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ANNUAL REPORT

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केन्द्रीयक टाई-उपरांतइ न्जीनियरिंगए वंप्रौद्योगिकीस ंस्थान

CENTRAL INSTITUTE OF POST HARVEST ENGINEERING & TECHNOLOGY

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PREFACE

The Institute made good progress in research and extension activities during the reported period of 2006-07. The institute executed 61 in house projects and 3 externally funded projects. The research projects covered the areas of value addition of horticultural crops, food grains, oilseeds, spices etc., assessment of losses, pre-harvest management practices, effects of mulching, utilization of crop residues and development of hardware (hand tools and machines) for improving post harvest technology operations.

The research outputs were standardization of technique to predict quality of apple using nondestructive method, optimization of parameters for ready to constitute makhana kheer mix such as particle size, total solids and temperature of milk, dehydration of onion slices in polyhouse, handtools for cutting banana comb and pomegranate aril extraction, processing of aonla by foam mat drying, process development for hard and soft type toffees and aonla beverage, studies on convection drying of basil leaves and apple slices and osmo-convective dehydration of banana and pineapple, guava rings, flakes, cubes and slices.

Tray shrink wrap packaging of tomato and kinnow, packaging and storage of pomegranate fruits and shrink-wrapping of individual apple fruits were found effective in extending the shelf life of these high value crops.

An exhaustive survey of guar processing industries was done and a successful process has been developed to dehull guar seeds. The grade standards for dhal such as grade I and II dhals were developed using the market samples and a pilot plant for milling of pulses was established at CIPHET. A solar energy based thermal (mathematical) model was developed to predict the temperature of wheat grain within the CAP storage.

A study was conducted to assess the composition of food processing industries in Punjab, employment/unit, value of production/rupee fixed investment, fixed investment/unit etc. were evaluated. The study revealed that employment per unit in food processing industries in Punjab grew moderately from 5.80 persons per unit in 1995 to 6.96 persons per unit in 2004. A mobile cool chamber mounted on the standard cycle rikhsaw has been developed for short distance transportation, holding and marketing of fresh water fish.

The AICRP on Post Harvest Technology and Application of Plastics in Agriculture have developed many useful technologies.

A good number of research papers, technical bulletins, project profiles and extension leaflets were published. The scientists of the institute participated in various conferences, meetings and workshops. The liaison with farmers and entrepreneurs was improved through various programmes and activities. Institute offered four technology based entrepreneurship development programmes for upcoming entrepreneurs namely sunflower based confectionary products, Kinnow processing, covered crop cultivation and guava processing.

I acknowledge with thanks the support and cooperation extended by Dr. Nawab Ali, DDG (Engg.), Dr. Pitam Chandra, ADG (PE) & Dr. S.K. Tandon, ADG (Engg.), ICAR, New Delhi. The help rendered by Drs. S.K. Nanda, PC(PHT), P.R. Bhatnagar, PC(APA), K.K. Singh, M. Prasad, R.K. Gupta, R.K. Goyal, D.Dhingra, Sh. Tej Ram, Sh. Vijay Kumar, Sh. J.S. Paul, all scientific, administrative technical and supporting staff at CIPHET in institute activities and preparation of this report is highly appreciated.

R T Patil
Director, CIPHET

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कार्यकारी सारांश

कार्यकारी सारांश

संस्थान ने सत्र 2006–2007 में अनुसंधान एवं प्रसार में उल्लेखनीय प्रगति की है। इस वर्ष में 61 परियोजनाओं एवं 3 बाह्य निधिक परियोजनाओं पर कार्य किया गया। अनुसंधान परियोजनाओं में अनाज, दहलन, मसालों, तेल बीजों व बागबानी फसलों के कटाई उपरान्त मूल्य वर्धन पर विशेष बल दिया गया। इसके साथ कटाई उपरान्त होने वाली क्षति का मूल्यांकन, कटाई पूर्व प्रबंधन के अधिनियमों, मल्चिंग के प्रभाव, फसलों के अवशेषों के उपयोग व कटाई उपरान्त कार्यों को सुधारने के लिए यंत्रों व मशीनों के विकास की ओर भी ध्यान दिया गया।

सेब की गुणवत्ता को बिना काटे आंकने के लिए एक तरीका तैयार किया गया। सेब की टी.एस. एस व एसिडिटी का अनुमान उसके छिलके के रंग से लगाया गया। एसिडिटी का अनुमान रंग की 'ए' एवं 'बी' मात्रायों से टी.एस.एस के मुकाबले ज्यादा सही पाया गया।

मखाने से तुरन्त तैयार होने वाली खीर के विकास के लिए मखाने के टुकड़ों, कुल मात्रा में ठोस एवं दूध के तापमान को अनुकूलतक किया गया।

पालीहाऊस में प्याज़ को सुखाने पर अध्ययन किया गया। तीन मिलीमीटर मोटी प्याज़ को पोलीहाऊस में सुखाने में 19 सूर्यताप घंटे लगे। सुखाया गया प्याज़ छः महीने बाद भी खाने के लिए उपयुक्त पाया गया।

हाथ से केले के गुच्छों को काटने के लिए यंत्र का विकास किया गया। इस यंत्र से केले के गुच्छों को काटने में होने वाले 2–6 % नुक्सान को कम करने में मदद मिलेगी। इस यंत्र का केला उत्पादन क्षेत्रों में प्रचार–प्रसार किया गया व किसानों को इसके उपयोग की विधि सिखाई गई।

आँवले के प्रसंस्करण पर कार्य किया गया। अंडे के एल्बयुमिन व ट्राई कैलशियम फासफेट से आँवले के रस का झाग बनाकर सुखाने की कोशिश की गई। 5 % अंडे के एल्बयुमिन एवं 1 % ट्राई कैलशियम फासफेट से सुखाये गये रस से वांछित गुणवत्ता का पाऊडर प्राप्त हुआ। आँवले के पाऊडर एवं आँवले के बारीक टुकड़ों से कठोर व नर्म प्रकार की टाफीयाँ बनाई गई। इन टाफीयों को बहुत पंसद किया गया व इनमें विटामिन सी की मात्रा भी प्रतिधारित रही। ओसमोटिक विधि से आँवले के टुकडों को चीनी के घोल में डालकर सुखाया गया। आँवले से बीवरेज बनाने की पद्धति का विकास भी किया गया।

तुलसी के पत्तों व सेब के टुकड़ों को 50–70 डिग्री सेलसियस तापमान में सुखाने के प्रयोग किए गये। थिन लेयर ड्राइंग माडलस के प्रयोग से प्राप्त आँकड़ो का निर्धारण किया गया।

