI of AICRP on PHT centres

The survey schedule has been finalised for detailed data collection from FCI and CWC warehouses. The guidelines and survey schedule has been circulated to all concerned cooperating centres. Most of the cooperatinig centres have recruited the field investigators and have started the work for selection of compartments and recording of daily and forthnightly data. Also an interaction meet of REs/PIs and FCI official was organised during 29th Workshop held at Udaipur and one seminar cum meeting of RE/PI with depot manager and FCI higher ups is proposed to be ogranised in the month of May 2014.

AICRP on Application of Plastics in Agriculture

The AICRP on Application of Plastics in Agriculture has eleven cooperative centres. The project has contributed in development or modification of technologies related to plasticulture in horticulture, irrigation, intensive fish culture and animal housing as per the need of the mandated area of the centres. Following are the specific achievements made by cooperating centers during the year under report.

- Abohar center studied the effect of overhead tree sprinklers, foggers and colour shade nets to reduce heat stress on pomegranate fruit in semi-arid region. Microclimate data indicated that the temperature remained in the range of 27-33°C and RH 60-80% within the sprinkler periphery. Comparatively, lowest sunburn and fruit cracking were found in overhead sprinkler. Approximately, 30-40% black spot disease (*Cercospora* sp.) was observed in all treatments. Good size and quality of fruits (300-430g) were obtained along with higher quantity of Vit. C (11.56 mg/100g aril) and acidity (0.449 g/100g aril) were recorded in sprinkler.

Capsicum cultivation in poly house at Ludhiana.

- Ludhiana center studied the effect of coloured plastic mulch on crop performance of capsicum. Four different types of coloured mulch (yellow on black, black-black, silver-black and white on black) were used. Total five pickings were done. The maximum yield of 1.8 kg/plant was obtained under silver-black followed by other coloured mulch. Whereas yield of the crop in case of no mulch is 1.0 kg/plant only and first picking in case of no mulched condition was about 20 days late as compared to mulched crop.

- Ludhiana center conducted a field research at the research farm to cultivate capsicum in a 560 m^2 polyhouse with three varieties viz. Syngenta, Nunhems and Holland under naturally ventilated greenhouse for improving year round production of vegetables. Treatments of 120% of targeted fertilizer dose along with 100% replenishment of crop evapotranspiration gave the maximum marketable yield of Syngenta yellow (5.691 kg per plant), Syngenta red (4.101 kg per plant) and Syngenta green (table size fruit) as 8.424 kg per plant. Out of three varieties Syngenta showed superiority over Nunhems (yellow: 4.060, red: 2.947 and green: 5.947 kg per plant) and Holland (yellow: 2.958, red: 2.102, and green: 5.117 kg per plant) varieties. Table size green fruits were picked up on an average of 15 days after last picking. Among three irrigation levels, 100% replenishment of ET gave higher yield than 80 and 60% replenishment of ET. In case of targeted fertilizer dose, 120 percent of targeted dose showed superiority over 100% and 80% of targeted fertilizer dose.

- Evaluation of polyhouse cultivation by the farmers in Punjab was undertaken in 3 districts viz. Ludhiana, Jalandhar, Patiala and selecting 4 farmers from each district. Flower cultivation was found most beneficial (B-C ratio 3.23) than vegetable cultivation (2.67). The payback period was as low as 0.71 for colored capsicum in an

area of 1000 m^2. Non adoption of poly house technology was due to its higher initial cost, risk factors and also due to unawareness in the farmers about this technology. Farmers suggested that increase in subsidy; proper training and knowledge about polyhouse technology should be provided for its successful adoption. Finally, it was concluded that poly house farming is need of the day and farmers must adopt it with proper knowledge and training so as to rise in fastly growing modern agriculture and to compete in the markets at international level to get maximum profits in order to lead a successful life.

- Studies on microclimate and plant growth of capsicum under different type of shade net by Junagadh center. Studies on microclimate and plant growth of capsicum under different types of shade net were conducted in Saurashtra region. Maximum temperature and light intensity was observed in 30% while compared to others. RH was observed maximum in 75% blue shade net and higher crop growth parameters. The physical parameters of fruits in terms of length (102.98 mm), width (69.5 mm), thickness (67.82 mm) and size (78.46 mm) was recorded maximum in 75% blue shade net house

Capsicum plant growth under different colour of net house at Junagadh

where maximum yield (23.5 t/ha) in 50% white net house followed by 50% green net house (8.7 t/ha) and minimum was found in control (0.34 t/ha).

- For growing water melon in Saurashtra region, double layered Silver – Black (25 micron thick) was found better than other plastic film mulches. The Silver – Black mulch film with irrigation scheduling at 0.4 ETc gave best results with yield (37.67 t/ha) and water use efficiency (165.15 kg/ha mm) as compared to yield (0.79 t/ha) and WUE (1.95 kg/ha mm) for control (no mulch condition with irrigation level of 0.8 ETc).

- Cumin crop is highly sensitive to adverse climate viz., dew deposition, rain, and high temperature and high RH. Hence the effect of different structures on protection of cumin crop against adverse climate in Saurashtra region was evaluated with different covering materials with low tunnels (1.0m high). A low tunnel type structure (4.0x2.0x1.0m) was conceptualized which can provide protective cover for the crop by different materials viz., plastic sheet (LDPE

Cumin crop cultivation in low tunnel with different covering sheets at Junagadh

50 μ), PP nonwoven (40 gsm), green shade net (50% shading), insect net (60 mesh). Cumin cultivated in the open field is considered as control. Minimum temperature was observed in control followed by green shade net (50%) structure. Maximum yield of cumin (1419 kg/ha) was observed in plastic sheet structure followed by PP nonwoven structure (1338 kg/ha). Net profit in plastic sheet structure is estimated to be 43700 Rs/ha as compared with control. Aphids and thrips were observed minimum in plastic sheet structure followed by aphids in PP nonwoven and thrips in insect net structure. In the structures, aphids and thrips were observed maximum in green net structure.

- Feasibility study of round the year production of vegetables in low cost bamboo poly house

Broccoli cultivation in bamboo polyhouse in Sikkim

structure was undertaken in Sikkim. The study was undertaken for the second year in the same existing poly house (18x4.5 with 3.1m middle height and side height: 2.1m) with bamboo frame after brief repairing. During the second year of replication of the crop rotation *broccoli-brinjal-broccoli* in low cost poly house, brinjal crop failed being infested with bacterial wilt. Spinach was taken up as a midterm contingent crop and leaf yield was 0.73 kg/sqm (7.3ton/ha) with WUE of 16.22 kg/m^3 per cubic meter of irrigation water applied. Yield of broccoli was observed to be highest at 3.13 kg/m^2 in spacing of 30X30cm, followed by 2.90 kg/sqm for spacing of 40X40cm, 1.84 kg/sqm for spacing of 45X45cm and 1.52 kg/sqm for spacing of 45X60cm. WUE was observed to be decreasing with increase in spacing of plants. WUE of 12.67, 11.73, 7.45 and 6.14 kg of broccoli per cubic meter of water used for the spacing of 30X30cm, 40X40cm, 45X45cm and 45X60cm, respectively. Daily max and min temperature within the polyhouse showed increasing and decreasing trend, respectively, with increase in height from the soil surface. In addition to the approved programme, the centre also conducted some preliminary trials on bio-control agents and cultivation of Gerkin and Asparagus.

- Construction and evaluation of small structures for protected cultivation of capsicum and tomato in Udaipur Region. Four structures of 64 sq. m floor area (16 m x 4 m) using GI pipe frame have been constructed in the farm and covered with (i) shade net, (ii) insect net, (iii) UV stabilized poly-sheet of 250 micron with ventilation with shade net and (iv) UV stabilized poly-sheet of 250 micron with ventilation with insect net respectively. The data were recorded from the randomly selected tagged plants of all four replications. The data revealed that maximum plant height (168.67 cm) was recorded under shade-net house while the minimum plant height (140.59 cm) was noted in T_2- Insect-net house. On the basis of yield data the poly-house (ventilation by insect-net) proved significantly better (1358.33 g/plant) and fruit yield (5433.32 g/m^2) while the highest average fruit weight (94.87 g/fruit) was found under poly-house (ventilation by shade-net). Whereas, T_1 treatment i.e. shade-net house was found with the lowest values for fruit weight per plant (1125.00 g/ plant) and fruit yield per square meter area (4500.00 g/sqm). The economic analysis indicated highest net income of Rs. 17,69,299/ha (Rs. 176.93 per sqm area) and B:C ratio of 3.62 with poly-house with insect-net vents. During Kharif season, 2012, tomato cv. "Dev" was taken with four replications on four raised beds each with two rows of crop plants with spacing of 50 x 50 cm. The results revealed that maximum plant height (198.42 cm) was recorded under shade-net house while, the minimum plant height (167.88 cm) was noted in insect-net house. On the basis of yield data the poly-house (ventilation by insect-net) gave significantly highest fruit weight per plant (1667.13 g/plant) and fruit yield (11119.80 g/sqm) while, the highest average fruit weight (73.82 g/fruit) was found under T_1 treatment i.e. shade-net house. Whereas shade-net house was also found with the lowest values for fruit weight per plant (818.13 g/ plant) and fruit yield per square meter area (5456.90 g/sqm). The economic analysis indicated that the poly-house with insect-net vents had the highest net income of Rs. 10,26,872/ha (Rs. 102.69 /sqm) and B:C ratio of 2.60. Though, according to B:C ratio both crops resulted equally good but on the basis

of net income the capsicum crop proved best for cultivation under small poly house having insect-net vents.

- Impact assessment of portable FRP carp hatchery technology in India was done by Bhubaneswar center. The result indicated that 90

Portable FRP carp Hatchery at CIFA, Bhubaneswar

out of 155 FRP carp hatchery units were in operation, each hatchery operated for about 5 cycles per year (20% utilization), total spawn production = 600 million, seed produced (fry) = 135 million, culture area covered = 7200 ha, total running cost = Rs 25.2 lakhs, total profit generated = Rs 24.3 lakhs, recovery of cost of gadget = 3 years with 20% utilization & 1 year with 60% utilization, on full utilization = total profit generated will be in the tune of 1.7 crores per year.

Mobile fish vending unit at CIFA, Bhubaneswar

- Design, development and evaluation of plastic gadgets for hygienic fish marketing by Bhubaneswar center. The prototype of mobile (on rickshaw trolley) fish vending unit as HPUV (Human powered utility vehicle) was successfully designed, which is a useful gadget and facilities for fish vendors. It was designed and fabricated using locally available materials at a cost of Rs.52,780/-. The main feature of this prototype is its 100 and 70 L insulated chilled crates; utility box; cutting and processing area; storage of water and waste disposal. Necessary effort has been made to maintain the possible market quality of fish and fish products in the form of raw and semi-processed / processed chilled products. Test trial of ergonomics evaluation indicated that the working heart rate (HR work) of the male operator ranged from 123.8 to 134 beats/min with a mean value of 131.9 ± 1.6 beats/min. The corresponding values with women were 119.0 to 149.6 and 131.2 ± 1.0 beats/min, respectively. The heart rate was lower with male as compared to the female. The forces on the pedal were 161.84 N and 377.6 N in case of first and second condition. The calculated mechanical advantages for first and second condition are 0.278 and 0.276, respectively. The design of mobile fish vending unit is stable. The operators both male and female have found the unit to be conducive both ergonomically as well as operationally. The benefits of HPUV includes assured best possible market quality; provide a proper form of semi-processed or final product; assured health safety of products; and apply the most rational raw processing method. The product is suitable in urban/municipality areas for proper waste disposal. The calculated pay-back period is 2.53 years, thus, the mobile unit is highly profitable. The ARR calculated over the project period is 2.53 year life, which is 39.60%. The retail vending of fish and fish products by the fisher folks are presently facing a large number of problems starting from a proper place in the fish market, waste disposal and fish

marketing during the bad weather and night time. Most of the problems have been addressed during the designing and layout of the prototype. The mobile fish vending unit may be popularized in the municipality and NAC areas with Government subsidies to overcome the retail fish vending problems.

- A participatory study has been undertaken in the farmer's field to work out the strategy for fish culture in cooler environment in higher hills at Almora center. The study was carried out in Todera and Dudhauli villages of Doonagiri in Almora (around 2200m aMSL) and DCFR, Bhimtal. A total of 43 polytanks (LDPE or silpauline film lined pond) have been constructed. Two types of design were adopted i.e. the film was laid in a pit mostly created by a embankment on slopy lands, or stairs like sides were prepared, polythene laid, and then side and bottom was covered with soil filling. To undertake the study, ponds in the farmers field were selected of nearly uniform size and shape for having comparable results. Growth performance of carp fish was evaluated in 5 different types of fish ponds i.e. earthen ponds, cemented ponds, polytank without soil, polytank with bottom sand (3-4 inch) bed, polytank with stair type sides and earth covering during the period of June 2011 to May 2013. Fish seed (Fry) of three exotic carps; Silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*) and Common carp (*Cyprinus carpio*) has been stocked in all the tanks @ 3-4 fish/m^3 during the month of June 2011. The species ratio was 40:30:30. Fish were fed daily with rice polish and mustard oil cake @ 3% of their body weight. The growth data reveal that the size of the all 3 carps does not reach up to the marketable size by end of one year, but good size was achieved by end of second year for all the species. 40-50% better growth was achieved in polytanks (850-1020g size) in comparison to earthen pond (622 g) and cemented tank (512 g). This might be due to comparatively higher water temperature (2-2.5°C) in polytank structure and better plankton and periphyton population. The total plankton volume varied from 1.6-3.2 ml/50 lit. in different experimental ponds with maximum in polytanks (2.4-3.2 ml/50 lit) and minimum in cemented tanks (1.6-1.9 ml/50 lit.). Among the polytank structures, polytank with bottom sand reflects highest production and better growth of all 3 fish species. The sand bed in this structure favours the dense population of plankton, especially the zooplankton and naked polythene surface of the side slope of pond provide the substratum for periphyton production and also keep the water warm even in the late evening hours. Among the all 3 species, grass carp performs better and its feeding is easy for the farmers. This seasonal effect is location

Fishing in polythene lined pond in village Doonagiri, Champawat

Bt Cotton growth under silver black plastic mulch and wheat straw mulch at Junagadh

specific and is more or less related to the water temperature. Water temperature below 12°C retards the growth and feeding completely and even fish loses the weight during this winter dormancy period. In the case of earthen and cemented tanks, this period was observed for 98 days, while it was 84 days in the all types of polytanks. In order to have faster growth, stocking of yearlings (reared for 9 months in polytank of one farmer) of 30-40 gm size was done, which resulted in growth of fish in polytanks to table size (765-872 g) in 9 months while in earthen pond and cemented ponds, it was 543 and 437 g, respectively.

- Junagadh center evaluated the performance of plastic mulch in Bt cotton in Saurashtra region was found to increase the yield substantially. Cotton yield was found in the range of 4130-5530 kg/ha for mulch condition and 3810-4250 kg/ha for no mulch condition.

- Junagadh center studied the transportation losses for sapota and tomato. A foldable plastic box with cells was designed and developed for 10 kg capacity with the help of Nilkamal Limited, Rajkot. Size of cells was made on the basis of size of fruits. For transportation of sapota, the size of foldable plastic box of blue colour with velcro was 390×325×245 mm (total volume 0.031 m^3) and thickness of plastic sheet was 3.5 mm. It was made from poly propylene 650 g/m^2 with the weight of 1.405 kg. The size of cell was 60×60×55 mm and total four layers of separation sheet were arranged in a box to keep individual fruit without rolling and no load occurs on upper layer of fruit. Number of cells per layer was 30 and total cells per box were 120. For air circulation, 5 mm holes were made on sheet in each cell as well as outer sheet with 0.90% perforation. The box was made with full corner reinforcement on four corners to bear the load of upper box and protection during transportation. Collapsed dimensions of box were 725×585×30 mm (total volume 0.013 m^3).

Foldable plastic box with cell used for transportation of sapota fruits at JAU, Junagadh.

- Comparative evaluation of seven types of containers or bags with 10 kg capacity stacking in six layers namely; gunny bag, gunny bag lined with bubble sheet, foldable plastic box with cells (FPBC), poly propylene bag, egg tray in CFB carton, plastic crate and corrugated fiber board (CFB) carton was made. The fruits in different containers were transported from Junagadh to Jamnagar and from Jamnagar to Junagadh by road requiring 12 h to cover approximately 300 km in goods rickshaw. Significantly higher quality parameters (hardness, firmness, bio-yield point, rupture force and marketable fruits) and minimum losses (bruising, cracking, impact damage, ripening and decay) were observed in FPBC, which was at par with ETB. Minimum deformation and total soluble solids were observed in FPBC. Maximum deformation was observed in GN and a maximum total soluble solid was in GBS. Maximum bruising was observed in the fruits on top layer while cracking and impact damaged fruits were observed in the fruits on bottom layer of stack. Minimum packaging cost (10 ₹/t) was found for gunny bag and maximum (1000 ₹/t) for CFB carton without considering the transportation losses. Net saving per tonne was found to be ₹ 1323 by using foldable plastic box with cells as compared to gunny bag and ₹ 698 as compared to plastic crate during transportation. Considering cost of container, transportation, returning empty

container/bag and total losses after transportation including decay after storage, FPBC was found cheapest container amongst all the containers and also quality of the fruits retained in the container.

- A low cost plastic ripening chamber for ripening of mango was developed and modified at Ranchi. The ripening chamber (120x80x70 cm) was fabricated by fixing 200 micron polythene

Low cost mango ripening chamber at BAU, Ranchi.

with profile & gripper at the sides of the chamber and base was sealed using 16 gauge M.I. sheet. This arrangement has helped against leaking of gas from the chamber which has helped ripening. Parameters inside ripening chamber was observed 23-38°C temperature, 96% relative humidity, 37.37 T.S.S with uniform colour whereas at outside 25-23°C temperature, 81% relative humidity, 27.37 T.S.S. with non-uniform colour. During respiration mango releases water, with time the RH inside the ripening chamber reaches near 100%. This shows that there is need to control the RH during ripening and it should be between 90-95% for better quality of ripened mango.