अनानास एवं केले की ओसमो–कन्वैक्टिव डिहाईड्रेशन प्रसंस्करण प्रक्रिया पर कार्य किया गया। चीनी के घोल में चीनी की मात्रा, फल के टुकड़ों की मोटाई, फल व चीनी के घोल के अनुपात व प्रक्रिया के समय का फलों में पानी की हानि व चीनी के लाभ पर प्रभाव को जाँचा गया। चीनी के घोल में चीनी की मात्रा, फल व चीनी के घोल के अनुपात व प्रक्रिया के समय को बढ़ाने से फलों में पानी की कमी व चीनी की मात्रा में लाभ में वृद्धि पाई गई जबकि फल के टुकड़ों की मोटाई बढ़ाने से इनमें विपरीत प्रभाव पड़ा। अनानास कैण्डी बनाने की प्रक्रिया का विकास किया गया।

अमरूद के गूदे एवं पनीर के पानी से आर. टी.एस बीवरेज बनाई गई। इनको बनाने के तरीके व सामान के अनुपात का मानकीकरण किया गया।

ये मानकीकरण चख कर स्वादिष्ट पाये जाने के आधार पर किया गया। अमरूद के रिंगस, फलेक्स, क्यूबज़ एवं स्लाईसिस को ओस्मो–कन्वैकटिव तरीके से सुखाने पर अध्ययन किया गया। तैयार वस्तुयों के भंडारण और उपयोग होने तक की अवधि का अलग–अलग पैकेजिंग की विधियों पर अध्ययन कर अनुमान लगाया गया।

टमाटर व किन्नु की ट्रे रैप पैकेज़िग पर अध्ययन किया गया। इस अध्ययन में 15 माईक्रोन मोटाई व गर्मी से सिकुड़ने वाली प्लास्टिक फिल्म का उपयोग किया गया । ट्रे में 9 टमाटरों का प्लास्टिक से आवरण करने से टमाटरों के भण्डारण की अवधि, साधारण व रैफरीजरेटड तापमान पर 11 व 35 दिन पाई गई । सी.एफ.बी ट्रे में चार किन्नु के फलों का प्लास्टिक से आवरण करने से इनकी भण्डारण अवधि में साधारण व कम तापमान पर 38 व 77 दिनों की बढ़ोत्तरी हुई ।

अनार के फलों की पैकेजिंग व भण्डारण पर कार्य किया गया। फलों को सोडियम बाईकारबोनेट, कैलशियम क्लोराईड, कैलशियम कारबोनेट, कारबैनडाज़िम से उपचार करके सी. एफ.बी के डिब्बों में भरकर साधारण व कम तापमान पर भण्डारण किया गया। 4 % कैलशियम कलोराइड व 0.1 % कारबैनडाज़िम से उपचारित फलों की भण्डारण और उपयोग होने तक की अवधि को साधारण व कम तापमान पर 30 से 48 दिनों तक बढ़ाया जा सका।

उमरान प्रजाति के बेरों को मुरब्बा व अन्य मूल्य वर्धित वस्तुयें बनाने के लिए उपयुक्त पाया गया। बेर का मुरब्बा बनाने के ढंग का मानकीकरण किया गया। बेर का बीज निकालने के लिए मशीन का विकास किया गया। इस मशीन से बीज निकालने में 15 % तक गूदा भी साथ ही निकल जाता है। इस गूदे का उपयोग पाऊडर बनाने के लिए किया जा सकता है।

सेब की गुणवत्ता व भण्डारण अवधि को बढ़ाने के लिए सेबों को प्लास्टिक की फिल्मों में बंद करने पर अध्ययन किया गया। अलग–अलग फल की 25 माईक्रोन मोटाई वाली प्लास्टिक फिल्म में श्रिंक रैपिंग से इनकी भण्डारण की अवधि में नियंत्रित अवस्थाओं से 4–10 दिन बढ़ोतरी हुई।

ग्वार की आर.जी.सी–936 एवं एच.जी–365 किस्मों के बीजों के भौतिक गुण निकाले गये। ग्वार प्रसंस्करण उद्योगों का सर्वेक्षण किया गया। ग्वार बीज की हस्क को निकालना सब से मुश्किल कार्य था। अलग–अलग पूर्ववर्ती मशीनों से ग्वार बीज की डि–हलिंग करने की कोशिश की गई लेकिन किसी भी मशीन से सफलता प्राप्त न हुई। इसके बाद अध्ययन करके ग्वार बीज की डि–हलिंग करने की नई प्रक्रिया का विकास किया गया।

बाज़ार में उपलब्ध दस किस्मों की तूर दाल के नमूने लिए गये। इनके विभिन्न गुणों जैसे कि साईज़, 1000–कौटीलीडन का वज़न, थोक सघनता, टूटे हुये दानों की प्रतिशत एवं आसत्र संघटकों का निर्धारण किया गया । गुणों के आधार पर इन्हें दो श्रेणीयों में बाँटा गया। सीफेट लुधियाना में दलहनों को दलने के लिए प्रयोगिक संयंत्र भी स्थापित किया गया।

गेहूँ के कैप (कवर एंड प्लिन्थ) भण्डारण में अनाज के तापमान का अनुमान लगाने के लिए सौर उर्जा पर आधारित थर्मल माडल विकसित किया गया।

अनार व अमरूद की पैदावार, गुणवत्ता एवं भण्डारण से उपयोग तक की अवधि पर सीमांत जल से सिंचाई के प्रभाव का अध्ययन किया गया। 100 % सीमांत जल (पी.एच. 7.70, ई.सी.19.50 डी एस/मी) से अनार की सिंचाई करने से पत्तों के मुख सूख गये, लेकिन अमरूद में ऐसा प्रतिकूल असर दिखाई नहीं पड़ा।

भिंडी एवं स्ट्राबेरी की वृद्धि एवं पैदावार पर बाओडीग्रेडेबल प्लास्टिक मल्च के प्रभाव का

अध्ययन किया गया। भिंडी की सबसे ज़्यादा पैदावार (242.7 ग्राम प्रति पौदा) काली साधारण प्लास्टिक से मल्चिंग करने से प्राप्त हुई। इसकी तुलना में काली बाओडीग्रेडेबेल फिल्म वाले अध्ययन में पैदावार 229.2 ग्राम प्रति पौदा थी। स्ट्राबेरी में भी सबसे ज़्यादा पैदावार (151.4 ग्राम प्रति पौदा) काली साधारण प्लास्टिक मल्च के प्रयोग में प्राप्त हुई।

भूमि की सोलराईज़ेशन से खरपतवारों की संख्या में उल्लेखनीय कमी पाई गयी। इससे सब्ज़ीयों के पौधों के तने व जड़ों में ज़्यादा विकास हुआ जो कि क्रमवार सोलराईज़ड भूमि में 19–28 % एवं 17–23 % ज़्यादा थी।

सिंचाई एवं मल्चिंग का बी.टी. कपास की वृद्धि एवं पैदावार पर प्रभाव का अध्ययन किया गया। काली बाओडीग्रेडबल प्लास्टिक फिल्म से मल्चिंग करने से पैदावार में उल्लेखनीय वृद्धि देखी गयी, व इससे खरपतवारों की संख्या में उल्लेखनीय कमी देखी गयी।

वर्मीकम्पोस्ट बनाने के लिए गोबर के साथ फसलों के अवशेषों के उपयोग पर अध्ययन किया गया। सब्ज़ियों के अवशेष हिस्सों, सरसों व कपास के तनों इत्यादि को गोबर में मिलाकर वर्मीकम्पोट बनाने की कोशिश की गई। वर्मीकम्पोस्ट के उपयोग से स्ट्राबेरी व अचल पूँजी भिंडी की विपणनयोग्य पैदावार में वृद्धि प्राप्त हुई।

पंजाब के खाद्धय उद्योगों का अध्ययन किया गया। खाद्य उद्योगों के संघटन, प्रति यूनिट रोज़गार, प्रति रूपया पूँजी निवेश इत्यादि की जानकारी समाहित की गई। पजांब में खाद्य उद्योगों में 1995 से 2004 तक में 5.80 व्यक्ति प्रति यूनिट से बढ़कर 6.96 हो गई।

पंजाब के फिरोज़पुर जिले के गाँवों में स्थित लघु ग्रामीण प्रसंस्करण ईकाइयों के मालिकों की सामाजिक एवं आर्थिक स्थिति की जानकारी सर्वेक्षण द्वारा प्राप्त की गई। अधिकतर प्रत्यर्थी 28–43 वर्ष के थे। लगभग 46.25 % साक्षर थे व आँठवी कक्षा तक पढ़ाई किए हुये थे। प्रत्यार्थीयों द्वारा कर्ज़ की ज़रूरत गैर संस्थाई स्रोतों से प्राप्त की हुई थी व सरकार द्वारा कृषि प्रंसस्करण को बढ़ावा देने के लिए लागू स्कीमों के बारे में जागरूकता बहुत कम थी।

कम दूरी तक ताज़े पानी की मछली को परिवहित अतिधारण व विपणन करने के लिए चलते फिरते शीत कक्ष का विकास किया गया। शीत कक्ष के अन्दर की लंबाई, चौड़ाई व ऊंचाई क्रमवार 1200, 750 एवं 700 मिलीमीटर है। पीछे एक दरवाज़ा रखा गया है। इस से मछलियों को शीत कक्ष में भरा जाता है। 300 X 300 मिलीमीटर का ढक्कन मछली को बिक्री हेतु निकालने के लिए रखा गया है। इस शीत कक्ष को चलता फिरता बनाने के लिए इसे रिक्शा की चेस्जि पर फिट कर दिया जाता है। ठंडा करने के लिए इसमें बर्फ का प्रयोग किया जाता है।

EXECUTIVE SUMMARY

The Institute made good progress in research and extension activities during the reported period of 2006-07. Research and extension activities were accelerated with more projects. The institute executed 61 in house projects and 3 externally funded projects. The research projects covered the areas of value addition of horticultural crops, food grains, oilseeds, spices etc., assessment of losses, pre-harvest management practices, effects of mulching, utilization of crop residues and development of hardware (hand tools and machines) for improving post harvest technology operations.

Prediction of quality of apple was standardized using nondestructive method. TSS and acidity were predicted on the basis of colour values. Prediction of acidity using colour values 'a' and 'b' was found to be better than TSS.

Particle size of makhana (gorgon nut), total solids and temperature of milk were optimized for development of ready to constitute makhana kheer mix.

Studies on dehydration of onion slices in a polyhouse were carried. Onion slices, 3 mm thick took 19 sunshine hours for drying in the greenhouse. The dried onion slices were safe to use even after 6 months of storage.

A manual banana comb cutter was developed to separate the banana combs attached to the banana bunch stem. The cutter has potential to reduce the losses during cutting by 2-6%. The cutting tool was demonstrated in the banana growing areas.

Processing of aonla was taken up. Foam mat drying of aonla juice with egg albumin, tri-calcium phosphate (TCP) and their combination was tried. Egg albumin (5%) with 1% TCP yielded aonla powder with desirable quality characters. Hard and soft type toffees were prepared from aonla powder and shreds. The toffees had higher acceptability and retained vitamin C. Osmotic dehydration of aonla segments was studied. Process technology has been developed to prepare aonla beverage.

Studies on drying of basil leaves and apple slices was conducted in the range of 50-70^{0}C air temperature. Thin layer drying models were fitted to the experimental data. Process parameters for osmo-convective dehydration of banana and pineapple were optimized. Effect of sugar syrup concentration, slice thickness, fruit to syrup ratio and time was studied on water loss and solute gain. Concentration of osmotic solution, fruit to syrup ratio and time had positive effects on water loss and solute gain whereas slice thickness had a negative effect. Method of preparation of pineapple candy by osmo-convective dehydration was standardized.

RTS beverages were prepared from guava pulp and dairy milk whey. Recipes for preparation of pure and guava based beverages were standardized by sensory evaluation. Osmo-air dehydration of guava rings, flakes, cubes and slices was studied. Shelf life of these products under different packaging conditions was also evaluated.

Tray wrap packaging of tomato and kinnow was studied using heat shrinkable film (15 micron thick). Over wrapping of nine tomatoes in a tray resulted in a shelf life of 11 and 35 days under ambient and refrigerated storage conditions respectively. Over wrapping of four kinnows in a CFB tray extended its shelf life by 38 and 77 days under ambient and low temperature conditions, respectively.

Studies on packaging and storage of pomegranate fruits were taken up. Fruits treated with sodium bicarbonate, calcium chloride, calcium carbonate, carbendazim and packed in CFB boxes were stored under ambient and low temperatures. Shelf life of fruits treated with 4 % calcium chloride and 0.1 % carbendazim could be extended upto 30 and 48 days under ambient and low temperature conditions, respectively.

Ber *(Zizyphus mauritiana* Linn.*)* cultivar 'Umran' was found suitable for making preserves and dehydrated products. Process parameter for preparing *ber* preserves was standardized. Ber destoner was developed to remove *ber* seeds. The loss in whole fruit was around 15 %, but these fruit remains could be used for the preparation of ber powder.

Polymeric-film packaging for enhancing quality and shelf-life of apple was studied. Shrink wrapping of individual fruits with 25 micron film resulted in enhancement of shelf life by 4-10 days as compared to control.

Physical properties of guar seeds of varieties RGC-936 and HG-365 were evaluated. A survey of guar processing industries was done. Dehulling of guar seeds was observed to be the most difficult task. Existing milling machines were evaluated and found unsuitable for dehulling of guar seeds. A successful process has been developed to dehull guar seeds and is being filed for obtaining patent.