- Ranchi center studied the development of low cost detachable roof greenhouse for round the year cultivation of tomato. Fruit yield from polyhouse was 2 times higher as compared to open field conditions. Among the mulches, fruit yield from poly house as well as open condition with black mulch was highest (74.37 t/ha) followed by silver black mulch (66.34t/ha).

Tomato cultivation in different colour of plastics mulch by Udaipur

- Udaipur center studied the effect of different coloured plastic mulching on tomato crop. Four colours of polythene mulch, i.e. black, transparent, white and yellow were evaluated with gravity fed drip irrigation system for tomato and okra cultivation. The results showed the maximum fruit yield (7205.00 g/sqm) in black poly-mulch. Economic analysis indicated that black mulch gave the highest net income of Rs. 9,20,382/ha and B:C ratio of 6.74 for tomato cultivation. During kharif in 2012, Okra (cv. Mahyco Bhendi No. 64) was cultivated. The silver poly-mulch was given maximum average fruit weight (260.53 g/plant) and fruit yield (1737.71 g/sqm) mean while, early days to flowering (37.55 days) and first harvesting (46.00 days) was also noticed under the same treatment. Net income was Rs. 1,03,432/ha and B:C ratio was 1.66. According to B:C ratio black poly-mulch is found best during said season while, during kharif season silver poly-mulch proved the best option. Whereas, according to the net return the tomato crop was found the best crop for growing on poly-mulch.

- The handling, packaging and transportation of custard apples was explored at MPUAT Udaipur and plastic film packaging was evaluated in participatory mode. The participatory study was carried out with tribal farmers who were involved in picking of custard apple and selling it in market at very cheap prices and Rajasthan

Different plastics film packaging and handling for transportation of custard apple at Udaipur

Vanvasi Vikas Parishad, Udaipur, who is helping the tribal people for improving their livelihood and other aspects including custard apple marketing. The interventions involved training to the farmers to collect needed information in the field and then different packing material has been tried to reduce the transportation losses. The results of second year revealed that on an average custard apple plant can produce nearly 127.06 fruits annually with having 144.92 g average fruit weight and 17.66 kg fruit yield per plant. The range of different parameters was found varying among farmers mainly because of genetic characters of plants as all plants in the area of study are growing wildly. Further, age & health of plants, topography of soil, intensity & amount of rainfall, moisture availability in the rocky area etc. are another reasons which affects the production ability of the plants. The loss in mass of the fruits, reduction in hardness of the fruits and variation in colour in various packaging materials are average of the fruits collected at five centres of the society. It was found that the fruits packed in foam sheet have minimum loss in mass (0.63%) and loss in hardness (3.14 %) while colour was same in all the treatments studied. The maximum loss in mass (2.93%) and loss in hardness (8.52%) was obtained for the control sample. The colour of the fruits after transportation was found to be good may be due to ripening of the fruits in packing. On the basis of data, it indicates that foam sheet (T_4) is found to be the best packaging material for custard apple fruits during transportation over long distance to avoid loss in mass of the fruits, reduction in hardness of the fruits and variation in colour. Shelf life study of custard apple fruits inside and outside of the Evaporative Cool Storage Structures (ECSS) indicated that during loaded condition inside of ECSS the temperature was recorded low (15 °C) while, RH was noted higher (30%) than its surrounding, which was found best in minimizing the weight losses of custard apple fruits.

Business Planning and Development Unit

Business Planning and Development (BPD) Unit (CIPHET, Ludhiana (NAIP Comp. I)

Dattatreya M. Kadam, K. Narsaiah and Praveen Verma

Business Planning and Development (BPD) provided platform to entrepreneurs to take advantages of the proven and commercialized technologies developed by the institute. Such units will provide end to end solution for establishing food processing unit in close coordination of subject matter specialists to establish a successful operational plant.

A) Special achievements

BPD Launch Workshop

BPD unit CIPHET, established with the vision to provide a platform to rural and small entrepreneurs to establish and operate processing plants. It organized a launch workshop on 13th September 2013 at the campus towards fulfilling its vision. Around 100 progressive farmers and budding entrepreneurs were invited to nurture them with the knowledge of latest CIPHET innovations in the areas of post-harvest technologies and with the information regarding incubation facility along with other vital facilities available at CIPHET.

The event was presided over by the Hon'ble DDG (Engg.), ICAR, New Delhi, Dr. N.S Rathod, the chief guest, Dr. S.N. Jha (Director (Acting), CIPHET), Dr. D.M. Kadam (Senior Scientist & CPI-BPD, CIPHET and scientists of the institute. Dr. N.S. Rathod gave the motivational and informative message to the gathering whereas Dr. D.M. Kadam gave an insight over becoming a successful entrepreneur through the incubation and other facilities of BPD unit to the progressive entrepreneurs and farmers. Event was concluded by the live demonstrations of selected processing units

Delegates during BPD launch workshop

and CIPHET workshop and facilities for the guests and gathering. Valued gathering found the event very helpful and informative. Potential entrepreneurs are in consistent touch with BPD unit and are being benefited by the timely consultancy over technical, business and marketing issues.

Incubation Facility Inaugurated at CIPHET, Ludhiana

Incubation facility of BPD Unit was inaugurated

Live demonstration of Agro Processing Facilities

at CIPHET, Ludhiana on 28th January 2014 during two days National Hindi Seminar on Food

processing and management: opportunities of self employment for entrepreneurs organised by CIPHET along with the ISAE (Punjab Chapter), Ludhiana. On this occasion, BPD brochure was also released by renowned guests. Dr. K. K. Singh, ADG (PE), ICAR, New Delhi, Dr. Bangali Baboo, Former National Director, NAIP, and Dr. W. S. Dhillon, Director, Punjab Horticultural Post-Harvest Technology Centre (PHPTC), Ludhiana, Dr. S. N. Jha, Director (Acting), Dr. R K Gupta, PC (PHT), Prof. V. K. Sehgal, Ex Prof PAU and Dr. D. M. Kadam, CPI-BPD were present during the occasion along with other dignitaries. Following facilities are provided by BPD unit :

Infrastructure support

- Appropriate size of office space each on exclusive as well as dual sharing basis.
- Basic set of furniture with limited availability of internet
- Access to common facilities like fax, printer, newspaper, cafeteria etc.
- Conference room and administrative support.

Operational and commercial support

- Referral to funding agencies/VC
- Promotion through various available platforms (website, exhibitions etc.).
- Guidance in business plan preparation
- Guidance in conducting market surveys and feasibility analysis
- Interaction with successful entrepreneurs

Scientific mentoring

- Advice from scientific experts of the domain
- Training and skill development
- Guidance for establishment of independent production unit

Apart from above, BPD is helping in transferring the technologies developed by CIPHET to entrepreneurs and train them on that technology. BPD CIPHET works as "Single window" system for people coming for taking technologies, training and guidance etc.

BPD CIPHET, Incubation Centre

Dr. Bangali Babu, Ex-ND NAIP inaugurating incubation facility

Incubation facility for amla processing incubatee

Mr. S. Jagtar Singh, an entrepreneur from Dewatwal, district Ludhiana who used to prepare various pickles and *murabba* of vegetables got started to prepare amla candies and *murabba* with the help of proper training and CIPHET incubation facilities such as washer, amla pricking machine etc. He enrolled as an incubatee at BPD-CIPHET incubation centre for 1 month i.e. from 15 January to 15 February, 2014. BPD team helped him to prepare the products. They also prepared the project layout

Mr. S Jagtar Singh demonstrating his developed products to the dignitaries and visitors present during occasion of incubation facility inauguration

and helped him to get the grant of about Rs. 15 lakh from KVIC. He also got the license from FSSAI. Then he started his food processing industry with the name ILEX Food Products which manufactures healthy and hygiene pickles (*achar*), *murabba*, *chutney*, beverages (*Sharbat*), aonla candy, turmeric (*haldi*) powder, etc.

B) Technology licensing and trainings

CIPHET tomato graders commercialized to Nagaland

CIPHET is well known for its innovative post-harvest technologies and machinery. CIPHET developed technologies and machinery is well accepted by the farmers /entrepreneurs across and beyond nation. One such classic example is demand for CIPHET developed tomato graders. Mr. Viren Agrawal from M/s. Radiant Enterprises, Dimapur, Nagaland came to know about the tomato grader through CIPHET website. Three (3) graders were fabricated at CIPHET workshop and transported to Nagaland. CIPHET developed tomato grader can be used to grade tomato in 3-4 sizes. It helps to reduce labour cost, time, damage/bruising and improves efficiency and accuracy. Graded tomatoes fetch more prices to the farmers and gives enhanced shelf-life to the consumers. The grader can also be used for other round vegetables by adjusting the gap between pipes of the grading table. The average grading capacity is 325 kg/h.

Training on sorting, grading, minimal processing and packaging of fresh fruits and vegetables

To develop entrepreneurial skills among potential processors and entrepreneurs through training is the one of the BPD objectives. The unit

CIPHET Tomato Grader

organised 3 days training on sorting, grading, minimal processing and packaging of fresh fruits and vegetables from 23rd-25th September 2013 at CIPHET Ludhiana, for Mr. Omprakash, a progressive farmer from Haryana. This training was focusesd on

extension of shelf-life of fresh fruits and vegetables through mechanical/physical process without altering the chemical composition of the same. This process also enhances the quality of the product and upgrades it to export quality. Process engages simple machines such as fruit/vegetable washer, mechanical

Dr. Rahul Kumar imparting training to Mr. Omprakash

grader, fruit/vegetable slicer, basket centrifuge and shrink wrap/nitrogen flush packaging machine (Fig. 82).

Dr. Rahul Anurag, Scientist imparted the training which was concluded by awarding the training certificate to Mr. Omprakash by Dr. S.N Jha Director

Director CIPHET, awarding training certificate to Mr. Omprakash

(Acting), CIPHET. Mr. Omprakash found the training very helpful and is now graduated to entrepreneur by registering his company, getting trademark, filling application for FSSAI and other needful licenses to start the business at Nagpur, Maharashtra.

Training of minimal processing of vegetables

Another three days training on "Minimal processing of vegetables" was conducted during 27th February to 1st March 2014. Accumulation of surface water on the fresh and minimally processed vegetables is a matter of concern as it helps in growth of pathogens and microorganisms. A basket

Fig. 82. Process flow chart for minimal processing of vegetables

centrifuge consisting of a detachable perforated cylinder helps to remove surface water from the minimally processed vegetables. Packaging systems and packaging materials play an important role in enhancement of shelf life of fresh and minimally processed vegetable. Dr. Rahul Anurag imparted the training to Mr. Abhinav Soni from Meerut. Dr. D. M. Kadam, PI-BPD and Mr Ajay Agarwal, Business Manager coordinated the activity.

Training on dried onion flakes and powder technology

Skyrocketing prices of onions have made the common man to cry and has forced the BPD unit CIPHET to rescue the common man from soaring prices of onion by conducted hands on training on processing of onion to dried onion flakes and powder for farmers and entrepreneurs from 3rd-5th October 2013 at CIPHET, Ludhiana. Mr. Pranit R. Maniyar and Mr. Deoram Baburao Mogal from Maharashtra and Mr. Balwinder Singh from Moga, Punjab participated in this.

Dr. D.M. Kadam, PI-BPD imparted the training (Fig. 83). Training dealt with conversion of raw onion into processed ready to use onion flakes and powder. Trainees showed great interest in the technology and are working towards setting up the

Peeling of onions

↓

Converting onions to flakes by using onion slicer

↓

Pre-treatment

↓

Drying of onions (using solar or tray dryer)

↓

Packaging of dried onion flakes/powder

Fig. 83. Process flow chart for onion processing

Dr. D.M. Kadam imparting hands on training for preparing onion flakes and powder to the trainees

processing units in their areas. Training was concluded by awarding the trainees with training certificate.

Training on novel process for production of green chilli puree and powder

India is the highest producer of green chillies in the world, yet huge amount of chilli is wasted due to lack of proper processing and storage facilities, which in turn leads to low returns to the

Handing over certificate to the trainee

farmers/producers. Keeping this problem in mind, CIPHET has developed a novel process for production of green chilli powder and green chilli puree, which has longer shelf-life and hence, reduc the post-harvest losses and at the same time it also delivers the high returns to the farmers/producers for their produce.

The hands on training on this was conducted from October 7 to 9, 2013 at CIPHET, Ludhiana. Dr. Mridula D and Dr. Ramesh Jangra, senior scientists imparted the 3 days training to Mr. Kamal Saraf from Khargone, M.P and Mr. Narayan R. Thakur from Nandurbar, Maharashtra. Trainees are in touch with BPD unit, CIPHET and are working forward to set up the processing plant in their respective area.

Licensing of Pearl millet based composite extrudates and pasta technology

Pearl millet based composite extrudates and pasta technology is used to develop instant product having a high caloric density, protein quality, high shelf-life by using small low-cost collet type food extruder. Relatively low capital and operating costs allow the manufacturer to prepare the product at lowest possible cost so that they can effectively reach the low income segments of population. Benefits and cost analysis of the aforesaid technology impacted entrepreneurs and farmers; Mr. Siddarath Agarwal from Ludhiana is one among those potential entrepreneurs. Dr. D. N. Yadav, Senior Scientist, Ms. Monika Sharma, Scientist imparted the training regarding technical know-how of the technology. License of the mentioned technology was transferred to the entrepreneur on December 2, 2013 by Dr. S.N. Jha, Director (Acting), CIPHET.

Licensing of ginger processing technology (dried ginger flakes, sweetened flakes, powder, and ginger paste)

The value added products such as dried ginger, ginger powder, ginger oil and ginger oleoresin are of commercial interest. These are exported from India to many countries. Hence, if they are processed and stored during peak season and made available during off-season, they command premium value. With growing income, changing lifestyle and hectic daily schedules, market for dehydrated powdered, ready to use ginger is growing especially in urban areas. In other words one can say that these products are the

Fig. 84. Process flow chart for ginger processing

Dr. Kadam imparting training to the trainees on ginger processing

Technology licensing to HP enterprenuers

demand of the time. Moving ahead with the time and taking care of the demand, CIPHET has developed ginger processing technology for dried ginger flakes, sweetened flakes, powder, and ginger paste. Processing of ginger into the value added products is given in Fig 84. Mr. Baldev Singh, Mr. Mohan Singh and Mr. Rakesh Thapa from Sirmaur, Himanchal Pradesh took the training and license of the technology.

Training on turmeric processing

Turmeric is highly used spice among the spices family and it fetches high returns to the producers/ farmers. But in many parts of India, farmers fail to get proper returns due to lack of knowledge regarding turmeric processing. Hence, farmer must know proper processing technique for turmeric. BPD in association with ToT division, CIPHET organized 3 days training from 13 to16 January 2014 for a group of 30 farmers from Chandarpur, Maharashtra. Concerned scientists from CIPHET imparted the training to the trainees and trainees found the training very helpful.

C) Participation, presentation and demonstration

Canara bank potato farmers' meet, Jalandhar

Canara bank is one of the renowned agri specialized bank in India, established in the year 1906. Agriculture Consultancy Services (ACS) is an exclusive division of the bank meant for appraising agro-based projects and to provide consultancy. The

Mr. Abinav Soni receiving technology license

Business Manager welcomed by CANARA bank officials

division, in the last 24 years, has handled more than 1000 projects involving an outlay of more than Rs. 4450 crores in the sectors (data courtesy-Canara bank) like floriculture, mushroom, dairy, poultry, plantation projects, food processing, bio-technology, cold storage, fisheries, etc., which included public issue appraisals also.

As a part of its ACS activities, Canara bank organized "Potato Farmers Meet" at Jalandhar on August 30 2013 to bring the various players of agriculture such as farmers, agri technocrats, financer and agri managers at one platform, in order to revolutionize potato farming. This meet was attended by more than 100 participants and guests.

BPD unit was privileged to be the guest and member of this remarkable event. Mr. Ajay Agrawal (Business Manager, BPD) and Er. Jasmeet Gill (SRF-BPD unit) spread the awareness among the potential farmers through resourceful presentation and easy interaction, regarding the post-harvest technologies developed and available at CIPHET. Washing and processing of harvested potato into value added products and conversion of potato by products into animal feed pallets were shown. Potato peeler and washer were the most queried technology and equipment at the event as farmers found these as easy to use, cost effective and time saving equipment. Through this event, BPD unit added progressive farmers/clients to its upcoming incubate/entrepreneur database and at the same time BPD unit also established B2B links with other potential machine manufacturers, marketing specialists to assist and help prospective CIPHET incubate/entrepreneurs.

PAU *kisan* club meeting

BPD CIPHET in collaboration with PAU *kisan* club organized interaction meeting on January 2, 2014 during PAU *kisan* club meeting. During this meeting Mr. Ajay Agrawal, Business Manager, BPD gave the presentation on CIPHET developed

Mr. Ajay Agrawal, Business Manager BPD CIPHET creating awareness among the farmers

technologies and created awareness among the Punjab farmers about post-harvest engineering and technology, food and agro processing, machine manufacturing. About 250 farmers attended the event. Mr. Harshad Mandge, RA also attended the meeting.

PAU *Kisan* Mela 2013

BPD unit participated in PAU *Kisan* Mela from 13th-14th September 2013 and created awareness among the farmers and food processors from all over India by showcasing the CIPHET developed post-harvest processing technologies and machinery.

FICCI food 360-International conference cum exhibition

FICCI Food 360 - an International conference organized in collaboration with ICRISAT at Hyderabad during 6th–7th November 2013. The conference made an attempt to bring technology, research, venture capitalists, social organizations and

Business Manager, BPD CIPHET, promoting CIPHET technologies and machinery at FICCI 360

corporates under one umbrella. The theme behind FOOD 360 was "The Next Wave of Opportunities". FOOD 360 plays a central role in connecting business opportunities in agriculture, food processing and allied areas. Conference has provided BPD unit CIPHET with a platform to promote CIPHET developed post-harvest technologies, machinery and structures, which helped to create and diversify business.

Kisan mela at Pimpri, Pune

Kisan mela fair was organized from 13th-17th December 2013 at Pimpri, Pune. Kisan forum invited BPD unit through ICRISAT to exhibit its post-harvest technologies and machinery for the benefit and upliftment of farmers in the Maharashtra and adjoining regions. Huge number of visitors visited the BPD stall during the fair and got their queries answered by the experts of agro/food processing sector. CIPHET banana-comb/hand cutter, pomegranate aril extractor (hand tool) and booklet on CIPHET developed post-harvest technologies were on demand during the fair. Farmers and entrepreneurs got benefitted from the BPD unit CIPHET stall. Few firms showed their interest in getting licenses of pomegranate aril extractor and CIPHET banana-comb/hand cutter.

Visitors at the BPD stall

Dr. D. M. Kadam, Sr. Scientist &PI-BPD demonstrating the CIPHET Banana-comb/hand cutter to the interested farmers

Demonstraton at NIRD Hyderabad

BPD unit participated in 12th Rural Technology and Crafts Exhibition Organized by National Institute of Rural Development (NIRD) Hyderabad from 14th-19th February 2014. Exhibition was inaugurated on 14th February 2014 by Hon'ble Director General (DG) of NIRD Dr. M.V. Rao in the presence of several dignitaries and renowned business personals from all over India. In a 6 day event, CIPHET has put its stall to demonstrate and display the post-harvest technologies and machinery developed by it. Dr. D. M. Kadam (Sr. Scientist and PI-BPD) and Samuel Devashish Mitra (SRF-BPD) participated in it and explained the activities of institutes to the interested visitors from all over India including Andhra Pradesh. About 30 potential clients has shown interest in CIPHET developed

12th Rural Technology and Craft exhibition

technologies such as agro/food processing machinery, groundnut based milk beverage, paneer and curd technology, evaporative cooled room structure, pearl millet based extrudates, pasta and weaning mix technology, fish processing machinery and technology, meat processing technology, tomato processing plant, bamboo processing and preservation technology, fruit beverage technology, oil extraction technology, tamarind processing and other medicinal plant based technology, roti/chapati making machine etc. Visitors and clients found the BPD CIPHET stall very helpful and highly innovative as they discovered several technologies and machinery related to their concerned post-harvest processing field/business. Clients were interested to adopt CIPHET developed technologies in their existing business/ wanted to establish new business.

Presentation in India-Africa forum summit

Dr. D. M. Kadam, Senior Scientist and PI-BPD gave presentation on "CIPHET Developed Technologies on Post-Harvest Engineering and Technology" to the 25 food processing incubator professionals from 5 African countries i.e. Cameroon, Uganda, Mali, Angola and Kenya on 27th February 2014. Two-week training program on "Development of Agribusiness and Food Processing Business Incubation Centres in Africa" under India-Africa Forum Summit (IAFS)-II 2013-14 from February 18 to March 01, 2014 was organized by ICRISAT at Hyderabad. It was great opportunity to showcase the CIPHET developed technologies to Africans and had B2B meeting with interested participants. Many were interested in CIPHET technologies and some persons have approached the BPD for technology and consultancy.

Dr. D.M. Kadam delivering lecture on post-harvest technologies and machinery structure developed by CIPHET

Entrepreneurship Development Programme at District Industries Commission

District Industries Commission (DIC) is a responsible body for the development of industries at district level invited BPD unit to create awareness among the interested and potential entrepreneurs of the district during Entrepreneurship Development Programme (EDP) on the topic: "Role of Post-Harvest Technology" at DIC office Ludhiana on 10th March 2014. Mr. Ajay Agrawal, Business Manager BPD unit made the participants aware about the business development through adopting CIPHET developed post-harvest technologies and machinery. He also informed the participants regarding incubation facility available at CIPHET for the budding and interested entrepreneurs, through which they can start their business without investing their capital over setting up of production unit at the initial stage. They can take the CIPHET plants (tomato processing plant, chilli processing unit, dhal mill, oil extraction plant, rice mill, soya milk plant, spices processing unit, animal feed plant etc.) on custom hiring basis at very minimum fee as

Mr. Ajay Agrawal, Manager BPD Unit, giving presentation at DIC office Ludhiana

incubatee. Participants found the information very useful and few interested entrepreneurs visited CIPHET facilities and are in touch with BPD unit to register for incubation facility.

PAU *Kisan* mela 2014

BPD participated in PAU *Kisan mela* from 14th-15th March 2014 and created awareness among the farmers and food processors from all over India by

Eager visitors thronging CIPHET stall

showcasing the CIPHET developed post-harvest processing technologies and machinery.

Orientation workshop and hands-on training programme for BPD units in the NARS Hyderabad

ICAR, NAIP in association with ICRISAT organized a Workshop and Hands-on Training Programme for BPD Units in the NARS between 24th–26th October 2013 at IIIT Hyderabad. During this programme, orientation for new BPD's and interaction sessions were carried out. They also gave information regarding BPD's *modus operandi*, incubation facility and regarding creation of business profile. Through this training BPD unit, CIPHET got to know the BPD team of other institutes (which helped new BPDs to sort out the various routine hurdles), widen the knowledge base, disseminate the technologies to other institute by sharing the information with each other.

LIST OF ON-GOING RESEARCH PROJECTS

INHOUSE & COLLABORATIVE PROJECTS

Sr. No.	Project Name	Name of Project Leader & Associates
1.	Impact Assessment of Entrepreneurship Development Programme (EDP) conducted by CIPHET	Dr. Sangeeta Chopra (PI) till March, 2011 Dr. Dilip Jain (PI) w.e.f April, 2011 to Aug 2011 Dr. A K Dixit (Co-PI & PI) from August, 2011 Dr. Indu Karki (Co-PI) w.e.f. September, 2010
2.	Development of nutritive functional flour & food products.	Dr. Mridula Devi (PI) Dr. Anita Kochar (Co-PI), PAU, Ludhiana Dr. M.R. Manikantan (Co-PI) till July, 2013 Ms. Monika Sharma (Co-PI) w.e.f. Nov, 2010
3.	Characterization, fortification, cooking and quality evaluation of soft rice.	Dr. Mridula D (PI) Ms. Deepika Goswami (Co-PI) Dr. N. Shobha Rani (Co-PI), DRR, Hyderabad) Dr. Suneetha Kota (Co-PI), DRR, Hyderabad
4.	Development of pilot level process and technology for the production of protein rich flour from deoiled sesame and sunflower seeds.	Dr. M.R. Manikantan (PI) Dr. D. N. Yadav (Co-PI) Dr. R.K. Gupta (Co-PI) w.e.f. March, 2012
5.	Assessment of poultry, goat, sheep and fish processing and its refinement and upgradation through technological intervention.	Dr. Tanbir Ahmad (PI) Dr. Gaikwad Nilesh (Co-PI) till 03-08-2013 Dr. Yogesh Kumar (Co-PI) till 02-04-2012 and again (Co-PI) w.e.f. 26-03-2013
6.	Enhancement of shelf-life and microbial safety of meat and meat products applying high pressure, vacuum packaging and natural extract.	Dr. S.K. Devatkal (PI) Dr. P.S. Rao, (Co-PI), IIT, Kharagpur till December, 2012 Dr. Rahul Kumar w.e.f. 17-04-2012 till foreign deputation period of PI
7.	Development of non-dairy based probiotic foods.	Dr. Sangita Bansal (PI) Dr. S.N. Bhowmik (Co-PI) till 19-10-2011 Dr. Satish Kumar (Co-PI) w.e.f. 22.02.2012 Dr. Manisha Mangal (Co-PI) w.e.f. 20-04-2012 till 07-08-2013
8.	Development of a PCR based diagnostic process for the detection of potential aflatoxin producing molds during post harvest handling in rice.	Dr. Manisha Mangal (PI) till 07-08-2013 Dr. Sangita Bansal (Co-PI) till 06-08-2013 and (PI) w.ef. 07-08-2013 Dr. H.S. Oberoi (Co-PI) till October 2013 Ms. Surya (Co-PI) w.e.f. November, 2013
9.	Extraction of dietary fibres from byproducts of selected coarse cereals and pulses and development of functional foods.	Dr. Satish Kumar (PI) till 30-03-2013 Dr. Sangita Bansal (Co-PI) Dr. Anil Dixit (Co-PI) Dr. P. Barnwal (Co-PI) w.e.f. January 2012 till 10-09-2013

Sr. No.	Project Name	Name of Project Leader & Associates
10.	Development of functional and convenience foods based on maize and sorghum.	Ms. Monika Sharma (PI) Dr. Mridula D. (Co-PI)
11.	Process technology for shelf stable millet flour and gluten free baked products.	Ms. Deepika Goswami (PI) Dr. R. K. Gupta (Co-PI) Dr. S.N. Bhowmik (Co-PI) till 19-10-2011
12.	Development of an ohmic -heating system for heating solid and liquid foods.	Dr. Devinder Dhingra (PI) till October, 2011. Dr. Sangeeta Chopra (Co-PI) till October, 2011 & (PI) w.e.f. October, 2011 till 05-03-2013. Dr Prasoon Verma (PI) w.e.f. 05-03-2013 till 06-08-2013. Dr. Manisha Mangal (Co-PI) w.e.f. 22.02.2012 till 21-02-2013
13.	Shelf life enhancement of fresh-cut fruits using enzyme technology.	Dr. Sunil Kumar (PI) Er. V. Eyarkai Nambi (Co-PI) till 22-08-2012 Dr. Ramesh Kumar (Co-PI)
14.	Assessment of occupational health hazards among workers in agro processing units.	Dr. Indu Karki (PI) Dr. Gaikwad Nilesh Nivrutti (Co-PI) till 03-08-2013
15.	Effect of over tree sprinklers, foggers and colour shade nets to reduce heat stress to pomegranate crop in semi arid region of Punjab.	Mr. V.S. Meena (PI) till 11-01-2013 Dr. Jitendra Singh (Co-PI) Dr. D.D. Nangare (Co-PI) till 01-09-2012
16.	Optimization of suitable colored plastic mulch for the repulsion of insect pests in vegetable crops.	Dr. Jitendra Singh (PI) Dr. Bharat Bhushan (Co-PI)
17.	Development of poly-house structure using ground air heat exchanger for mushroom cultivation in semi-arid region.	Dr. Jitendra Singh (PI) Dr. Bharat Bhushan (Co-PI)
18.	Development of animal handling and automated cooling systems for dairy farms.	Dr. K. Narsaiah (PI) Dr. Yogesh Kumar (Co-PI) Ms. Leena Kumari (Co-PI) Dr. Sandeep Mann (Co-PI) w.e.f. 01.11.2013 Association of Dr. Sandeep Mann as Co-PI w.e.f. 1.11.2013 Dr. Mukesh Bhakat (CCPI), NDRI, Karnal Dr. T.K. Mohanty (CCCo-PI), NDRI, Karnal
19.	Development of nano-particle embedded biodegradable food packaging biopolymer	Dr. D.M. Kadam (PI) Dr. P. Jaiswal (Co-PI)
20.	Development of nano-biocomposite based construction material for storage of food grains	Dr. D.M. Kadam (PI) Dr. Manju Bala (Co-PI) w.e.f 01.11.2013
21.	Development of hybrid cold storage structure for onion and tomato.	Er. Manpreet Kaur (PI) till 24-07-2013 Ms. Leena Kumari (Co-PI) Dr. R.K Vishwakarma (PI) w.e.f. 1.11.2013

Sr. No.	Project Name	Name of Project Leader & Associates
22.	Shelf life extension of strawberry and plum fruits using active packaging in high barrier metal laminates.	Dr. Rahul Kumar (PI) Dr. Pranita Jaiswal (Co-PI)
23.	Development of RFID based quality tracing system	Ms. Leena Kumari (PI) Dr. K. Narsaiah (Co-PI) Dr. Rahul Kumar (Co-PI)
24.	Technology for production of protein concentrate / isolate from commercial peanut cake	Dr. D.N. Yadav (PI) Dr. R.K. Gupta (Co-PI) Dr. Mridula D (Co-PI) Dr.Manisha Mangal (Co-PI) till 07-08-2013
25.	Primary processing and value addition of pseudocereals	Dr. Aleksha Kudos (PI) Dr. Mridula D (Co-PI) Dr. R.K. Gupta (Co-PI)
26.	Development of process technology for browning inhibition, novel product development and by product utilization of pear (Revised Title).	Dr. Ramesh Kumar (PI) Dr. Sunil Kumar (Co-PI) Dr. P.C. Sharma (Co-PI) w.e.f. 1.11.2013
27.	Development of process protocol for de-bittering of kinnow juice.	Dr. Sunil Kumar (PI) Dr. Ramesh Kumar (Co-PI) Dr. P.C. Sharma, (Co-PI)
28.	Design and development of bael pulper	Dr. Nilesh Gaikwad (PI) till 03.08.2013 Dr. Rahul Kumar (Co-PI) & PI w.e.f. 03-08-2013 Dr. D. R. Rai (Co-PI) till 20-04-2013
29.	Development of national database on post harvest technologies.	Dr. Indu Karki (PI) Dr. Tanbir Ahmad (Co-PI) Dr. D. R. Rai (Co-PI) till 20-04-2013 Dr. S.K. Nanda (Co-PI)
30.	Development of continuous primary processing and shrink packaging line for cauliflower and cabbage	Dr. R.K. Vishwakarma (PI) Dr. Ramesh Kumar (Co-PI) Ms. Leena Kumari (Co-PI
31.	Development of fat replacer and hydrocolloid from pearl millet and barley.	Ms. Monika Sharma (PI) Dr. D.N.Yadav (Co-PI) Dr. A.K Singh (Co-PI), NDRI, Karnal
32.	Development of vegetable mixed-wadi making system	Dr. Sandeep Mann (PI) Ms. Deepika Goswami (Co-PI)
33.	Design & development of oat dehuller.	Dr. Aleksha Kudos (PI) Dr. Anil Dixit (Co-PI)
34.	Shelf life enhancement and quality improvement by controlling pericarp browning of litchi fruits using enzyme technology.	Dr. Bharat Bhushan (PI) Dr. P.C. Sharma (Co-PI)
35.	Development of carrier system for live table carps rohu (Labeo rohita Hamilton) and silver carp (Hypophthelmicthys molitrix Valenciennes)	Dr. Armann U. Muzaddadi (PI) Dr. Tanbir ahmed (Co-PI) Dr. Monika Kundu (Co-PI)

EXTERNALLY FUNDED PROJECTS

Sr. No.	Project Name	Name of Project Leader & Associates
1.	Optimization of parameters for utilization of paddy straw, kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements	Dr. H.S. Oberoi (PI) Dr. D.S. Uppal (Co-PI) w.e.f. 19-07-2006 to 31-03-2007 Dr. V.K. Bhargav (Co-PI) w.e.f. 10-03-2008 to 27-11-2010 Dr. Pranita Jaiswal (Co-PI) w.e.f. 04-04-2009 to 11-08-2010
2.	Value chain on potato and potato products	Dr. Devinder Dhingra (CCPI) till 04-10-2011 Dr. Sangeeta Chopra (CCPI) w.e.f. 20.10.2011 to 05.03.2013 Er. Prasoon Verma (CCPI) w.e.f. 05.03.2013 till 08.08.2013 Dr. Tanbir Ahmad (CCPI) w.e.f 08-08-2013
3.	Value chain on commercial exploitation of underutilized fruits of tribal zones of Rajasthan	Dr. R.K. Gupta (CCPI) till 20.10.2011 Dr. A.K. Thakur (CC-CoPI) till transferred Dr. Ramesh Kumar (CC-CoPI) w.e.f. 24-04-2009 Dr. Goutam Mandal (CC-CoPI) w.e.f. 24-04-2009 till 13-01-2010 Dr. R.K. Vishwakarma (CC-CoPI) w.e.f. 19-01-2010 and (CCPI) w.e.f. 21.10.2011till 18-07-2013 Dr. P.C. Sharma (CCPI) w.e.f. 18-07-2013 Er. V. Eyarkai Nambi (CC-CoPI) w.e.f. 03-08-2010 till 22-08-2012
4.	Novel biotechnological process for production of high value products from rice straw & baggasse	Dr. H.S. Oberoi (CCPI) Dr. V.K.Bhargav (Co-CCPI) till 27-11-2010 Dr. M. Manjunatha (Co-CCPI) w.e.f. 04-05-2011 till 26-05-2012 Dr. K. Narsaiah (Co-CCPI) w.e.f. 06-10-2012
5.	Studies on cryogenic grinding for retention of flavour and medicinal properties of some Important Indian spices	Dr. K.K.Singh (CPI) till 18-02-2010 Dr. S. Balasubramanian (Co-CPI) & (CPI) w.e.f. 18.02.2010 till 22-06-2011 Dr. D.M. Kadam (Co-CPI) till 04-02-2011 Dr. P. Barnwal, (Co-CPI) till 04-02-2011 & (CPI) w.e.f. 10-08-2011 till 10-09-2013 Dr. D.N. Yadav (CPI) w.e.f. 01-10-2013
6.	A value chain on composite dairy foods with enhanced health attributes	Dr. S. Balasubramanian (CCPI) till 22-06-2011 Dr. D.N. Yadav (Co-PI) & (CCPI) w.e.f 23-06-2012 Ms. Monika Sharma (CCo-PI) w.e.f. 25-03-2013