Samples of ten different brands of pigeonpea dhal were procured from local market. Size, 1000-cotyleden weight, bulk density, percentage of whole cotyledons and proximate composition were evaluated and standards for grade I and II dhals were developed. A pilot plant for milling of pulses was established at CIPHET.

A solar energy based thermal model was developed to predict the temperature of wheat grain within the CAP storage.

The effect of marginal quality water (saline) on yield, quality and shelf life of pomegranate and guava was studied. Irrigation with 100 % saline water (pH 7.70, EC 19.50 dSm^{-1}) resulted in tip burning of pomegranate leaves, however no adverse effect was observed on guava plants.

Studies on effect of biodegradable plastic mulches on growth and yield of okra and strawberry were conducted. Fruit yield of okra was observed highest in black ordinary film (242.7 g/plant) followed by black biodegradable film (229.2 g/plant) and only 125.2 g/plant under control. In case of strawberry maximum fruit yield was observed with the use of black plastic film (151.4 g/plant) followed by black biodegradable film.

Soil solarization treatments significantly reduced the weed population as compared to control. It resulted in better shoot and root length of nursery of vegetable plants. The shoot and root length of nursery plants were observed to be 19-28 %, and 17-23 % higher in solarized soil.

Effect of irrigation and mulching on growth and yield of Bt-cotton was studied. Significantly higher yields of cotton and reduction in weed population was observed with the use of black biodegradable film as mulch.

Utilization of crop residues (cotton stick, mustard straw vegetable waste etc.) alongwith cowdung for preparation of vrermicompost was studied. The use of vermicompost increased the marketable fruit yield of strawberry and okra.

Food and feed industry of Punjab was studied. The composition of food processing industries in Punjab, employment/unit, value of production/rupee fixed investment, fixed investment/unit etc. were evaluated. The study revealed that employment per unit in food processing industries in Punjab grew moderately from 5.80 persons per unit in 1995 to 6.96 persons per unit in 2004.

Socio-economic status of small rural agro-processors of Ferozepur district was carried out by survey. Most of the processors belonged to middle age (28-43 year) and less than half of the respondents (46.25%) were educated upto middle standard. Non-institution credit system was adopted for credit requirement. The respondents were 'slightly aware' about government schemes to boost the food processing sector.

A mobile cool chamber has been developed for short distance transportation, holding and marketing of fresh water fish. The dimensions of cool chamber are 1200 X 750 X 700 mm (inside). A door on backside was provided for loading. An opening of 300 X 300 mm at the top was kept for sale of fish. The cool chamber was mounted on the standard cycle rickshaw.

The AICRP on Post Harvest Technology and Application of Plastics in Agriculture have developed many useful technologies.

A good number of research papers, technical bulletins, project profiles and extension leaflets were published. The scientists of the institute participated in various conferences, meetings and workshops. The liaison with farmers and entrepreneurs was improved through various programmes and activities.

CIPHET - AN OVERVIEW

CIPHET - AN OVERVIEW

The Central Institute of Post Harvest Engineering and Technology (CIPHET) was established under the aegis of the Indian Council of Agricultural Research (ICAR), New Delhi on 29 December 1989 at Ludhiana in the state of Punjab as a nodal institute to undertake lead researches in the area of post harvest engineering and technology appropriate to agricultural production catchment and agro-industries. The Institute has another campus at Abohar (Punjab), which was established on 19 March 1993. The Abohar campus is primarily responsible for conducting research and development activities on fruits and vegetables and commercial crops. The Institute is catering to the need of both growers and processors.

The Institute is also coordinating two All India Coordinated Research Projects (AICRPs) namely AICRP on Post Harvest Technology and AICRP on Application of Plastics in Agriculture. These two projects have been engaged in development and multi-locational adaptive trials of technologies for reduction in post harvest losses, value addition, development of agro-processing centres for income generation and application of plastics in agriculture.

Mandate

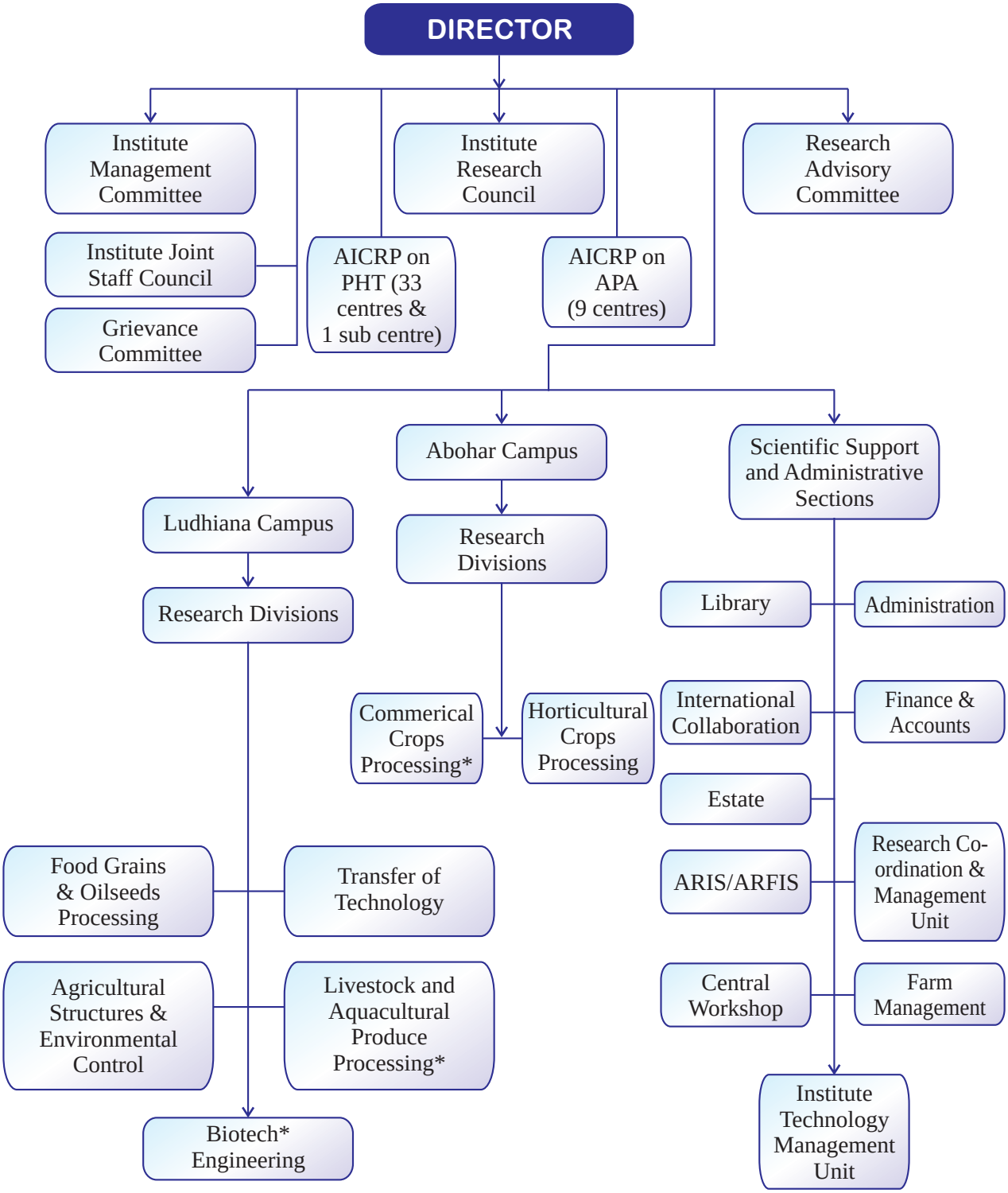
To undertake basic, applied and adaptive engineering and technology research on post harvest sector of cereals, pulses, oilseeds, fruits, vegetables, flowers, spices, plantation crops, products of forest origin, livestock and aquaculture produce including agricultural structures and environmental control.