Sr. No.	Project Name	Name of Project Leader & Associates
7.	Mobilizing mass media support for sharing Agro-information	Dr. Indu Karki (CCPI) w.e.f. 10.04.2013 Dr. D.R. Rai (CCPI) till 10.04.2013 Dr. Jitendra Singh (Co-CCPI) Dr. Sangeeta Chopra (Co-CCPI) till 19.03.2013
8.	Developing, commissioning, operating and managing and online examination system for NET/ARS-Prelims. Exam for ASRB, ICAR	Dr. R.K. Gupta (CCPI) w.e.f. 14-02-2014 Dr. S.N. Jha (CCPI) w.e.f 17-05-2013 till 13-02-2014 Dr. U.S. Shivhare (CCPI) w.e.f 23-03-2012 till 16-05-2013 Dr. R.K. Gupta (CCPI) w.e.f. 22-06-2011 till 22-03-2012 Dr. R.T. Patil, Director CIPHET (CCPI) \till 21-06-2011 Dr. Devinder Dhingra , Nodal Officer till 04.10.2011 Dr. M.R. Manikantan, Nodal Officer w.e.f. 05/10/2011 till 18.07.2013 Dr. R.K. Gupta, Nodal Officer w.e.f. 26-10-2012 till 13-02-2014 Ms. Leena Kumari, Nodal Officer w.e.f. 18.07.2013
9.	Microencapsulation methods for bacteriocins for their controlled release	Dr. K. Narsaiah (CPI) Dr. S.N. Jha (CCPI) Dr. M.R. Manikantan (CCPI) till 18-07-2013
10.	Improvement the microbial safety and nutritional quality of fresh meat using a low cost refrigerated cabinet for retail marketing of meat in street meat shops.	Dr. Suresh Devatkal (PI) Dr. Rahul Kumar (Co-PI) w.e.f. 06-09-2013
11.	Up-gradation of quality control food testing laboratory	Dr. S.N. Jha (PI) Dr. S. Kumar Devatkal (Co-PI) Dr. H.S. Oberoi (Co-PI) Dr. Rahul Kumar (Co-PI)
12.	Development of spectroscopic methods for detection and quantification of adulterants and contaminants in fruit juices and milk	Dr. S.N. Jha (PI) Dr. Pranita Jaiswal (Co-PI) Er. Manpreet Kaur Grewal (Co-PI) till 24.07.2013
13.	Assessment of quantitative harvest and post harvest losses of major crops/commodities In India.	Dr. R.K. Gupta w.e.f. 14.11.2013 Dr. S.K. Nanda (PI) till 13.11.2013 Dr. R.K. Vishwakarma (Co-PI) Dr. Anil Dixit (Co-PI) w.e.f. 14.11.2013 Dr. Aleksha Kudos (Co-PI) w.e.f. 14.11.2013

Sr. No.	Project Name	Name of Project Leader & Associates
14.	Adaptation of top lit updraft gasifier stove for rural poor woman of Punjab	Er. Prasoon Verma (PI) w.e.f. 20-02-2013 till 05-08-2013 Dr. Sangeeta Chopra (PI) till 19-02-2013 & (Co-PI) w.e.f. 20-02-2013 till 05-03-2013 Dr. D.R. Rai (Co-PI) till 20-04-2013 Dr. Indu Karki (Co-PI) w.e.f. 20-02-2013 & (PI) w.e.f. 05-08-2013 Sh. O.P. Moodan, T-5 (Co-PI) till 31-12-2013
15.	Business Planning & Development (BPD) Unit at CIPHET, Ludhiana	Dr. D.M. Kadam (PI w.e.f. 20-08-2013); Co-PI from 22-05-2013 to 19-08-2013 Er. Prasoon Verma (22-05-2013 to 19-08-2013) Dr. K. Narsaiah (Co-PI) Dr. P. Barnwal (Co-PI) (17-05-2013 to 10-09-2013) Dr. Nilesh Gaikwad (Co-PI) (17-05-2013 to 02-08-2013)
16.	Technology for enhancing oil recovery and production of edible grade de-oiled meal from sunflower and groundnut and their diversified uses.	Dr. R.K. Gupta (PI) Dr. M.R. Manikantan (Co-PI) till 18-07-2013 Dr. Mridula D (Co-PI)
17.	Development of molecular tools for detection of adulteration of medicinal oilseeds and spices for value addition and processing	Dr. Sangita Bansal (PI) w.e.f. 22-01-2014 Dr. Anupan Mangal (Co-PI) Dr. Sanjeev Kumar (Co-PI)
18.	Study on determining storage losses in food grains in FCI and CWC warehouses and to recommend norms for storage losses	Dr. R.K. Gupta (PI) w.e.f. 14-11-2013 Dr. S.K. Nanda (PI) till 13-11-2013 Dr. Anil Dixit (Co-PI) w.e.f. 14-11-2013 Dr. S.K. Aleksha Kudos (Co-PI) w.e.f. 14-11-2013

RESEARCH PAPERS PUBLISHED

Babbar N, Agarwal P and Oberoi HS (2014). Effect of addition of hydrocolloids on the colloidal stability of litchi (*Litchi chinensis Sonn.*) Juice. Journal of Food Processing and Preservation. DOI: 10.1111/jfpp.12220.

Bansal S, Singh A, Mangal M and Sharma SK (2013). Isolation and characterization of lactic acid bacteria from fermented foods. Vegetos, 26(1): 325-330.

Bhogal NS, Bala M, Kumar S, Nanjundan J and Singh YP (2013). Distribution of (n-9) and (n-7) isomers of monounsaturated fatty acids in Indian mustard (*Brassica juncea*). J Am Oil Chem Soc. DOI 10.1007/s11746-013-2387.

Bhowmik SN, Balasubramanian S and Yadav DN (2013). Influence of most-probable-number method and container perforation numbers on fungal population density during tempeh production. Indian Journal of Agricultural Sciences, 83 (8):889-892.

Bhushan B, Pal A, Kumar S and Jain V (2013). Biochemical characterization and kinetic comparison of encapsulated haze removing acidophilic xykinase with partially purified free xylanase isolated from Aspergillus flavus VI ICC 9390. Food Science and Technology. DOl: 10.1007/s 13 197-013-1013-7.

Bhushan B, Kumar S and Pal A (2013). Production and partial characterization of extracellular xykinase from acidophilic Aspergillus flavus MTCC 9390 grown in SSF mode. Research J. Biotechnol. Accepted : Online ISSN : 2278-4535.

Bhushan B, Pal A and Singh A (2013). Effect of lead on protein dissolution and phosphate mobilization in germinating oat seeds [Avena saliva L. cv. 11.1-8). Ind. J. Agri. Res., 47 (5): 402-410.

Bisht TS, Sharma SK, Sati RC, Rao VK, Yadav VK, Dixit AK, Sharma AK and Chopra CS (2013). Improvement of efficiency of oil extraction from wild apricot kernels by using enzymes. J Food Sci Technol, DOI 10.1007/s3197-013-1155.

Chaves MA, Barreto IMA, Reis RC and Kadam DM (2013). Physicochemical and sensory properties of purple Brazilian cherry (Eugenia uniflora, L.) foams. International Journal of Food Science and Technology, 48 (8), 16881697. DOI: 10.1111/ijfs.12139.

Dixit AK, Sharma SK, Sikka BK, Sharma R and Sharma AK (2013). Entrepreneurship development in wild apricot processing: a study of Tehri Garhwal and Dehradun district of Uttarakhand (India). Indian Journal of Agricultural Marketing, 27 (1): 91-103.

Grewal MK, Jha SN, Patil RT, Dhatt AS, Kaur A and Jaiswal P (2013). A less energy intensive process for dehydrating onion. Journal of Food Science and Technology, DOI: 10.1007/s13197-013-1092x.

Jai Paul, Dixit AK, Sharma AK and Vinod K (2014). Nutrient recycling and its relationship with biofertility

indicators of soil health and nutrient uptake in a rice (Oryza sativa L.)-wheat (Triticaum aestivum L. emed. Fiori &Paol) cropping sequence. Agroecology and Sustainable Food System, 38(4): 445-459.

Jaiswal P, Jha SN, Singh AK and Bhardwaj R (2013). Diversity of pectinolytic molds on major Indian mango cultivars. Egyptian J Biology, 15: 48-54.

Jha SN, Narsaiah K, Jaiswal P, Bharadwaj R, Gupta M, Kumar R and Sharma R (2014). Nondestructive prediction of maturity of mango using near infrared spectroscopy. Journal of Food Engineering, 124: 152-157.

Jha SN, Jaiswal P, Narsaiah K, Kaur PP and Kumar R (2013). Textural properties of mango cultivars during ripening. Journal of Food Science and Technology, 50(6):1047-1057.

Jha SN, Jaiswal P, Grewal MK, Gupta M and Bhardwaj R (2013). Detection of adulterants and contaminants in liquid foods - a reviews. Critical Reviews in Food Science and Nutrition (In Press).

Jha SN, Jaiswal P, Narsaiah K, Kumar R, Sharma R, Gupta M, Bhardwaj R and Singh AK (2013). Authentication of mango varieties using near-infrared spectroscopy. Agriculture Research, 2(3): 229-235.

Jha SN, Jaiswal P, Narsaiah K, Kumar R, Sharma R, Kaur PP and Bhardwaj R (2013). Determination of maturity parameters of Indian mango cultivars based on eating quality during natural ripening. Journal of Agricultural Engineering, 50(2):26-35.

Jain D, D Mridula and Thakur N (2013). Study on the effect of machine operative parameters on physical characteristics of rice/maize based fruit/vegetable pulp fortified extrudates. Agriculture Engineering International, 15(2): 231-242.

KB Vivek, Kondal K, Reddy PV, Reddy M, Kumar MS and Narsaiah K (2013). Effect of co-encapsulation of probiotics with prebiotics and their survivability in *dahi* during storage. International Journal of Agriculture and Food Science Technology, 4 (1): 67-75.

Kadam DM, Gupta MK and Kadam VM (2013). The thin layer drying kinetics of henna leaves. Agricultural Engineering Scientific Journal, Serbia, 38(3): 85-100.

Kadam DM, Thunga M, Wang S, Kessler MR, Grewal D, Lamsal B and Yu C (2013). Preparation and characterization of whey protein isolate films reinforced with porous silica coated titania nanoparticles. Journal of Food Engineering, 117 (1), 133-140.

Karki I, Sharma P and Samantaray SD (2013). Shift work and its impact on the sleep quality of nurses. Indian Journal of Social Research, 54 (4): 43-47.

Kaur B, Oberoi HS and Chadha BS (2014). Enhanced cellulase producing mutants developed from heterokaryotic Aspergillus strain. Bioresource Technology, 157: 100-107.

Kaur B, Sharma M, Soni R, Oberoi HS and Chadha BS (2013). Proteome-based profiling of hypercellulase-

producing strains developed through interspecific protoplast fusion between Aspergillus nidulans and Aspergillus tubingensis. Applied Biochemistry and Biotechnology, 169: 393-407.

Kotwaliwale N, Singh K, Kalne A, Jha SN, Seth N and Kar A (2014). X-ray imaging methods for internal quality evaluation of agricultural produce. Journal of Food Science and Technology, 51(1): 1 - 15.

Kumar S, Kumar R, Nambi VE and Gupta RK (2013). Post-harvest changes in antioxidant capacity, enzymatic activity and microbial profile of strawberry fruits treated with enzymatic and divalent ions, Food and Bioprocess Technology: An Int. J.(IX)I 10.1007/s I 1947-01 3-1 2 12-7.

Kumar V and Bala M (2013). Development of web based database on biochemical characteristics of rapeseed-mustard. Bioinformation, 9(10): 537540.

Kumar Y and Deo C (2013). Response of feeding different sources and levels of zinc on growth performance and carcass yield of broiler chicks. Indian Veterinary Journal, 91 (2): 11.

Kumar Y, Deo C, Shrivastava HP, Mandal AB, Wadhwa A and Singh I (2013). Growth performance, carcass yield, and immune competence of broiler chickens as influenced by dietary supplemental zinc sources and levels. Agricultural Research, 2:270-274.

Kumar Y, Langoo BA, Sharma SK and Yadav DN (2013). Technological, physico-chemical and sensory properties of raw and cooked meat batter incorporated with various levels of cold milled flaxseed powder. Journal of Food Science and Technology, DOI 10.1007/S13197-013-1185.

Kumar Y, Narsaiah K and Namdeo A (2013). Effect of pediocin, acidified sodium chlorite and benzoic acid on color, oxidative and microbial shelf life of goat meat. Journal of Food Science and Technology, (accepted).

Manikantan MR, Sharma R, Yadav DN and Gupta RK (2013). Selection of process parameters for producing high quality defatted sesame flour at pilot scale. Journal of Food Science and Technology, DOI: 10.1007/s13197-013-1131-7.

Mishra BK, Jain NK, Kumar S and Sharma KC (2013). Storage stability of ready-to-serve beverage from malum (*Maclhuca indica*) llovvers. Indian Journal of Horticulture, 70(3): 459-462.

Mridula D and Jha P (2013). Preparation of iron-fortified rice using edible coating materials. International Journal of Food Science and Technology, DOI: 10.1111/ijfs.12305.

Mridula D, Barnwal P and Singh KK (2013). Screw pressing performance of whole and dehulled flaxseed and some physico-chemical characteristics of flaxseed oil. Journal of Food Science and Technology, DOI 10.1007/s13197-013-1132-6.

Mridula D, Sharma M, Manikantan MR and Gupta RK (2014). Development of quick cooking dalia utilizing sprouted wheat. Journal of Agricultural Engineering, 50(4): 14 -22.

Mridula D, Singh KK and Barnwal P (2013). Development of omega-3 rich energy bar with flaxseed. Journal of Food Science and Technology, 50(5): 950-957.

Muzaddadi AU, Barman P, Goswami UC and Mandal SC (2014). A modified method for the preparation of sukati mas: a traditional fish powder of northeast India from mola (Amblypharyngodon mola). Fishery Technology, 51: 1-8.

Narsaiah K and Jha SN (2013). Mechanical methods for tenderization of goat meat. Journal of Agricultural Engineering, 50 (3): 46-50.

Oberoi HS, Rawat R and Chadha BS (2014) Response surface optimization for enhanced production of cellulases by Aspergillus niger HN-2 with improved functional characteristics. Antonie van Leeuwenhoek. Journal of Microbiology, 105: 119-134.

Sahu BB, Sarkar B, Mahapatra BC, Barik NK, Pillai BR, Lalrinsanga PL, Patra G, Jaysankar P, Ghosal MK, and Bhatnagar PR (2013). Development and performance of a microbound larval feed dispenser in macrobrachinm rosenbergii hatcheries. The Asian Journal of Animal Sciences, 8(1): 40-43.

Sandhu SK, Oberoi HS, Babbar N, Miglani K, Chadha BS and Nanda D (2013). Two-stage statistical medium optimization for augmented cellulase production via solid-state fermentation by newly isolated Aspergillus niger HN-1 and application of crude cellulase consortium in hydrolysis of rice straw. Journal of Agriculture and Food Chemistry, 61: 12653-12661.

Sarkar B, Sahu BB, Mohapatra BC, Barik NK, Majhi D, Jayasankar P and Bhatnagar PR (2013). Design and development of an innovative mobile fish vending unit for retailers. International Journal of Innovative Technology and Exploring Engineering, 2 (3): 158-162.

Sharma A, Joshi A, Rajamani G, Kumar S, Srinivasan R and Chakravarti D (2013). Molecular profiling of pectinase producing fungi. Annals of Biology, 29(3): 264-270.

Sharma M and Mridula D (2014). Probiotics : a comprehensive approach towards health foods. Critical Reviews in Food Science & Nutrition, 54(4): 537-552. DOI : 10.1080/10408398.2011.594185.

Sharma M, Kadam DK, Chadha S, Wilson RA and Gupta RK (2013). Influence of particle size on physical and sensory attributes of mango pulp powder. International Agrophysics, 27 (3): 323-328.

Sharma M, Mridula D and Gupta RK (2013). Development of a formulation for instant corn based dessert mix powder and quality evaluation. Research advances. Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci. DOI 10.1007/s40011-013-0267-6.

Sharma R, Sharma PC, Rami JC and Joshi VI (2014). Improving the olive oil yield and quality through enzyme assisted mechanical extraction, antioxidant and packaging. Journal Food Processing & Preservation. DOl. 101 I I I .If pp .12216.

Sharma SK, Yadav VK, Rao VK and Dixit AK (2013). Enhancement of health promoting properties while substituting exogenous citric acid by seabuckthorn (Hippophae salicifolia) pulp in preparation of sweet orange. Journal of Food Processing and Preservation (on line published, 16 May 2013).

Singh BK, Bala M and Rai PK (2013). Fatty acid composition and seed meal characteristics of Brassica and allied genera. National Academy Science Letters India (Accepted).

Singh R, Mishra BK, Shukla KB, Jain NK, Sharma KC, Kumar S, Kant K and Ranjan JK (2013). Fermentation process for alcoholic beverage production from mahu (*Maclhuca indica* J. F. Mel.) flowers. African Journal of Biotechnoloy, 12(39): 5771-5777.

Wilson RA, Kadam DM, Chadha S, Grewal MK and Sharma M (2013). Physicochemical quality evaluation of stored foam mat dried mango powder. Journal of Food Processing and Preservation. DOI: 10.1111/jfpp.12158.

Yadav DN, Anand T, Navnidhi and Singh AK (2013). Co-extrusion of pearl millet-whey protein concentrates for expanded snacks. International Journal of Food Science and Technology. DOI:10.1111/ijfs.12373.

Yadav DN, Navnidhi, Anand T, Sharma M and Singh AK (2013). Rheological quality of pearl millet porridge as affected by grits size. Journal of Food Science and Technology. DOI:10.1007/s13197-013-1252.

Yadav DN, Thakur N, Sunooj KV and Singh KK (2013). Effect of partially de-oiled peanut meal flour (DPME) on textural, organoleptic and physico-chemical properties of bread. International Food Research Journal, 20(3): 1307-1312.

Yuvraj, Kaur P, Uppal SK, Sharma P and Oberoi HS (2013). Chemical composition of sweet sorghum juice and its comparative potential of different fermentation processes for enhanced ethanol production. Sugar Tech., 15: 305-310.

PAPERS PRESENTED AND PUBLISHED IN PROCEEDINGS OF SEMINARS/ CONFERENCES/ WORKSHOPS/ SYMPOSIA

Ahmad T and Gaikwad N (2014). Design and development of poultry processing table. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Ahmad T, Gaikwad N, Kumar Y and Kumar R (2014). Assessment of poultry dressing table layout with respect to workspace envelope. Poster presented in International Conference on Emerging Food Safety Risks: Challenges for Developing Countries held at NIFTEM, Kundli, Sonipat, Haryana during January 9-10, 2014.

Bansal S, Mangal M and Oberoi HS (2014). Molecular detection of aflatoxigenic fungi in rice. Paper presented in National Conference on Perspective and trends in plant sciences and biotechnology held at Punjab University, Chandigarh during Feb. 21-23, 2014.

Bansal S, Mangal M and Sharma SK (2013). Effect of concentration of solids on physico-chemical properties of soy yoghurt. Paper presented in International Conference on Impact of technological tools on food security under global climatic scenario held at Shobhit University, Meerut from May 11-12, 2013.

Dixit A K (2014). Agricultural marketing and foreign Direct Investment (FDI). Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Dixit A K and Karki I. (2013) Impact of Entrepreneurship Development Programme and licensing of CIPHET technology. Poster presented in 7th International Food Convention (IFCON 2013), organized by AFST during Dec 18-21, 2013 at CSIR-CFTRI, Mysore.

Dixit AK (2014). Post harvest management and marketing of agricultural produce: an economic perspective. Paper presented in National Seminar on Reorientation of agricultural research to ensure national food security organized by CCS HAU Hisar during Jan. 6-7, 2014.

Dixit AK, Nanda SK and Kudos SKA (2013). Social and economic impact of agro processing centres at national level. Agricultural Economics Research Review, 26 :248.

Dixit AK, Nanda SK, Singh KP, Kudos SKA (2014). Economic and social benefits of Vivek thresher cum pearler in hilly regions. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Devatkal SK (2013). Effect of high pressure and pomegranate peel extract on colour, texture and microbiological characteristics of cooked chicken nuggets Paper presented in the IFCON 2013 during Dec 18-21, 2014.

Devatkal SK (2014). Applications of high pressure (HPP) in meat processing and food safety Paper presented at IAVPH during Feb. 4-5, 2014 at Assam Agricultural University, Assam.

Goswami D and Gupta RK (2013). Quality characteristics of barnyard millet based biscuits. Poster presented in the 7th International Food (IFCON) on NSURE- Healthy Foods at CFTRI, Mysore during Dec 18-21, 2013.

Goswami D, Gupta RK, Sharma M and Mridula D (2014). Baking taknik dwara sawa athwa maadira ka moolya samwardhan. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Jaiswal P (2014). Dashehari aamo ke bhandaran awadhi vistar ke liye sanshodhit vatavarniya packaging pranali. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Jaiswal P (2014). Fourier transform infra-red spectroscopy (FTIR): rapid tool for detection of non-dairy ingredient in milk. Paper presented in International Conference on Emerging Food Safety Risks: Challenges for Developing Countries at NIFTEM, Kundli during January 9-10, 2014.

Jaiswal P (2013). Spectroscopy and chemometrics: a tool for differentiation of live and dead Escherichia coli Poster presented in 7th International Food Convention (IFCON) on NSURE- Healthy Foods at CFTRI, Mysore, India held on Dec 18-21, 2013.

Kadam DM (2014). CIPHET developed technologies on post-harvest engineering and technology (Invited Lecture/ Paper) presented in Development of Agribusiness and Food Processing Business Incubation Centres in Africa under India-Africa Forum Summit (IAFS)-II 2013-14 held at ICRISAT, Hyderabad during Feb 18 to March 01, 2014.

Kadam DM, Thunga, M, Srinivasan G, Kessler MR, Grewal D, Lamsal B and Yu C (2013). Nano functionalized biodegradable corn zein protein biopolymer. Poster presented in International Food Convention (IFCON), 2013 at CFTRI, Mysore during Dec 18-21, 2013.

Kadam DM, Thunga M, Wang C, Kessler MR, Grewal D, Yu C and Lamsal B (2013). Mechanical, microstructural and antimicrobial properties of nano enhancer-reinforced corn zein protein film poster presented during AACC International Annual Meeting (AACCI 2013) at Albuquerque Convention Center, Albuquerque New Mexico, USA during Sept 29 - Oct 2, 2013.

Karki I, Chhuneja NK and Gite LP (2014). Punjab ke krishi prasanskaran udyogoen mein swasthya samasyaon ka akalan. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Karki I and Gaikwad N (2012). Assessment of prevalent health risks among agro processing workers of Punjab. Paper presented in 8th International Conference of HWWE on safety for all at GBPUA&T, Pantnagar during Dec. 6-8, 2012.

Kumar R, Kumar S and Sharma PC (2014). Prevention of enzymatic browning in fresh cut pear by using natural compound. Paper presented in International Conference on Emerging food safety risks: challenges for developing countries held at NIFTEM, Kundli (Sonepat) during Jan 9-10, 2014.

Kumar S and Kumar S (2013). Storage stability of pomegranate arils using enzymes and divalent ions. Paper presented in National Seminar on New vistas in food processing with quality assurance for augmenting rural prosperity organized by MPUAT, Udaipur during June 21-22, 2013.

Kumar S, Kumar R and Nambi VE (2013). Post harvest biochemistry of enzymatic and divalent ions treated pomegranate arils during low temperature storage. Paper presented in International Conference on Biosciences with special reference to environmental issues organized by Department of Zoology, Shivaji University, Kolhapur during Dec 19-21, 2013.

Kumari L (2014). RFID taknik dwara khadya padartho ke bhandaran tapman ki nigrani. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Mangal M, Bansal S and Sharma SK (2013). Rice bran stabilization using papain enzyme. Paper presented in International Conference on Impact of technological tools on food security under global climatic scenario held at Shobhit University, Meerut during May 11-12 , 2013.

Mishra BK, Mudgal V I, Jain NK, Kumar S and Sharma KC (2013). Value added products of Mahua flowers for rural prosperity. Paper presented in National Seminar on New vistas in food processing with quality assurance for augmenting rural prosperity organized by MPUAT, Udaipur during June 21-22, 2013.

Muzaddadi AU, Ahmad T and Monika (2014). *Jivit machhali parivahan.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Monika and Patel KM (2014). Electrostatic nozzle: *fasal katai uprant sanrakshan ke liye parishuddh chhidkau prodyogiki*. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Mridula D, Chatterjee S and Sharma M (2014). Development of multigrain based functional pasta. Paper presented in 48th Annual Convention of ISAE and Symposium on Engineering Interventions in Conservation Agriculture at Maharana Pratap University of Agriculture and Technology, Udaipur during Feb 21-23, 2014.

Mridula D, Chatterjee S, Kochhar A, Sharma M and Gupta RK (2014). *Vishishta karyatmak gunon se bharpur poshak aata.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Mridula D, Gupta P, Gupta RK, Sharma M and Kochar A (2014). Development of multigrain based health food using extrusion technique. Paper presented in International Conference on emerging food safety risks: challenges for developing countries at NIFTEM, Kundli, during Jan 09-10, 2014.

Mridula D, Mishra A, Goswami D and Gupta RK (2014). Development of calcium fortified soft rice using spraying technique. Paper presented in 48th Annual Convention of ISAE and Symposium on Engineering Interventions in Conservation Agriculture at Maharana Pratap University of Agriculture and Technology, Udaipur during Feb 21-23, 2014.

Mridula D, Mishra A, Goswami D, Rani NS and Kota S (2014). Development of iron fortified soft rice. Paper presented in the International Conference on Emerging food safety risks: challenges for developing countries at NIFTEM, Kundli, during Jan 09-10, 2014.

Mann S (2014). Scope & Challenges of machine vision system in detection of cereal grain quality. Paper presented in International Conference on Emerging food safety risks: challenges for developing countries and workshop on Food Safety & Quality at NIFTEM, Kundli during Jan 9-11, 2014.

Narayan M and Bhatnagar PR (2013). Efficient water application with use of micro-irrigation system under canal command area in south-west Punjab. Paper presented in 5th Swadesh Prem Jagriti Sangosthi in International Conference on Water management for climate resilient agriculture organized by jointly ASM Foundation, New Delhi and Jain Irrigation System Ltd, Jalgaon (MS).

Nanda SK and Jain NK (2014). *Gwarpatha prasanskaran evam mulya samvardhan takniki.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Nanda SK (2014). *Katai uparant khadya utpadon ki shati evam bachav:ek avalokan.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Rawat R, Srivastava N and Oberoi HS (2013). A thermo stable endoglucanse enzyme from Aspergillus fumigatus having industrial potential: purification and characterization. Paper presented in 54th Annual Conference of Association of Microbiologists of India (AMI-2013) held at MDU, Rohtak, Haryana during Nov 17-20, 2013.

Rawat R, Srivastava N and Oberoi HS (2013). Endoglucanses: characterization and its role in bioconversion of cellulosic. Paper presented in 3rd National Conference on Recent advances in bio-energy research held during Nov 22-24, 2013 at Sardar Swaran Singh National Institute of Renewable Energy (SSSNIRE), Kapurthala, Punjab.

Sharma KC, Kumar S, Jain NK, Mishra BK, Sahay SB and Ralhore IS (2013). Effect of pulse beetle (Callosobriichus maculalus L) infestation on biochemical composition of stored pigeon pea (Cajanus cajan). Paper presented in National Seminar on New vistas in food processing with quality assurance for augmenting rural prosperity organized by MPUAT, Udaipur during June 2 I -22. 2013.

Sharma M and Mridula D (2014). Development and quality evaluation of maize based energy bar. Proceeding of 48th Annual Convention of ISAE and Symposium on Engineering Interventions in Conservation Agriculture, organized by Maharana Pratap University of Agriculture and Technology, Udaipur during February 21-23, 2014.

Sharma M (2013). Nanotechnology & its applications in functional foods, processing and food safety. Invited paper presented in National Seminar on Novel approaches in formulating functional foods on April, 2013 organized by Society of Food and Dairy Technology at Sam Higginbottom Institute of Agriculture, Technology & Science, Allahabad.

Sharma M, Mridula D and Gupta RK (2014). *Makka adharit poshak* energy bar. Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Sharma R, Kocher GS and Oberoi HS (2013). Sweet Sorghum - an ideal feedstock for bioethanol production. Paper presented in 3rd National Conference on Recent advances in bio-energy research held at SSSNIRE, Kapurthala, Punjab during Nov 22-24, 2013.

Sharma R, Kocher GS and Oberoi HS (2013). Characterization of newly isolated thermophilic Aspergillus terreus strain for cellulolytic enzyme production. Paper presented in 54th Annual AMI Conference held at MDU Rohtak, Haryana during Nov 17-20, 2013 .

Sharma PC (2013). Post-harvest management and value addition of horticultural crops. Paper presented in Indo US Africa Triangular international training program on agricultural marketing management held at CCS MAM, Jaipur during July 22- Oct 19, 2013.

Srivastava N, Rawat R and Oberoi HS (2013). Hydrolysis of different feed-stocks by thermo stable alkali tolerant cellulase obtained by newly isolated thermo tolerant Eurotiomycetes sp. Paper presented in 54th AMI Conference held at MDU, Rohtak, Haryana during Nov 17-20, 2013.

Srivastava N, Rawat R, Oberoi HS, Srivastava M and Singh J (2013). Impact of nickel-cobaltite nanoparticle on the production and thermo stability of cellulases produced by newly isolated Eurotiyomycetes sp. Paper presented in India-Japan Workshop on Biomolecular Electronics and Organic Nanotechnology for Environment Preservation held at DTU, Delhi, India during Dec 13-15, 2013.

Srivatsava N, Rawat R and Oberoi HS (2013). Application of thermo stable cellulase in bioethanol production from lignocellulosic waste. Paper presented in 3rd National Conference on Recent Advances in Bio-Energy Research held at SSSNIRE, Kapurthala, Punjab during Nov 22-24, 2013.

Yadav DN, Mridula D. and Gupta RK (2014). *Moongfali ke vanijyik vasa rahit khali ka shudhikaran evam bahirvarddhit khadya utpado me upyog.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Yadav DN, Navnidhi, Anand T and Sharma M (2014). *Swasthwardhak gudo se paripurn samagra dugdh khadya utpad.* Paper presented in the *Rashtriya Sangoshthi* on *Khadya prasanskaran evam prabandhan: udhyamiyo ke liye swarojgar ki sambhavnaye* at CIPHET, Ludhiana during Jan 28-29, 2014.

Yadav DN, Mridula D, Mishra PK and Gupta RK (2013). Process development for removal of impurities from commercial groundnut cake and its utilization in extrudate snacks. Paper presented in IFCON-2013 at CFTRI Campus, Mysore, during Dec 18-21, 2013.

बंसल संगीता, मंगल मनीषा एवं शर्मा एस के (2014) रैस्पॉन्स सरफेस मैथेडोलोजी द्वारा प्रोबायोटिक सोया दही उत्पादन प्रकिया का विकास। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबन्धनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

अनुराग आर के (2014) उच्च दबाव प्रसंस्करण विधि एवं अनार के छिलकों द्वारा प्राप्त रस का प्रयोग कर मांस उत्पादों के शेल्फ जीवन की वृद्धि। राष्ट्रीय संगोष्ठी: खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

भटनागर पी आर एवं नारायण एम (2014) पॉली हाऊस का ड्रायर एवं गुणवत्ता युक्त कृषि उपज हेतु उपयोग। राष्ट्रीय संगोष्ठी: खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

नारायण एम एवं भटनागर पी आर (2014) प्लास्टिकल्चर द्वारा सघन मछली उत्पादन। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

नरसईया के (2014) पशुधन एवं मात्स्यिकी प्रसंस्करण एवं प्रबंधन में स्वरोजगार की संभावनाए। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

नरसईया के, झा एस एन, मनीकंटन एम आर, विल्सन आर ए, भदवाल एस एवं मागडे एच एम (2014) खाद्य पदार्थों के सूक्ष्म संपुटिकरण और एमल्सीफिकेशन के लिए छोटी बूँद जनरेटर का विकास। राष्ट्रीय संगोष्ठी खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

कुमार एस (2014) अनार दानों का शीत भण्डारण एवं संरक्षण। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

कुमार एस (2014) जामुन फलों से पेय पदार्थ बनाने की तकनीक एवं भंडारण। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

शर्मा पी सी (2014) खुमानी की गुठलियों से गिरि अलग करना एवं गिरियों से तेल निकालने की उन्नत विधि। राष्ट्रीय संगोष्ठी : खाद्य प्रसंस्करण एवं प्रबंधनः उद्यमियों के लिए स्वरोजगार की संभावनाएं, 28-29 जनवरी, 2014, केन्द्रीय कटाई उपरान्त अभियांत्रिकी एवं प्रौद्योगिकी संस्थान, लुधियाना।

TECHNICAL/POPULAR ARTICLES PUBLISHED

Bhushan B, Singh J and Pal A (2014). Prasanskaran and khadya padarth. Raksha Khadya Vigyan Patrika. (Accepted).

Bansal S, Mangal M and Sharma SK (2013). Probiotic cultures ka soya dahi ke bhoutik rasayanic guno par prabhav, Krishi Prasanskaran Darpan, 14: 15-16.

Barnwal P, Singh KK and Mridula D (2012). Alsee ka chhilka nikalane hetu machine ka vikas (flaxseed dehuller). Krishi Prasanskaran Darpan, 13:7-8.

Dhingra D, Chopra S and Karki I (2012). Ohmic heating-adhunik khadya prasanskaran taknik. Kheti. 64 (7):31.

Jha SN (2013). Go for community grain depots (Guest column). Hindustan Times, Jalandhar dated 17.04. 2013, p4.

Kadam DM (2013). Dried onions to the rescue. The Indian Express, November 2013, P.14

Kadam DM (2013). Greater benefits of dehydrating onion, Agrowon, September 2013, P.12

Kadam DM and Mitra SD (2013). Post-harvest management and value addition through entrepreneurship development. Udyogprerana. 8(4): 43-49.

Kadam DM, Yogmaya and Kuashik P (2013). Future of food processing technologies in India and role of CIPHET. Processed Food Industry, 16 (9): 12-13.

Karki I and Mangai P (2012). Upbhokta sanrakshan: Jaago grahak jaago. Krishi Pransanskaran Darpan, 13: 63-66.

Karki I and Sharma S (2013). Dhal ka chilka: khumbi ki kheti ke liye ek behtar madhyam. Modern Kheti, 11 (7): 38-40.

Karki I, Nishita, Sonali, Gaikwad N and Rai DR (2012). Atta chakki mein dhool ki sandrata ka aklan: ek adhyyan. Krishi Pransanskaran Darpan, 13: 32-34.

Kumar S, Kumar R, Nambi VE, Gupta RK and Sharma KC (2013). Strawberry ka rakh-rakhav. bhandaran evam prasanskaran. Krishi Prasanskuran Darpan, 14: 32-33.

Kumar Y and Yadav DN (2014). Supercritical dravya nishkashan: maans prasansakaran kshetra me upayogita. Raksha Khadya Vigyan Patrika, 22: 42-49.

Mamgai P, Kaur N and Karki I (2012). Poshak tatva bachao aur bhojan ko swasthayaprad banao. Krishi Pransanskaran Darpan, 13: 58-60.