To act as national institute for research, training and education in post harvest engineering and technology.

To act as repository of information on post harvest engineering and technology.

To transfer technology and provide advisory and consultancy services.

ORGANIZATIONAL STRUCTURE



** Proposed to be established*

RESEARCH DIVISIONS

Ludhiana Campus

1. Food Grains and Oilseeds Processing
2. Agricultural Structures and Environmental Control
3. Transfer of Technology
4. Livestock and Aquacultural Produce Processing*
5. Biotech Engineering*

Abohar Campus

6. Horticultural Crops Processing
7. Commercial Crops Processing*

** Proposed to be established*

INFRASTRUCTURE

LIBRARY

CIPHET library plays as important role in serving the scientific information in the areas of Post Harvest Engineering & Technology. The current stock of books is 3083, gratis publications 372, annual reports and research highlights etc. 1106 as on 31.03.2006. 26 Indian journals & 15 foreign journals were subscribed during the year. In this financial year 60 books have been added in the stock. Apart from the purchase of books and periodicals, Institute library is rendering the following services to the readers:

Current contents service: Current list of journals & new arrivals are circulated regularly among CIPHET staff and ICAR institutes.

Library consultation services: Faculty members and students from other Institutes and Universities are also welcomed to consult CIPHET Library.

Sale of publications: The Library puts on sale, the technical bulletins and books published by the Institute.

Reference service: The Library also arranges photocopy of research articles from other libraries on payment basis as per reader's request. Library also arranges references and abstracts of research papers/articles as per request of the readers on a specific subject/keyword from SAARC Agricultural Information Centre, Dhaka (Bangladesh).

ARIS Cell

The institute has an Agricultural Research Information System Cell for the scientists/for their data analysis and electronic communication. The unit has six computers including one LAN server. The institute computers are connected through Local Area Network. LAN nodes have been increased to connect more number of computers. Round the clock internet connectivity is available through VSAT provided by Council under ICAR Net project. The bandwidth of 128 kbps is available at present from ERNET India. The Internet is provided to different nodes through proxy server. The Cyberoam manages internet bandwidth; user details and provides security and stability on the network. Besides, the ARIS cell houses a number of analysis and design software. Pro/E was made available to users for CAD/CAM. The facilities in the cell were strengthened through more number of analysis and general software.

At present following services are offered by ARIS Cell.

Provide electronic communication in the institute for the scientists

Provide data analysis facility for the scientists.

Provide assistance in software application in different research works

Internet browsing

Software and computer hardware support to the scientists, administrative and other staff

Assistance in online patent search through various databases.

CIVIL WORKS

I. Completed

1. Pilot plant for pulse milling at CIPHET, Ludhiana

II. Under Progress

Divisional building at Ludhiana.

III. New works awarded for construction

1. Chillies processing plant, CIPHET, Ludhiana
2. Agro-processing cluster, CIPHET, Ludhiana
3. Pilot plant building, CIPHET, Abohar

STAFF POSITION (AS ON 31.03.2007)

Details of Personnel Sanctioned Posts in Position

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	71*	31*
Technical	28	28
Administrative	19**	19**
Supporting	6	4
Total No. of Posts	124	82

* including Director

** Including Administrative Officer

AICRP on Application of Plastics in Agriculture, CIPHET, Ludhiana and Abohar

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	4	2
Technical	1	1
Administrative	2	2
Supporting	1	1
Total No. of Posts	8	5

AICRP on Post Harvest Technology, CIPHET, Ludhiana

Details of Personnel	Sanctioned Posts	Posts in Position
Scientific	2	1
Technical	1	1
Administrative	1	1
Supporting	11	0
Total No. of Posts	5	3

STATEMENT OF BUDGET ESTIMATES AND EXPENDITURE

PLAN

(Rs. in lakhs)

S.No.	Head of Account	Revised Budget Estimates	Expenditure up to 31.03.2007
1.	Establishment Charges (TS/OTA)	15.50	15.48
2.	Travelling Allowance	7.00	6.39
3.	Other charges including equipment	312.56	306.82
4.	Revenue Resources	-	-
5.	Works (Major)	157.00	157.00
	a. Office building	-	-
	b. Residential building	-	-
6.	Other items (HRD)	0.50	0.50
	Total	**492.56**	**486.19**
7.	Pension & Retirement Benefits		

NON - PLAN

(Rs. in lakhs)

S.No.	Head of Account	Revised Budget Estimates	Expenditure up to 31.03.2007
1.	Establishment Charges (TS/OTA)	173.70	168.72
2.	Travelling Allowance	2.00	2.00
3.	Other charges including equipment	24.30	24.30
4.	Revenue Resources		
5.	Works (Major)	-	-
	a. Office building	-	-
	b. Residential building	3.00	3.00
6.	Other items (HRD)	-	-
	Total	**203.00**	**198.02**
7.	Pension & Retirement Benefits	19.00	17.60

RESEARCH ACHIEVEMENTS

RESEARCH ACHIEVEMENTS

Development of a nondestructive technique for prediction of quality of apple

S N Jha and D R Rai

Three different varieties of freshly harvested apple namely, Golden Delicious, Red Delicious and Ambri were procured from local fruit brokers, and two unknown varieties from local market. 135 sound samples were stored for 28 days at 32±0.5 C and 65±7 % temperature and relative humidity, respectively. On alternate days, three samples from each variety were taken for conducting experiments to acquire colour values, NIR spectra in the range of 900 - 1700 nm and other biochemical and physical parameters.

Size, shape, spherecity, gloss, acidity, TSS and dry matter of apple stored at ambient were analyzed, plotted and the best form of equations were fitted. Two phases of the change in TSS content of fruit were clearly visible during the storage period under study (Fig 1) Filtering of data and removal of outliers were performed for modeling the colour and NIR spectra for nondestructive evaluation of quality of apple in terms of TSS and/or acidity. Two methods: partial least square and multiple regression analyses with cross validation algorithm were performed on

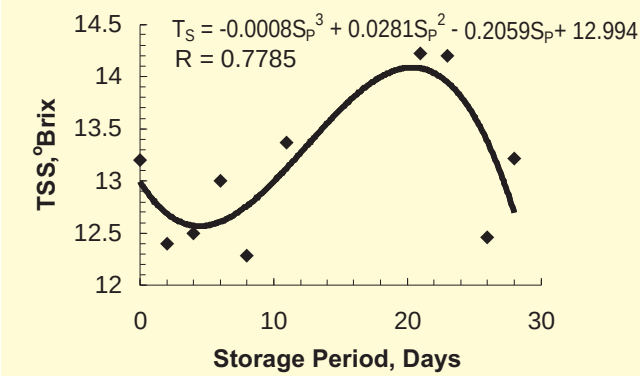


Fig 1 Changes in total soluble solids (TSS) content in apple during storage

102 samples. Prediction of acidity using colour values was found to be better than TSS. Statistical details of the best models (MLR), till now obtained, are presented below in Table 1.

Table 1: Statistical details of the models (MLR)

Predictable parameters	Model parameters	Calibration			Validation		
		SEC	R	Bias	SEP	R	Bias
Acidity	a, b, a^2	0.02	0.77	-0.0	0.02	0.74	-0.0
Acid brix ratio	a,b,ab,a^2,b	0.002	0.698	0.0	0.002	0.64	0.0

SEC -Standard error of calibration, SEP Standard error of prediction, R- multiple correlation coefficient

The table indicates that acidity of apple may be predicted nondestructively using colour values 'a' and 'b' with SEC/SEP and R values of 0.02 and 0.77/0.74 respectively. Combination of acidity and brix, an indicator of overall taste, may also be predicted reasonably well (Table 1). Similarities in SEC, SEP and R values indicate that these predictions are stable in the range of sample studied.

Development of post-harvest processes and machinery for *makhana* processing and value addition

S. N. Jha, Janardanjee and B K Jha

Design and drawings of *makhana* popping machine of capacity 25 kg conditioned seeds per hour were finalized for fabrication. The machine mainly consisted of two parts: one roaster for conditioning and roasting of makhana seeds and other a popping unit attached with the roaster for immediate hitting of hot roasted seed for popping.

Experiments for understanding the kinetics of absorption of milk by whole as well as ground *makhana* using response surface methodology and factorial designs of experiments respectively were conducted to optimize the particle size of makhana, total solids and temperature of milk for development of ready to constitute makhana *kheer* mix. Primary analysis of data indicated that particle size between 0.83 to 1.4 mm absorbed maximum milk and is

suitable for making instant kheer mix (Table 2). Different constituents with major parts of makhana were standardized using sensory score as major parameters. Sensory scores of the product in most of cases were found to be more than 8. Instant makhana kheer mix is shown in Fig. 2.

Fig 2 Instant makhana kheer mix

Table 2: Treatment combinations and amount of milk absorbed

Treatment No.	Milk temp, ^{0}C	Milk TS %	Absorpt--ion time, sec	Mak--hana m.c. %, w.b.	Amount of milk absorbed, g/g		
					Large#	Medium	Small
1	40	23	60	4	5.00	**9.21**	6.10
2	80	23	60	4	5.29	**10.30**	6.40
3	40	37	60	4	4.74	**7.71**	5.62
4	80	37	60	4	5.5 3	**8.03**	7.28
5	40	23	120	4	5.16	**10.72**	6.62
6	80	23	120	4	6.02	**11.07**	8.06
7	40	37	120	4	5.20	**8.41**	6.05
8	80	37	120	4	6.11	**9.00**	7.85
9	40	23	60	10	4.72	**8.02**	4.31
10	80	23	60	10	4.57	**8.57**	5.54
11	40	37	60	10	4.12	**7.32**	4.71
12	80	37	60	10	4.68	**7.53**	6.30
13	40	23	120	10	5.19	**8.39**	6.43
14	80	23	120	10	5.51	**9.54**	7.08
15	40	37	120	10	4.31	**7.54**	6.05
16	80	37	120	10	5.36	**8.72**	7.55
17	20	30	90	7	4.74	**6.39**	5.70
18	100	30	90	7	4.75	**7.56**	7.43
19	60	16	90	7	4.55	**7.91**	6.25
20	60	44	90	7	1.80	**3.27**	2.53
21	60	30	30	7	3.35	**4.54**	3.21
22	60	30	150	7	4.97	**7.85**	6.45
23	60	30	90	7	4.95	**6.75**	6.64
24	60	30	90	1	2.27	**6.32**	5.84
25	60	30	90	13	5.32	**9.54**	8.57
26	60	30	90	7	5.91	**9.28**	8.54*

large > 1.4 mm, 1.4 mm ≥medium ≥0.83 mm, small < 0.83 mm

Evaluation of evaporative cooled room for cultivation of mushrooms and their shelf life assessment

H S Oberoi, S Kapoor and P K Khanna

Trials were conducted for evaluating the performance of Evaporative Cooled Room (ECR) of 2 tonne capacity for extending the cultivation period of mushrooms (*Agaricus bisporus*) beyond the normal cultivation season. The total additional yield for 40 bags was 2.27 kg. The average height and diameter of fresh fruit body was found to be 4.83 and 3.7 cm respectively. The average colour values of fruit bodies in terms of L, a, b and Y_1 values were recorded as 86.06, 0.50, 11.77 and 24.99 respectively which indicated a high degree of opacity in the freshly harvested crop. The average temperature in the evaporative cooled room was 22 ^{0}C during cultivation.

Optimization of fermentation parameters for bioethanol production using whey and vegetable wastes through different microbial strains in a batch fermenter

H S Oberoi, D Dhingra, V K Bhargav and B S Chadha

The proximate composition analysis of whey, cauliflower waste and pea pods on (%) dry weight basis is given in Table 3.

Table 3: Proximate composition of whey, cauliflower waste & pea pods.