Mangal M, Bansal S and Sharma SK (2013). *Khadya janit rogjanako ki anvik jaanch: khadya suraksha ke liye ek tez aur sateek uttar.* Krishi Prasanskaran Darpan, 14: 46-47.

Mangal M, Bansal S and Sharma SK (2013). *Sooksham evam sthool roopatmak sanrachna ke aadhar par vibhinn Aspergillus naslo ki pahchan.* Krishi Prasanskaran Darpan, 14: 48-49.

Mridula D (2013). *Swasthyaprad composite aata.* Krishi Prasanskaran Darpan, 14: 17-21.

Mridula D and Mishra A (2013). *Upvas men khane yogya falon avam sabji aadharit gluten rahit biscuts.* Krishi Prasanskaran Darpan, 14:29-31.

Mridula D, Barnwal P and Singh KK (2012). *Chhilka rahit alsee se tel nishkasan evam tel kee gunvatta.* Krishi Prasanskaran Darpan, 13: 9-11.

Mridula D, Kaur D, Barnwal P, Gurumayum S and Singh KK (2012). *Broiler evam andon men omega-3 badhane hetu alsee khalee yukta poultry ration.* Krishi Prasanskaran Darpan, 13:16-20.

Mridula D, Sharma M and Gupta RK (2013). *Sheeghra pakane yogya gehun ka dalia.* Krishi Prasanskaran Darpan, 14: 12-14.

Mridula D and Sharma M (2012). *Khadyannon evam soybean dudh aadharit non-dairy probiotic pey.* Krishi Prasanskaran Darpan, 13: 21-25.

Narayan M and Kumar S (2012). लवणीय व क्षारीय भूमि की स्थिति, कारण एवं निराकरण, कृषि किरण, CSSRI, Karnal.

Sharma M, Mridula D, Goswami D and Gupta RK (2013). *Makka adharit energy bar.* Krishi Prasanskaran Darpan, 14: 24-26.

Singh J, Nangare DD, Bhushan B and Narayan M (2013). Strawberry cultivation with plastics mulch in semi-arid region in Abohar published in Plasticulture in Field: Success Stories of AICRP on Application of Plastics in Agriculture. Ed. PR Bhatnagar, Project Coordinator, AICRP on APA, CIPHET, Ludhiana.

Singh J Nangare DD, Bhushan and Narayana M (2013). Plasticulture in held: success stories of AICRP on A PA. Strawberry cultivation with plastic mulch in semi-arid region in Abohar, Punjab. pp. 11-13.

Singh R, Kumar S and Narayan M (2013). Cultivation of summer squash with low plastics tunnel in Abohar, Punjab published in Plasticulture in field: success stories of AICRP on Application of Plastics in Agriculture. Ed. Bhatnagar PR, Project Coordinator, AICRP on APA, CIPHET, Ludhiana.

Wilson RA, Narsaiah K and Mandge HM (2013). Controlled release of functional ingredients in processed foods: methods and applications of controlled release. Beverage and Food World, 40 (5): 36-37.

Yadav DN (2014). Moongphali se doodh, dahi evam paneer kaa utpadan. Raksha Khadya Vigyan Patrika, 22, 60-66.

Yogesh K, Narsaiah K and Ahmad T (2013). *Bharatiya Maans Udyog: a sankah parichaya*. Krishi Prasansakaran Darpan, 14: 36-38.

Yogesh K, Narsaiah K, Ahmad T and Gaikwad N (2013). *Maans men payjane wale jaiv sakriya yogik*. Krishi Prasansakaran Darpan, 14: 39-41.

मंगल मनीषा एवं बंसल संगीता (2014) एफ्लाटॉक्सिन– कवक द्वारा उत्पादित ज़हर। राजभाषा आयुर्वेद के संग। पेज नं. 10।

बंसल संगीता एवं मंगल मनीषा (2014) प्रोबायोटिक्– आंत्र स्वास्थ्य के लिए लाभकारी जीवाणु। राजभाषा आयुर्वेद के संग । राष्ट्रीय आयुर्वेदिक भेषज अनुसंधान संस्थान, मोती बाग रोड़, पटियाला, पेज नं. 13।

यादव दीपनारायण, शर्मा मोनिका, आनंद तनुप्रिया एवं नवनिधि (2013) बाजरा-छाछ प्रोटीन आधारित बर्हिवर्धित उत्पाद, कृषि प्रसंस्करण दर्पण, 14:22-23।

यादव दीपनारायण, शर्मा मोनिका, आनंद तनुप्रिया, नवनिधि एवं गोस्वामी दीपिका (2013) सब्जी समावेशित पास्ता कृषि प्रसंस्करण दर्पण, 14:27-28।

PATENTS GRANTED AND FILED

- Jha S N and Vishwakarma RK (2013). Mechanized system for popping and decortications of makhana seeds (gorgon nut, Euryale ferox) – Application no 674/DEL/2013 Filed on 7.3.2013.
- Kumar Y, Kairam N and Ahmad T (2013). Low fat meat emulsion and process for making the same.CBR No. 8079. APP. No. 2351/DEL/2013.
- Oberoi HS (2013). Process for preparation of alcoholic beverage with nutraceutical properties from kinnow peels. CBR No. 3538. APP. No. 1049/DEL/2013.

BOOKS/CHAPTERS IN BOOKS/TECHNICAL BULLETINS

Babbar N and Oberoi HS (2012). Potential of agro-residues as sources of bioactive compounds. In: Biotransformation of waste biomass: Fine Chemicals, Springer- Verlag (Accepted).

Bansal S, Verma N, Bhatnagar SK, Gaurav SS, Yadav SK, Yadav R, Goswami A, Vaishali and Gupta S (2013). Abstract book of the International conference on Impact of technological tools on food Security under global warming scenario (ITTFS-2012) p. 432.

Bhatnagar PR (2013). Plasticulture research – research achievements under AICRP on APA during the decade (2003-12). Coordinating Unit, CPHET, Ludhiana. p 112.

Bhatnagar PR (2013). Plasticulture at field – success stories under AICRP on APA. Coordinating Unit. CPHET, Ludhiana. p 38.

Bhakar SR, Lakhawat SS, Jain SK, Sharma GP, Sisodia SS, Champawat PS and Bhatngar PR (2013). Pre and Post harvest management of underutilised forest fruit custard apple: an overview. AICRP on APA centre, MPUAT, Udaipur. p 60.

Bhatnagar PR (2013). Design and construction of greenhouse in India. In: Advances in protected cultivation (Ed. Singh B. *et al.*). New India Publishing Agency, New Delhi : 37-45.

Bhatnagar PR (2013). Project Coordinator's Report of AICRP on APA. Presented in the Biennial Workshop at JAU, Junagadh during 7-9 October 2013.

Devi Mridula, Vishwakarma R, Barnwal P, Singh KK and Patil RT (2013). Cereals and millets. In: Handbook of Agricultural Engineering (Eds: Singh R, Sharma RP, Dutt S, Kandwal R and Verma R), DKMU, Indian Council of Agricultural Research, New Delhi, pp. 474-493.

Devi Mridula, Gupta RK and Jha SN (Sampadak) 2014. SMARIKA, Rashtriya Sangoshthee – Khadya Prasanskaran Evam Prabandhan: udyamiyon ke liye swarojgar kee sambhavanayen. Kendriya Katayee Upranta Abhiyantriki Evam Praudyogikee Sansthan (CIPHET), Ludhiana, p82.

Gupta RK, Nanda SK, Oberoi HS, Mridula D., Ahmad T and Rawat I (2014). CIPHET News (January-March 2013), p 1-8.

Jha SN, Oberoi HS, Mridula D, Ahmad T and Karki I (2013). CIPHET News (October-December 2013), p 1-6.

Jha SN, Oberoi HS, Mridula D, Ahmad T and Karki I (2013). CIPHET News (July-September 2013), p 1-4.

Jha SN, Verma P, D Mridula, Oberoi HS, Gaikwad N, Ahmad T and Karki I (2013). CIPHET News (April-June 2013), p 1-4.

Jha SN, Mridula D, Kadam DM, Verma P, Gaikwad N, Ahmad T and Karki I (2013). Annual Report (2012-13), p 128.

Jaiswal P, Oberoi HS and Jha SN (2013). Food safety and quality. In: Handbook of Agricultural Engineering. Indian Council of Agricultural Research, New Delhi.

Jaiswal P, Grewal MK, Jha SN and Bhardwaj R (2012). Infra-red spectroscopy: scope in food microbiology. In: Recent Advances in Microbiology (Eds. S.P. Tiwari, R Sharma and R. Gaur). (In press).

Kumar S, Verma RK Mishra BK and Chopra DS (2013). Role of enzymes in food processing. In: Food and nutritional security by sustainable agriculture: methods to attain and sustain (Eds. Mishra BK, Kumar S and Tiwari JK) New India Publishing Agency. New Delhi, pp. 453-477 (ISBN: 978-93-81450-04-9).

K Narsaiah, Jha SN, Kotwaliwale N, Chandra P and Murugkar DA (2013). Engineering properties. Handbook of Agricultural Engineering. Indian Council of Agricultural Research, New Delhi: pp. 421-432.

Kadam DM and Sharma M (2014). Extraction methods and health benefits of nutraceuticals from medicinal plants in utilization and management of medicinal plants, Vol. 2, Eds: Gupta, VK and Kaul, Anpurna. Daya Publishing House, New Delhi, International ISBN 9789351301882 (Volume 2) (International Edition), pp: 343-354.

Karki I, Sharma P and Rastogi SK (2010). Occupational safety and management of risks in health care industry. Concept Publishing Company Pvt. Ltd., New Delhi. p 270.

Mridula D, Gupta RK, Katoch BC and Narayan M (2013). *Krishi Prasanskaran Darpan, Ank*-14, p 50.

Mridula D, Gupta RK, Katoch BC and Narayan M (2013). *Krishi Prasanskaran Darpan, Ank*-13, p 68.

Mudgal VD, Kumar S, Mishra BK and Rathore NS (2012). Practical Manual on food quality. Published by Department of Processing and Food Engineering, College of Technology and Engineering. Maharana Pratap University of Agriculture & Technology, Udaipur (p. 43).

Mishra BK, Kumar S and Tiwari JK (2013). Food and nutritional security by sustainable agriculture: methods to attain and sustain (Edited Book). New India Publishing Agency. New Delhi, p. 484 (ISBN: 978-93-81450-04-9).

Mishra BK, Kumar S and Sharma A (2013). Composting process: physiology and microbiology. In: Food and nutritional securilty by sustainable agriculture: methods to Attain and sustain (Eds. Mishra BK, Kumar S and Tiwari JK) New India Publishing Agency. New Delhi, p. 119-132 (ISBN: 978-93-81450-04-9).

Nanda SK, Muzaddadi AU, Ahmad T and Karki I (2014). Fruits and vegetable processing. PAMETI, PAU Campus, Ludhiana, pp. 1-8.

Nanda SK, Muzaddadi AU, Ahmad T and Karki I (2014). Meat processing and value addition technologies. PAMETI, PAU Campus, Ludhiana, pp 1-4.

Rai DR, Karki I, Chopra S and Shivhare US (2013). Innovative post-harvest technologies developed by farmers. CIPHET, Ludhiana. p 36.

Sharma PC and Kumar R (2013). Equipment and technology for post-harvest management and processing of fruits and vegetables under small scale and unorganized sector. In: Compendium **of** Model Training Course on value addition and post-harvest management of horticultural crops, Directorate of Extention Education, Dr Y S Parmar University of Hon & Foresty. Solan, p 106-1 10.

Singh J, Singh MR, Jain A, Bhardwaj S, Singh Ajcel, Singh DK, Bhushan B and Dubey SK (2014). An introduction of plant nutrients and foliar fertilization: a review in precision farming: a new approach. Daya Publishing House New Delhi pp. 258-320.

PARTICIPATION IN INTERNATIONAL/ NATIONAL TRAINING PROGRAMME/SEMINARS

Ahmad T (2014). National Workshop on Horizon of bioinformatics in animal and veterinary sciences held at Madras Veterinary College, Chennai from December 9-13, 2013.

Bansal S (2013). Refresher Course on Agriculture Research Management at National Academy of Agricultural Research Management, Hyderabad from July 15- 27, 2013.

Bansal S (2014). Perspective and trends in plant sciences and biotechnology, Punjab University, Chandigarh held on Feb. 21-23, 2014.

Bansal S (2013). International Conference on Impact of technological tools on food security under global Climatic Scenario held at Shobhit University, Meerut from 11-12 May, 2013.

Bansal S (2013). Delivered a Radio Talk on Probiotics to All India Radio, Jalandhar on October 20, 2013.

Bhatnagar PR (2014). Reliance Industries with McCain Group for interaction on PP non-woven fabric to be used for potato cultivation at different locations by personnel of McCain, at Hotel Sheraton, Udaipur, on Dec 19, 2013.

Bhatnagar PR (2014). 48th ISAE Convention at MPUAT Udaipur during Feb 21-23, 2014.

Bhatnagar PR (2014). Annual conference of VCs and Directors at Baramati/Pune during Jan 18-22, 2014.

Bhatnagar PR (2014). Mid term review meeting of AICRP on Vegetable crops at NASC Complex New Delhi during Dec 19-21, 2013.

Dixit AK (2014). 6th Refresher Course for Agricultural Research Management held at NAARM Hyderabad on Feb. 3-5, 2014.

Devatkal SK (2013). 7th International Food Convention (IFCON) on NSURE- Healthy Foods at CFTRI, Mysore, India held on Dec 18-21, 2013.

Devatkal SK (2014) IAVPH on Applications of high pressure (HPP) in meat processing and food safety from Feb 4-5, 2014 at Assam Agricultural University.

Devatkal SK (2013). Refresher course at National Academy of Agricultural Research Management (NAARM), Hyderabad during July 14-28, 2013.

Goswami D (2013). National training on Project formulation, risk assessment, scientific report writing & presentation sponsored by NAIP Division of Agricultural Engineering at IARI, New Delhi during Dec 9-13, 2013.

Goswami D (2013). 7th International Food Convention (IFCON) on NSURE- Healthy Foods held during December 18-21, 2013 at CFTRI, Mysore, India.

Jaiswal P (2014). International Conference on Emerging Food Safety Risks: Challenges for Developing Countries at NIFTEM, Kundli (9-10 January 2014).

Jaiswal P (2013). 7th International Food Convention (IFCON) on NSURE- Healthy Foods at CFTRI, Mysore, India held on December 18-21, 2013".

Jaiswal P (2013). Refresher course at National Academy of Agricultural Research Management (NAARM), Hyderabad during July 14-28, 2013.

Jha SN (Incharge Director) (2013). 12 days trainings on Management development programme on leadership development (Pre-RMP cadre) in August -Sept 2013.

Jha SN (Incharge Director) Visited IARI centre of the project and attended NAAS meeting.

Jha SN (Incharge Director) (2013). 4th meeting of the Technical Scrutiny Committee, Food Testing Lab (MoFPI) held on June 7, 2013, KAB-II, New Delhi.

Jha SN (Incharge Director) (2013). Preparatory meeting for organizing workshop on 10.07.2013 for sharing of protocols of Repeat Study on the Assessment of post-harvest losses of major crops and commodities in India on June 17, 2013 at Panchsheel Bhawan, New Delhi.

Jha SN (Incharge Director) (2013). ASRB meet on 18.06.2013 and 09.07.2013 at ASRB Office.

Jha SN (Incharge Director). Meeting of Directors of the Institutes under NRM and Agricultural Engineering Divisions for discussion on Performance Indicators at NCAP, New Delhi on July 15, 2013.

Jha SN (Incharge Director). ICAR Annual Day celebration and meeting with DG, ICAR on July 16, 2013.

Jha SN (Incharge Director). Third Annual Review Workshop of NFBSFARA at NASC complex on July 22-23, 2013.

Jha SN (Incharge Director). Programme Advisory Committee (PAC) for International Cooperation in the area of Food Technology and related areas (DST) at SERB Office, New Delhi on July 29, 2013.

Jha SN (Incharge Director). 15th meeting of the Board of Management of NIFTEM, Kundli, Sonipat on Aug 20, 2013.

Jha SN (Incharge Director). Management Development Programme on Leadership Development (pre-RMP cadre) at NAARM, Hyderabad.

Kadam DM (2013). 6th Bangalore India Nano conference at The Lalit Ashoka Hotel, Bangalore from Dec 4-6, 2013.

Kadam DM (2013). Radio talk on Business Planning and Development (BPD) Unit for establishment of Incubaion at CIPHET to All India Radio, Jalandhar.

Kadam DM (2013). Radio talk on Onion, garlic and ginger processing for value added products to All India Radio, Jalandhar.

Kadam DM (2013). Radio talk on Tomato processing for value added products to All India Radio, Jalandhar.

Kadam DM (2014). Karnataka Agricultural Engineers Association (KAEA) Conference and Silver Jubilee Programme of the College of Agricultural Engineering, Raichur (Karnataka) on Feb 15-16, 2014.

Kadam DM (2013). 2nd foundation day of AgrInnovate India Ltd. and conglomerate on innovative partnerships at NASC complex, New Delhi in October 19, 2013.

Kadam DM (2013). 7th International Food Convention (IFCON) at CFTRI, Mysore from Dec 18-21, 2013.

Kadam DM (2013). CIPHET Technologies at KISAN 2013, Pune from December 13-17, 2013.

Kadam DM (2014). CIPHET Technologies at 12th Rural Technology and Crafts Exhibition Organized by National Institute of Rural Development (NIRD) at Hyderabad from February 14 -19, 2014.

Kadam DM (2013). Workshop on Mid-term review of achievements of RFD 2013-14 held at IASRI, New Delhi on Nov 6, 2013.

Kumari L (2013). 7th International Food Convention (IFCON) on NSURE- Healthy Foods, CFTRI, Mysore.