Components %	Whey,	Cauliflower waste	Pea pods
Proteins	0.40 ± 0.03	14.9 ± 0.86	18.2 ± 0.23
Ash	0.40 ± 0.04	14.0 ± 0.85	7.8 ± 0.19
Organic Matter	-	85.5 ± 1.05	90.8 ± 1.10
Lactose	4.0 ± 0.12	-	-
Cellulose	-	16.6 ± 0.50	25.5 ± 0.32
Hemicell-ulose	-	8.4	19.4 ±0.20
Acid Detergent Lignin	-	3.47 ± 0.27	3.90 ± 0.06

Water soluble fractions and mineral content of vegetable wastes (% dry weight basis) is given in Table 4

Table 4: Water soluble fractions and mineral content of vegetable wastes

Components	Cauliflower waste	Pea pods
Total sugars	17.9 ± 0.65	4.90 ± 0.15
Reducing sugars	3.50 ± 0.12	0.32 ± 0.02
Phenolics	6.25 ± 0.35	0.30 ± 0.04
Sodium	4.26 ± 0.09	4.80 ± 0.09
Calcium	9.83 ± 0.13	4.74 ± 0.13
Potassium	28.74 ± 0.14	13.49 ± 0.17
Magnesium	6.12 ± 0.12	3.36 ± 0.10
Sulphur	0.62 ± 0.03	0.44 ± 0.03

Effect of pea pod supplementation alone on -galactosidase activity using *Kluyveromyces marxianus* NCIM 3465 after 24h is given in Table 5.

Table 5: Effect of pea pod supplementation alone on -galactosidase activity

Treatment	-galactosidase activity (U mg dry weight^{-1})	Specific activity (U mg protein^{-1})
Whey	0.98	35.00
Whey + 5% Pea Pod	0.99	31.14
Whey + 10% Pea Pod	1.01	31.01
Whey + 15% Pea Pod	1.05	30.00
Whey + 20% Pea Pod	1.04	28.89
Whey + 25% Pea Pod	1.01	26.58
CD	0.02	1.89

Optimization of bioethanol production parameters using paddy straw and kinnow waste (NBAIM coordinated project under AMAAS)

H S Oberoi

Proximate composition of paddy straw and kinnow waste was analysed and is presented in Table 6.

Table 6: Proximate composition of paddy straw and kinnow waste on dry weight basis

Component	Paddy straw %	Kinnow waste %
Cellulose	37	20
Hemicellulose	25	15
Lignin	11	5.5
Silica	11	-
Total sugars	-	20.2
Reducing sugars	-	10.4
Protein	2.4	11.5
Ash	10	12.5
Calcium	0.28	0.58
Magnesium	0.18	0.80
Sulphur	0.18	0.40

Thirty two strains including eleven isolates from different environments of cellulase producing microbes have been thoroughly screened. Ten strains of pentose fermenting yeasts and 6 strains of hexose fermenting strains procured from MTCC and NCIM or other known sources have been screened for ethanol production potential using standard media (Table 7). Acid hydrolysis treatment in terms of concentration and time of treatment has been standardized for paddy straw which yielded about 30-35 % fermentable sugars.

Application of greenhouse for drying onion slices

D D Nangare Dattatreya M Kadam, Rajbir Singh and Satyendra Kumar

The cured red onion (*Allium cepa* L) bulbs were cleaned, peeled trimmed and washed in cold water to remove dirt and infection. Edible bulb of onion was sliced into 3 mm thick slices by manual stainless steel slicer. The onion slices were pre-treated with sodium chloride (NaCl) and potassium meta-bisulphite for 5 minutes in three concentration levels (0.25, 0.50 and 0.75 %) and drained onion slices were spread in thin layer in trays before keeping them in greenhouse for drying. Onion slices were dried in 19 sunshine hours.

Table 7: Screening of isolates for cellulase activity

S.No.	Isolate	FPU/ml	CMCase/ml	Cellobiase/ml
1.	*Trichoderma ressei* QM-9414	1.04	3.24	0.74
2.	*Trichoderma ressei* RC-30	0.96	3.75	0.88
3.	*Aspergillus fumigatus* NCIM 902	0.78	2.89	0.32
4.	*Fusarium solani* MTCC 1756	0.14	0.24	0.24
5.	*Trametes hirsuta* NCIM 1207	0.29	0.22	0.06
6.	*Trichoderma ressei* NCIM-992	0.24	0.15	0.05
7.	*Trichoderma viridae* NCIM-992	0.36	0.18	0.04
8.	*Trichoderma ressei* NCIM-1052	0.08	0.18	0.04
9.	*Fusarium sp.* NCIM 1075	0.35	0.26	0.09
10.	*Trichoderma viridae* NCIM 1221	0.21	0.14	0.11
11.	*Fusarium oxysporum* MTCC 1755	0.41	0.16	0.15
12.	*Cellulomonas bibula* NCIM 2333	0.44	0.23	0.09
13.	*Cellulomonas gelida* NCIM 2433	0.55	0.21	0.25
14.	*Bacillus apporohoes* NCIM 2234	0.55	0.24	0.21
15.	*Cellulomonas uda* NCIM 2353	0.14	0.45	0.03
16.	*Cytophaga hutchinsonii* NCIM 2388	0.31	0.54	0.15
17.	*Streptomyces albaduncus* MTCC 1764	0.68	0.89	0.54
18.	*Trametes hirsutum* NCIM 1201	0.94	1.57	0.88
19.	*Neurospora crassa* NCIM 1021	0.18	0.25	0.13
20.	*Bacillus* sp MTCC 297	0.67	0.95	0.05
21.	*Cellulomonas uda* NCIM 2353	0.24	0.15	0.08
22.	*Aspergillus* sp HO -1	0.21	0.45	0.01
23.	*Aspergillus* sp HO - 2	1.07	1.56	0.28
24.	*Aspergillus* sp HO-3	0.34	0.89	0.31
25.	*Aspergillus niger* HO -4	0.09	0.24	.01
26.	*Aspergillus* sp HO -5	0.07	0.21	0.01
27.	*Trichoderma* sp HO -6	0.99	1.58	0.26
28.	*Trichoderma* sp HO -7	0.73	1.06	0.35
29.	*Trichoderma* sp HO -8	0.21	0.56	0.14
30.	*Trichoderma* sp HO -9	0.53	0.78	0.22
31.	*Fusarium* sp HO -10	0.46	0.54	0.12
32.	*Streptomyces* sp HO - 11	0.74	0.93	0.34

HO refers to the strains isolated from different environments

Preservatives used as pre-treatment (sodium chloride and potassium meta-bisulphite) were found to be significantly different on 3 mm sliced onion ($p<0.05$) from each other. Potassium meta bisulphite pre-treatment (0.5 %) was best. Moisture ratio, drying time and drying rate curves were not dependent on the preservative. Greenhouse was found effective for drying of onion slices.

Dimensions of greenhouse were 6 x 4 x 1.8 m. Transparent UV polyethylene sheet of 200 micron was used as cladding. Black plastic film of 150 gauge was laid on floor to increase the temperature inside greenhouse and to reduce the soil moisture accumulation through ground (Fig 3). A fan capable of delivering an airflow rate of 0.61 $m^3 s^{-1}$ was used to remove the moisture present in greenhouse air. Total volume of the greenhouse was about 32.75 m^3. The performance of the greenhouse on drying was highly dependent on the solar radiation, ambient temperature and relative humidity.