Kumar R (2014). 2nd International Conference on Agriculture & Horticultural Science at Hyderabad during Feb 3-5, 2014.

Kumar R, Thakur AK and Sharma PC (2014). 2nd International Conference on Agricultural & Horticultural Sciences on Feb 03-05, 2014. Redisson Blu Plaza Hotel, Hyderabad, India.

Mann S (2014). Reorientation of agricultural research to ensure national food security and delivered a lecture on Role of agro-processing in income & employment generation at CCS HAU Hisar during Jan 6-7, 2014.

Mann S (2014). Agricultural Research Management NAARM Hyderabad from Feb 03-15, 2014.

Mridula D (2014). 48th Annual Convention of ISAE and Symposium on Engineering Interventions in Conservation Agriculture at Maharana Pratap University of Agriculture and Technology, Udaipur during Feb 21-23, 2014.

Mridula D (2014). International Conference on emerging food safety risks: challenges for developing countries at NIFTEM, Kundli, during Jan 09-10, 2014.

Muzaddadi AU (2013). Research & Extension Specialists Workshop for fruits, mushroom, agro-forestry, along with post harvest management, farm power & machinery, food technology & agri-economics, organized by Directorate of Extension Education, Punjab Agricultural University, Ludhiana on December 19-20, 2013.

Rawat I (2014). Radio talk on Agro processing and related health hazards was delivered to All India Radio Jalandhar on January 15, 2014.

Rawat I (2014). Radio talk on Agro processing was delivered to All India Radio Jalandhar on January 31, 2014.

Sharma PC (2013). HP State level ICAR- Regional Committee No I meeting at Dr. Y.S. Parmar University of Horticultural and Forestry. Nauni (Solan) on August 13, 2013.

Sharma PC (2014). 48th Annual convention of ISAE and symposium on Engineering intervention in conservation Agriculture at MPAUT, Udaipur on Feb 21-22, 2014.

All CIPHET Scientists (2014). Rashtriya sangoshthi on 'Khadya prasanskaran evam prabandhan: udyamiyon ke liye swarojgar ki sambhavnayen', organized by CIPHET and Punjab Chapter of IASE, Ludhiana, Punjab during January 28-29, 2014.

Sharma M (2013). Winter School on Advances in bio-processing system for development of functional Foods and value addition to by-products during Dec 3- 23, 2013 at CIAE, Bhopal.

Sharma M (2013). Delivered a Radio Talk on Value addition of maize and sorghum to All India Radio Jalandhar on October 6, 2013.

Vishwakarma RK (2013). Workshop on repeat study on assessment of post harvest losses of major horticultural crops, animal and fishery products in India held at NASC complex, ICAR, New Delhi on Aug 29, 2013.

Yadav DN (2013). Awareness building and sensitization workshop on National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA) held at NDRI, Karnal from Sept 6-7, 2013.

Yadav DN (2013). Delivered a Radio talk on *Bajra* Processing to All India Radio, Jalandhar on November 10, 2013.

AWARDS AND HONOURS

- **CIPHET awarded ISO 9001:2008**

  CIPHET has been awarded the ISO 9001: 2008 certification for "Research and Development, Training and Extension on Post-harvest Engineering and Technology".

- A Team Award was bagged by the team comprising SK Nanda, RK Vishvakarma, Anil Rai, HVL Bathla, VK Sehgal, P C Sharma, Robinson J, Abraham and Pitam Chandra for their work on 'Assessment of harvest and post-harvest losses of major crops and livestock produce in India' during 48th Annual Convention of ISAE and Symposium on Engineering Intervention in Conservation Agriculture held during Feb. 21-23, 2014.

- CPCRI, Kasargod, one of the centres of AICRP on PHT received the National award 2012 of Coconut Development Board for best research work (Machinery/equipment development). Award was presented by Sh. Sharad Pawar, Hon. Agri. Minister on Feb. 11, 2014 at New Delhi.

- CIPHET Nominated Farmer got Innovative Farmer Award in Pusa Krishi Vigyan Mela organized by Indian Agricultural Research Institute, New Delhi during Feb. 26-28, 2014 on the theme 'Climate Resilient Technologies for Sustainable Agriculture'. Sh. Krishan Jangra from Haryana, one of the farmer-entrepreneur nominated by CIPHET was selected for ICAR innovative award 2014 at this occasion. Sh. Krishan Jangra developed a small capacity carrot washer first in 2000 for use in and around Bahabalpur, Hissar where carrot is one of the major crops. Through continuous innovations, he has developed upto 16 feet long continuous carrot washing machine. During the last financial year, Sh. Jangra marketed 42 numbers of units.

- Manju Bala (co-author) received Best Poster award for the research paper entitled 'Biochemical marker for salinity in rapeseed-mustard' by Bhogal NS, Sandeep Kumar, Bala M and H P Meena in 2nd *National Brassica Conference on* 'Brassicas for addressing edible oil and nutritional security' held at PAU, Ludhiana during February 14-16, 2014.

- Dattatreya M. Kadam received IFCON 2013 Best Poster award for poster entitled "Nano functionalized

biodegradable corn zein protein biopolymer" by Dattatreya M. Kadam, Mahendra Thunga, Gowrishanker Srinivasan, Micheal R. Kessler, David Grewell, Buddhi Lamsal and Chenxu Yu at CFTRI, Mysore in International Food Convention (IFCON), during December 18 to 21, 2013.

- Dattatreya M. Kadam received Mother Teresa Sadhavan Award 2013 for outstanding Individual Achievements and Distinguished Services to the Nation from Global Achievers Foundation, New Delhi.
- DN Yadav received IFCON 2013 Best Poster award for research paper entitled "Process development for removal of impurities from commercial groundnut cake and its utilization in extrudate snacks" by Yadav DN, Mridula D, Mishra PK and Gupta RK at CFTRI, Mysore in International Food Convention (IFCON) held during Dec 18 to 21, 2013.
- DN Yadav received BEST POSTER award for research paper entitled "Quality Evaluation and Shelf Life Study of Vegetable Blended Wheat Pasta" presented in International symposium on Frontier Discoveries and Innovations in Microbiology and its Interdisciplinary Relevance (FDMIR-2013) held during November 17-20, 2013 at Maharishi Dayanand University, Rohtak, Haryana.
- K. Narsaiah got best Scientist award of CIPHET for 2013.
- Sangita Bansal received SRDA Gold Medal Award 2012 from Society for Recent Development in Agriculture.
- Sangita Bansal received Young Scientist Award (Biotechnology) 2013 from the executive committee of Society for plant research during International Conference on Impact of Technological Tools on Food Security under Global Warming Scenario held during May 11-12, 2013.
- Sunil Kumar received best paper award for the oral presentation entitled 'Storage stability of pomegranate arils using enzymes anil divalent ions' al National Seminar on 'New vistas in food processing with quality assurance for augmenting rural prosperity" organized by Dept. of PFF., CTAE , MPUAT. Udaipur during June 21-22. 2013.

INSTITUTE ACTIVITIES

Licensing and Commercialization of CIPHET Technologies in the year 2013-2014

During the year 2013-14, four new patent applications have been filed and one patent has been granted. The technologies commercialized and consultancies provided by the Institute during 2013-14 are listed as under:

S. No.	Technology/ Consultancy	Contracting party	License fee (Rs.)	Date of signing agreement	Type	Innovator
1.	Agreement for licensing of Technology on Beetroot Powder making technology	Shri Preetinder Singh S/o Narinder Singh, H. No. 1201, Sector-22-B, Chandigarh	35000	15.04.2013	Licensing and training of non-IP protected technology	Dr Mridula D
2.	Agreement for licensing of Mechanized system for popping and decortications of makhana seeds	M/s Jwala Engineering and Consultancy Services, # 354, Sector-2, Growth Centre, Saha, Ambala (Haryana)-133104	168540	21.05.2013	Licensing of IP protected technology	Dr. S. N. Jha, Dr. R. K. Vishwakarma
3.	Agreement for transfer of KNOWHOW of CIPHET Cryogenic spice grinding system	M/s Spectra Cryogenic Systems Pvt. Ltd. H-326(E), Road No. 6, IPIA, Kota, Rajasthan	224730	19.07.2013	Licensing and training of non-IP protected technology	Dr. P. Barnwal
4.	Agreement for licensing of Pearl millet based composite extrudates and pasta	Siddarth Aggarwal, S/o Ravin Aggarwal, B09/884, Gulchaman Gali, Ludhiana	40000	02.12.2013	Licensing and training of non-IP protected technology	Dr.D.N Yadav
5.	Agreement for licensing of Ginger processing technology (Dried ginger flakes, sweetened flakes, Powder, and Ginger Paste)	Mr.Rakesh Thapa, Block Inspector, Co-Oprerative Societies, Block Sangrah, Sirmaur, HP	17000	27.12.13	Licensing and training of non-IP protected technology	Dr. D.M Kadam
6.	Agreement for licensing of Ginger processing technology (Dried ginger flakes, sweetened flakes, Powder, and Ginger Paste)	Mr. Mohan Singh, Secretary, The Sirmaur Ginger Seed Development Farmer Cooperative Society, Sirmaur, HP	17000	27.12.13	Licensing and training of non-IP protected technology	Dr. D.M Kadam
7.	Agreement for licensing of Ginger processing technology (Dried ginger flakes, sweetened flakes, Powder, and Ginger Paste)	Baldev Singh, s/o KaliaRamVill Khala Kyar, PO Jammu Koti, The Renukaji, Sirmaur, HP	17000	27.12.13	Licensing and training of protected technology	Dr. D.M Kadam
8.	Agreement for licensing of "Minimal Processing of vegetables"	Abhinav Soni, 32/25A Ajanata Colony, Street No 3, Near Sahara Hospital, Garh Road, Meerut, UP	16854	03.03.14	Licensing and training of non-IP protected technology	Dr. Rahul Anuraag

International Training on Dehydration of Onion

Dr. Michel BakarDiop from Senegal took one month training under DST's (GoI) 'C. V. Raman International Fellowship for African Researchers 2012-13. Dr. Michel joined the CIPHET for training during September 17, 2013 to October 17, 2013 on 'Processing and Dehydration of Onion' with Dr. D. M. Kadam, Senior Scientist at CIPHET, Ludhiana as Host Scientist. This training has provided better opportunities to explore the best possible collaboration in future between both countries

Training on Micro-encapsulation

Dr. K. Narsaiah, Principal Scientist paid training programme titled "Micro Encapsulation Methods for Food and Biotechnological Applications" was organized from 20th to 22nd November 2013. The program provided hands on training with orientation towards commercial level application of microencapsulation methods to entrepreneurs and researchers.

Consultancy/Licensing of Technology

A training on 'Sorting, grading, minimal processing & packaging' was conducted on Sep 24-26, 2013 for an entrepreneur under BPD. Dr. Rahul Kumar Anurag coordinated the training programme.

Technology of Minimal processing of Vegetables was licensed to Meerut, UP based entrepreneur Mr. Abhinav Kumar in sorting, grading and minimal processing of vegetables. He was given a certificate after completion of three days training programme from 27 Feb -1 Mar 2014 imparted by Dr. Rahul Kumar Anurag Scientist. Mr. Abhinav Kumar said that he is interested to supply minimally processed vegetables to retail outlets as he wishes to set up his business in retail.

Programmes Organized

CIPHET organized a Rashtriya Sangoshthi in collaboration with Punjab Chapter of ISAE

CIPHET organised a *Rashtriya Sangoshthi* on *"Khadya Prasanskaran Evam Prabandhan: Udyamiyon Ke Liye Swarojgar Kee Sambhavanayen"* during Jan 28-29, 2014 in collaboration with Indian Society of Agricultural Engineers (Punjab Chapters), PAU, Ludhiana. Dr KK Singh, Additional Director General, (Process Engineering) graced the occasion as Chief Guest, emphasised the development of need based technologies for loss reduction of agricultural produce and economic upliftment of the farmers and entrepreneurs. Dr Bangali Baboo, Former National Director (NAIP) and the Guest of Honour stressed

upon the technology dissemination to the end users i.e. entrepreneurs and hoped that knowledge gained by participants and entrepreneurs from national seminar would help in their future research endeavours and employment generation. Dr RK Gupta, PC (PHT) and convener of this Seminar also said that adaptation of improved food processing package of practices would be profitable to the growers, processors and marketers. Dr AK Singh, Chairman, ISAE (Punjab Chapter) and member of organizing committee appreciated the efforts of CIPHET for organizing the National Seminar in collaboration with ISAE (Punjab Chapter). He has highlighted the importance of food processing for sustaining agricultural growth and development of the country. Dr SN Jha, Acting Director, CIPHET expressed that food processing sector has huge potential to create the rural industries. He also added that it is possible to evolve appropriate technologies, which can establish agriculture based rural industries. The entrepreneurs also shared their views regarding their venture and desired for collaborative work with CIPHET. Dr Mridula D., Sr. Scientist and Co-convener of this Seminar appreciated the efforts of all the scientists and professors, who have presented their technologies in the area of post harvest processing and management in the understandable Hindi language that will certainly bring a remarkable change in the agricultural based entrepreneurship in rural areas.

Institute Management Committee (IMC) Meeting

The Institute Management Committee (IMC) meeting was held on July 4, 2013 under the chairmanship of Dr. S.N. Jha, Director (Acting) at the Institute with the other members being Dr KK Singh, Assistant Director General (PE), Dr PG Patil and Dr N Prasad. During the visit, IMC members especially appreciated the newly developed technologies by the institute including Makhana popping machine, cryogenic grinder and Basl pulper. Dr SN Jha informed the members about research and institution achievements during the past one year. "The institute has made significant progress in terms of patents, revenue collection and improvement in administration," he added.

Research Advisory Committee (RAC) Meeting

Research Advisory Committee meeting of CIPHET was organized during September 27-28, 2013 under the chairmanship of Dr S.M Ilyas, former Director, CIPHET and Project Director, Distance Education at National Institute of Rural Development, Hyderabad. The objective of this meeting was to formulate strategies for future

research and evaluate the progress made by the Institute in the on-going projects. The Chairman expressed the need for technological interventions in designing integrated pilot plants encompassing all the unit operations in a synchronized way so that the end-to-end approach could be followed. Chairman mentioned that the research should be carried out keeping end consumers in mind. Dr KK Singh, ADG (PE), ICAR stressed that recommendations of RAC should be strictly followed and CIPHET should become a global Institute in the area of Post-Harvest Engineering and Technology in the years to come. The RAC team included Dr B Rangamma, Emeritus Professor, University of Agricultural Sciences, Bangalore; Dr TK Srinivasa Gopal, Director, Central Institute of Fisheries Technology, Cochin; Dr AM Paturkar, Associate Dean, Bombay Veterinary College; and Dr (Mrs) Maninder Arora, Senior Microbiologist, Department of Microbiology, PAU, Ludhiana. The team also visited various research facilities at CIPHET and appreciated the technologies developed by the Institute.

Institute Research Council (IRC) Meeting

The 22nd Institute Research Council Meeting was held during October 28-29, 2013 at CIPHET, Ludhiana under the chairmanship of Dr SN Jha, Director, CIPHET. Dr DC Joshi, Dean, faculty of Food Processing Technology and Bioenergy, Anand Agricultural University, Anand; and Dr WS Dhillon, Director, Punjab Horticulture Post-harvest Technology Centre, PAU, Ludhiana were experts for the meeting. The completed, ongoing and new research project proposals were discussed. Dr DC Joshi suggested that the problem defining and identification should be done on the basis of actual conditions in the field in addition to the published literature before formulating a new project. Dr WS Dhillon stressed upon the need of developing indigenous technologies catering to the needs of the local entrepreneurs initially, which can then be disseminated to entrepreneurs across the country. During IRC meeting, eleven RPP-I, sixteen RPP-II and sixteen RPP-III were presented and discussed. Out of eleven RPPs presented, six got approved. Other than these institute projects, eleven externally funded projects (majority of projects were NAIP sponsored) were successfully completed

CCM of AICRP on PHT

Coordination Committee Meeting (CCM) of AICRP on Post-Harvest Technology was jointly organized by CIPHET and PAU Ludhiana on March 7-9, 2014. Dr Ajit Kumar, Hon'ble Vice Chancellor, NIFTEM was the Chief Guest and Dr RP Kachru, the Ex-ADG(PE), ICAR, was the Guest of Honour in Inaugural session. Dr RK Gupta welcomed the dignitaries and participants and briefed about CCM and CIPHET research activities. Dr Ajit Kumar, VC, NIFTEM and Chief Guest, emphasized on futuristic research with problem solving approach. Dr RP Kachru made a presentation on technology needed for business and entrepreneurship development. Dr. KK Singh urged the RE/PIs of the centres to prepare good project proposals with strong scientific base

संस्थान में हिन्दी कार्यशालाओं का आयोजन

सीफेट, लुधियाना में 19 सितम्बर 2013 को हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में डॉ. मधुलिका मित्रा, प्राध्यापिका (हिन्दी), भारतीय विद्या मन्दिर, लुधियाना ने 'समसामयिक हिन्दी एवं शुद्ध हिन्दी' पर मुख्य प्रस्तुति देकर संस्थान के सभी अधिकारियों एवं कर्मचारियों को लाभान्वित किया।

सीफेट, लुधियाना में 17 दिसंबर 2013 को हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्रीमती किरण साहनी, सहायक निदेशक (राजभाषा) एवं सदस्य सचिव (न.रा.का.स.), लुधियाना ने 'मानक हिन्दी वर्तनी' पर मुख्य प्रस्तुति देकर संस्थान के सभी अधिकारियों एवं कर्मचारियों को लाभान्वित किया।

सीफेट, लुधियाना में 15 मार्च 2014 को हिन्दी कार्यशाला का आयोजन किया गया। इस कार्यशाला में श्रीमती किरण साहनी, सहायक निदेशक (राजभाषा) एवं सदस्य सचिव (न.रा.का.स.), लुधियाना ने 'टिप्पणियां एवं मसौदा लेखन' पर मुख्य प्रस्तुति देकर संस्थान के सभी अधिकारियों एवं कर्मचारियों को लाभान्वित किया।

Workshop of AICRP on APA

Xth Biennial Workshop of AICRP on APA has been organized by CAET, JAU, Junagadh centre during 7-9 October, 2013. On this occasion, Dr. Brahama Singh, President, Indian Society of Protected Cultivation, New Delhi was the chief guest. Honable VC, Dr NC Patel, JAU, Junagadh, Gujarat was president and inaugurator of this workshop. Also all PIs and Co-PIs of AICRP on APA centers presented the research results of last two years of the respective centres and discussed about new projects and other related issues.

RESEARCH ADVISORY COMMITTEE

Research Advisory Committee of CIPHET for the period w.e.f. 01.08.2011 to 31-07-2014

Sr. No.	Name & Address of RAC Members	Designation	Contact/Fax No/Email
1.	**Dr. S.M. Ilyas** Project Director, Distance Education National Institute of Rural Development, Rajendra Nagar, Hyderabad- 500 030, A.P.	Chairman	Ph.: 040-24008417 Fax : 040-24008585 Mobile: 098487-80141
2.	**Dr. D.C. Joshi** Dean, Faculty of Food Processing Technology & Bio Energy, Anand Agriculture University, Anand - 388 110, Gujarat	Member	Ph/Fax: 02692-261302 Mobile : 099980-09965 E-mail: deanfpt@aau.in
3.	**Dr. B. Ranganna** Professor Emeritus, University of Agricultural Sciences, J- Block, GKVK Campus, Bangalore – 560065, Karnataka	Member	Ph: 080-23330153 (O) Extn : 346 Fax : 080-23330277 Mobile: 097400-10564 E-mail: rangannab@gmail.com
4.	**Dr. R.K. Pal** Acting Head, Division of Post Harvest Technology, IARI, New Delhi.	Member	Phone: 011-25842155 Fax:011-25842155 Mobile: 098686-68868 E-mail: head_pht@iari.res.in
5.	**Dr. A.M. Paturkar** Professor & Head, Department of Veterinary Public Health, Bombay Veterinary College, Parel, Mumbai- 400012. Maharashtra	Member	022-24130162 Fax: 022-24172301 Mobile: 98202-01522 E-mail: ashishpaturkar@gmail.com
6.	**Dr. T.K Srinivasa Gopal** Director, Central Institute of Fisheries Technology, Matsyapuri P.O., Cochin 682029, Kerala	Member	Phone: 0484-2666880, 2667727 Fax: 0484-2668212, 3011576 Mobile: 094463-93249 E-mail: tksgopal@gmail.com
7.	**Dr. (Mrs.) Maninder Arora** Head, Deptt. of Microbiology, College of Basic Science, PAU, Ludhiana – 141004 (Pb.)	Member	Ph: 0161-240196079, Extn.:330 Fax: 0161-2400945 Mobile:098887-13419 E-mail: hodmb@pau.edu
8.	**Director,** Central Institute of Post-harvest Engineering, and Technology, P.O. PAU, Ludhiana 141 004	Member	0161-2308669, 2313102 Fax: 0161-2308670 Mobile: 94176-01715 E-mail: ciphetludhiana1989@gmail.com
9.	**Dr. K.K Singh (Ex-Officio)** ADG (PE), ICAR, Krishi Anusandhan Bhawan - II, Pusa, New Delhi- 110012.	Member	Ph/fax Fax: 011-25846492 Mobile: 095825-62695 E-mail: kksingh@icar.org.in
10.	**Dr. H.S. Oberoi** Principal Scientist, AS&EC Division & OIC, PME Cell Central Institute of Post-Harvest Engineering & Technology, PO: PAU Campus, Ludhiana - 141004 (Pb.)	Member Secretary	Ph : 0161-2313126 (O) Ph: 0161-2313126, 2313119 Fax: 0161-2308670 E-mail: hari_manu@yahoo.com

INSTITUTE MANAGEMENT COMMITTEE

Sr. No.	Name & Address of IMC Members	Designation
1.	**Director** CIPHET, Ludhiana	Chairman (Ex-Officio)
2.	**Director** (Agriculture), Govt. of Punjab, Directorate of agriculture, S.C.O. No. 85-88, Sector 34-A, Chandigarh 160022	Member
3.	**F&AO** Directorate of Wheat Research, Karnal-132001	Member
4.	**Director** (Research), C.S.K, Krishi Bhawan Agricultural University, Palampur–176062, Himachal Pardesh	Member
5.	**Director** (Horticulture), Government of Gujarat, Directorate of Horticulture, First Floor, Krishi Bhawan, Sec-10 A, Gandhi Nagar-382010	Member
6.	**Dr. P.C. Bargale** Head, Division of Transfer of Technology, Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal - 462 038, M.P.	Member
7.	**Dr. P.G. Patil** Head, Division of Transfer of Technology, Central Institute for Research on Cotton Technology, Post Bag No. 16640, Adenwala Road, Matunga Mumbai - 400 019, Maharashtra	Member
8.	**Dr. Niranjan Prasad** Principal Scientist Indian Institute of Natural Resins and Gums, Namkum, Ranchi- 834010	Member
9.	**Dr. D. Nag** Head, Division of Transfer of Technology, National Institute of Research on Jute & Allied Fibre Technology, 12, Regent Park, Kolkata - 700 040, West Bengal	Member
10.	**Sh. Abhijit Shantaram Rokade** Shukrawar Peth, House No. 5, Taluka-Junnar, Distt. Pune-410502 (Maharashtra)	Member
11.	**Sh. Sharanjeet Singh** V.P.O. Jogipur, Patiala, Punjab	Member
12.	**Sh. Raj Kumar** SAO, CIPHET, Ludhiana	Member Secretary

PERSONALIA

JOINING

◆ Dr. RK Gupta Joins as Director, CIPHET

Dr. Ram Kishor Gupta has taken over the charge of Director, CIPHET on 14th February, 2014. He addressed the scientists of CIPHET and said that he would make the best efforts to see CIPHET as a global institution in the field of post harvest research and increase its visibility in national and international arena with its work. "We should preserve high moral values, punctuality, respect and honesty," he said, advising the staff to be punctual, sincere and dedicated for work. He also laid stress on the importance of planning for better execution and timely output. Dr. RK Gupta obtained Bachelor's degree in Agricultural Engineering from Allahabad University and M. Tech. Degree in Post Harvest Engineering from Indian Institute of Technology, Kharagpur. Further, Dr. Gupta had obtained PG Diploma in Food Processing Management from International Institute of Management, Masstricht, The Netherlands in 1992 and Ph.D. from IIT Kharagpur in the area of Agricultural Food Engineering.

◆ Dr. Sanjeev Kumar Tyagi joined CIPHET, Ludhiana on 25th Feb, 2014. He did his B.Tech (Chemical Technology) from H.B.T.I, Kanpur, M.E (Chemical Engineering) from I.I.T, Roorkee, Ph.D on "Removal of phenolic compound by activated carbon and Regeneration of activated carbon" and D.Sc. (Agricultural Chemistry) on "Development of an adsorbent for Removing colour of Mustard oil from the by-product of Rice milling industry" from C.C.S university, Meerut. He obtained his post doctoral Training in fermentation Technology from North Carolina State University, USA. He joined CIPHET, Ludhiana, Punjab on 20 June 1998 as Scientist (Chemical Engg.) through Agricultural Research Service. He became Sr. Scientist (Chemical Engg.) on 25 August 2006, and then Principal Scientist (Chemical Engg) on 22 January 2010. Dr. Tyagi is a life member of many professional societies viz. ISAE, Indian Institution of Chemical Engineers Association and ARS forum. He has developed and commercialized ten technologies and designed and fabricated thirteen machines and handled eleven projects. He published a significant number of research papers and books and also guided six M.Tech students for their projects and many B.Tech students for their summer training programmes. He is an author of seven books based on basic principles of Physics, Mathematics and Thermodynamics. Dr. Tyagi Won Team Leader Award for inter disciplinary team research in Agriculture and allied Sciences of ICAR in 2008, Best Scientist Award CIPHET 2005 and was with Empanelment of FAO 2002-2003 and won Bioved Fellowship Award.

◆ Dr. Sandeep Mann joined as Senior Scientist in AS&EC Division on 17th Aug, 2013. He did his B.Tech.(Agril. Engg.) during 1997 and M.Tech. (Processing & Food Engineering) during 1999 from CCS Haryana Agricultural University Hisar. He accomplished his Ph.D (Processing & Food Engineering) during 2010 from Punjab Agricultural University, Ludhiana. He has served as Assistant Professor & Associate professor at Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu.

He has published more than 12 papers in journals of international and national repute, and contributed 4 book chapters and a training manual. He has expertise in modified atmosphere packaging of perishables.

- Mrs. Monika has joined CIPHET on 10th April, 2013 as Scientist in the Division of Transfer of Technology. Her ARS discipline is Electronics & Instrumentation. She has done B.Sc.(Hons.) in 2001 and M.Sc.(Physics) in 2004 from Delhi University. She has also served as Lecturer in Physics in Technical Education Deptt., Haryana.

- Ms. Surya Tushir joined CIPHET as Scientist on 12th April 2013. She has been posted in Food Grains & Oilseeds Processing division. She did her B.Sc (Botany Hons.) in 2007 and M.Sc. (Applied Microbiology and Biotechnology) in 2009 from Banasthali University, Jaipur, Rajasthan. Her discipline in ARS is Agricultural Microbiology.

- Dr. Armaan Ullah Muzaddadi joined as Senior Scientist (Fish Processing Technology) in CIPHET, Ludhiana on 22nd August, 2013. Earlier he was working as Assistant Professor (Sr. Scientist) in Dept. of Fish Processing Technology, College of Fisheries (Central Agricultural University), Lembucherra, Agartala, Tripura. He has teaching, research & extension experience of about 12 years in the field of Fish Harvest and Post Harvest Technology, Fishery Microbiology & Quality Control.

- Dr. Manju Bala joined CIPHET, Ludhiana as Senior Scientist (Plant Biochemistry) in pay band-IV on 12th August, 2013. Before joining CIPHET, she worked as a Senior Scientist at Directorate of Rapeseed-Mustard Research (ICAR), Sewar, Bharatpur, Rajasthan from 2010. She served as Assistant Professor & Vice-Principal for six years at M.N. Institute of Applied Sciences, Bikaner, a college affiliated to MGS University, Bikaner. She has contributed 29 research papers in various National and International Journals.

PROMOTION

- Dr. K.Narsaiah, Senior Scientist got promoted to Principal Scientist (AS&PE) from 28th July 2012.

TRANSFERS

- Dr. (Mrs.) Manisha Mangal, Sr. Scientist (Biotechnology Plant-Sci) has been transferred from CIPHET, Ludhiana to IARI, New Delhi w.e.f. 7.8.2013.
- Er. Prasoon Verma, Scientist (SG) (AS&PE) has been transferred from CIPHET, Ludhiana to IISR, Lucknow w.e.f. 8.8.2013.
- Sh. Gaikward Nilesh Nivrutti, Scientist (AS&PE) has been transfeared from CIPHET, Ludhiana to NRCP, Solapur w.e.f. 3.8.2013.
- Dr. M.R. Manikantan, Sr. Scientist (AS&PE) has been transferred from CIPHET, Ludhiana to CPCRI, Kasargod -Kerala w.e.f. 18.7.2013.
- Dr. P. Barnwal, Sr. Scientist (Mechanical Engineering) has been transferred from CIPHET, Ludhiana to NDRI, Karnal w.e.f. 10.9.2013.

RETIREMENT

- Sh. Mahipal Singh, T-6 (Technical Officer) has been retired on 31.8.2013.
- Sh. Om Parkesh Moodan, T-5 (Technical Officer) has been retired on 31.12.2013.
- Smt. D.B. Chadha, T-4 (Sr. Technical Officer) has been retired on 31.03.2014.

PERSONNEL

Name	Designation
Dr. R.K. Gupta	Director
Dr. S.N. Jha	Head, AS&EC Division
Dr. R.K. Gupta	Head, FG&OP Division
Dr. S.K. Nanda	Incharge Head TOT
Dr. R.K. Gupta	PC (PHT)
Dr. P. R. Bhatnagar	PC (APA)
Dr. S.K. Tyagi	Pr. Scientist (Chemical Engg.)
Dr. Harinder Singh Oberoi	Pr. Scientist (Microbiology Plant Sci)
Dr. K. Narsaiah	Pr. Scientist (AS&PE)
Dr. (Mrs.) Mridula Devi	Sr. Scientist (F&N)
Dr. Suresh K. Devatkal	Sr. Scientist (Livestock Process Tech.)
Dr. Anil Kumar Dixit	Sr. Scientist (Agril. Economics)
Dr. Deep Narayan Yadav	Sr. Scientist (Food Science & Tech.)
Dr. (Mrs.) Pranita Jaiswal	Sr. Scientist (Microbiology-Plant Sci)
Dr. Dattatrya M. Kadam	Sr. Scientist (AS&PE)
Dr. Sangita Bansal	Sr. Scientist (Biotechnology Plant Sci)
Dr. R.K. Vishwakarma	Sr. Scientist (AS&PE)
Dr. Manju Bala	Sr. Scientist (Plant Biochemistry)
Dr. Sandeep Mann	Sr. Scientist (AS&EM)
Dr. Armaan Ullah Muzaddadi	Sr. Scientist (Fish Processing Technology)
Dr. (Mrs.) S.K. Aleksha Kudos	Scientist (SS) (AS&PE)
Er. (Mrs.) Manpreet Kaur Grewal	Scientist (AS&PE)
Dr. Yogesh Kumar	Scientist (LPT)
Dr. Tanbir Ahmad	Scientist (LPT)
Dr. Deepika Goswami	Scientist (FST)
Ms. Monika Sharma	Scientist (FST)
Dr. (Mrs.) Indu Rawat	Scientist (Home Mgmt.)
Dr. Rahul Kumar	Scientist (FST)
Ms. Leena Kumari	Scientist (Electn. Inst.)
Ms. Monika	Scientist (Electn. Inst.)
Ms. Surya	Scientist (Agri. Microbiology)
CIPHET, Abohar	
Dr. Pritam Chand Sharma	Head, HCP Division, Abohar
Dr. Dinesh Kumar Bharti	Sr. Scientist (Agril. Eco.)

Name	Designation
Dr. Jitendra Singh	Sr. Scientist (Agril. Ento.)
Dr. Ramesh Kumar	Sr. Scientist (Hort.)
Er. Eyarkai Nambi V.	Scientist (AS&PE)
Sh. Vijay Singh Meena	Scientist (Hort.)
Dr. Sunil Kumar	Sr. Scientist (Bio-chem-Plant Sci)
Dr. Bharat Bhushan	Scientist (Bio-chem-Plant Sci)
Technical	
Dr. Mukund Narayan	T-5 (Agril. Structure)
Sh. Gurdeep Singh	T-4 (Lab. Asstt.)
Sh. Hardev Singh Sekhon	T-4 (Driver)
Sh. Beant Singh	T-3 (Driver)
Sh. Chaman Lal	T-3 (Lab. Asstt.)
Sh. Lakhwinder Singh	T-3 (Fitter)
Sh. Bhajan Singh	T-3 (Fitter)
Sh. Jaswant Singh	T-3 (Welder)
Smt. Sonia Rani	T-3 (DEO)
Sh. Hardeep Singh	T-3 (Turner)
Sh. Jaswinder Singh	T-2 (Machinist)
Sh. Jagtar Singh	T-2 (Electrician)
Sh. Vishal Kumar	T-3 (DEO)
Sh. Pradip Kumar	T-2 (Field Asstt.)
Sh. Yashpal Singh	T-2 (Field Asstt.)
Sh. Satwinder Singh	T-2 (Lab. Technician)
Sh. Sarup Singh	T-1 (Lab. Technician)
Sh. Rajiv Sharma	T-3 (Lab. Technician)
CIPHET, Abohar	
Sh. V.K. Saharan	T (9) (Technical Officer)
Sh. Prithvi Raj	T-6 (Technical Asstt.)
Sh. Rajesh Kumar	T-6 (Technical Asstt.)
Sh. Ganpat Ram	T-3 (Driver)
Sh. Devinder Kumar	T-3 (Fitter)
Sh. Dalu Ram	T-3 (Fitter)
Sh. Pawan Kumar	T-3 (Electrician)
Administrative	
Sh. Raj Kumar	SAO
Sh. Manni Lal	AF&AO
Sh. Neeraj Tahiliani	F&AO
Sh. B.C. Katoch	AAO
Sh. Kunwar Singh	Assistant
Sh. Avtar Singh	Assistant
Sh. Tarsem Singh Purba	Assistant
Sh. Gurdial Singh	UDC
Smt. Jasvir Kaur	Assistant

Name	Designation
Sh. Harbhupinder Singh	UDC
Sh. Iqbal Singh	UDC
Sh. Ashwani Kumar	UDC
Smt. Sunita Rana	LDC
Sh. Ajay Kumar Tandon	LDC
Sh. Ram Khelawan Yadav	LDC
Sh. Sohan Lal	LDC
Sh. Rajinder Kumar	LDC
Sh. Sughar Singh Verma	PS
CIPHET, Abohar	
Sh. J.S. Paul*	AAO
Sh. Pawan Kumar	AAO
Sh. Mohan Lal	Assistant
Sh. Sanjay Kumar Gaur	LDC
*On deputation since 24.11.2012	
Supporting	
CIPHET, Ludhiana	
Sh. Sukhbir	Skilled Support Staff
Smt. Viran Bali	Skilled Support Staff
Sh. Shalikgram Dwivedi	Skilled Support Staff
CIPHET, Abohar	
Sh. Surinder Kumar	Skilled Support Staff