Fig 3: Greenhouse for drying of onion slices at full load

The dehydrated samples of onion were analysed for microbial load of bacteria, fungi, yeast and *E coli* and found that dehydrated onion slices were safe to use even after 6 months of storage (Fig. 4)

Fig 4: Dehydrated onion slices dried inside the greenhouse

Design development and evaluation of banana-comb cutter

Dattatreya M Kadam and D Dhingra

The design of manual banana-comb cutter is shown in Fig 5. The cutting blade of the cutter is attached to the handle with a 150 mm round pipe of diameter 12.5 mm. The handle is 100 mm long and provides easy grip during cutting. The cutting blade of the device is made of stainless steel sheet of 25 mm width. The length of the cutting blade was kept 75 and 100 mm. The cutting edge of the blade was sharpened. The blades were made semi-circular to suit the banana bunch stem and banana-comb for cutting and ease of separation of banana-comb in a single cut. The curvature of the blade is

important and it should be appropriate to the natural geometry of the stem to avoid damage to the bananas. Ten banana-comb cutters were fabricated. Cutting operation and view of cut are presented in Figs. 6 and 7.

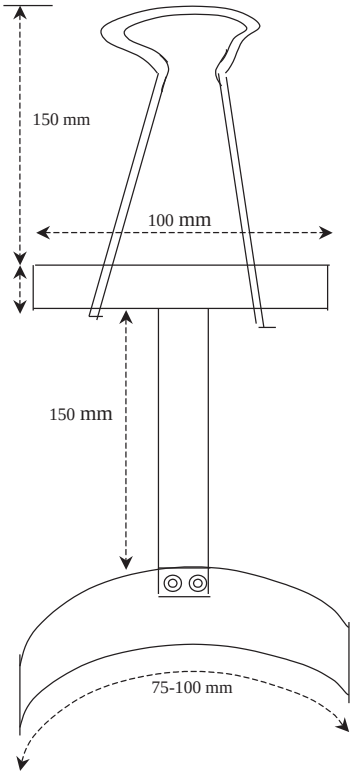


Fig 5: Design of banana-comb cutter

Size and shape of banana bunch was evaluated. Each bunch had seven to eight banana combs (each having 12-20 fingers). Banana combs had 50 to 100 mm linear and 120 angular spacing on the banana bunch stem. Details of banana bunch are given in Table 8.

Table 8: Physical characteristics of banana bunch and stem

Obser -vation	Stem length, cm	Total bunch length, cm	Width of bunch, cm	No. of combs per bunch	No. of fingers per comb
1.	50	65	38	7	20
2.	60	72	38	8	12
3.	60	64	34	8	14

Fig 6: Banana comb cutter in operation

Fig 7: View of location of cut (banana-comb and stem)

Development of aonla processing plant

R K Goyal and A R P Kingsly

Foam mat drying for preparing aonla powder was tried with the following foaming agents:

- Egg albumin (0, 5 and 15 % with and without sucrose, 25 %).
- Tri Calcium Phosphate (TCP) (1, 2 and 3 % with and without sucrose, 25 %).
- Egg albumin + TCP (Optimized from trials).

The foaming was done for 5 min and drying was carried out at 60 ^{0}C. Drying behaviour, colour change during drying and chemical composition (Acidity, Vit C, TSS) were evaluated.

Aonla pulp was extracted from the fruits by a commercial pulper. The pulp was then mixed with the foaming agents and foam was prepared. After foaming, the pulp was dried in a cabinet dryer. The pulp dried in 4 hours and after drying, it was powdered. After chemical analysis, the treatment of egg albumin (5%) with 1% TCP was found to retain the desirable quality characters and colour of aonla. Aonla powder was prepared with and without sucrose. Aonla powder is shown in Fig. 8.

Fig 8: Aonla powder

Toffees were prepared from aonla shreds and powder. Two types (hard and soft) toffees were prepared with the help of M/s Meryln Food Products, Abohar. Powder was used to prepare hard type of toffee with 6-8 % of aonla powder along with other ingredients like glucose, sugar and some coloring agents. Soft type of toffee was prepared by

Fig 9: Aonla toffee (hard type)

using shreds (10.4 %) and other ingredients as mentioned above. The toffees had higher acceptability and retained vitamin C which was present in the shreds and powder. Aonla toffees are shown in Figs 9 and 10.

Fig 10: Aonla toffee (soft type)

Aonla pricking machine

Pricking is one of the most important pretreatment operations in the preparation of Aonla preserve. Due to the acidic nature of the aonla fruit, pricking is necessary for improving the degree brix characteristics when immersed in sugar syrup. The effect of the pricking depth is also important for deciding the degree brix. The depth of pricking varies from 4 - 10 mm. The more the pricking depth, better is the movement of aonla juice from interior to the exterior of the fruit during the osmosis process. Similarly, better is the movement of sugar syrup into the aonla fruit. Conventionally pricking is done manually with the help of hand held devices. In this pretreatment uniformity is not maintained as holes are made of variable depth. In order to improve pricking, conceptual design of the aonla pricking machine as shown below has been prepared (Fig. 11)

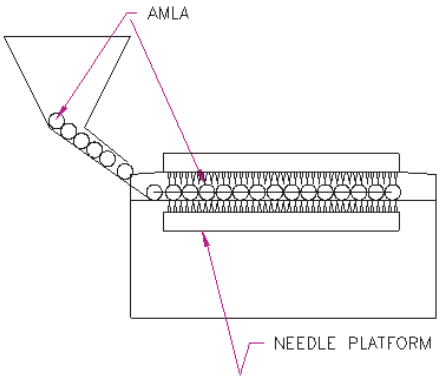


Fig 11: Schematic of aonla pricking machine under fabrication

Aonla Grader

Aonla size varies from 20 - 50 mm. It is very important to grade aonla as it fetches high price to grower and improves packaging during transit to distant markets. During the grading operation, the infected, deformed and rotten fruits are removed. Due to the lack of grading equipment, the study was undertaken to develop aonla grader which reduces labour cost, damage, time and improves efficiency and accuracy. The approximate grading efficiency would be 65 to 75 % and capacity 350 to 400 kg/hr. The conceptual design of the grader is given in Fig 12.

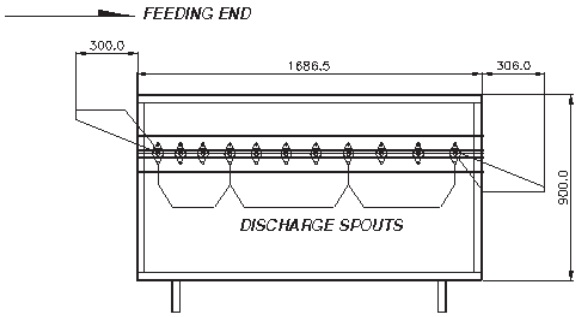


Fig 12: Schematic of aonla grader under fabrication

Osmotic dehydration of Aonla

The experiment was undertaken to prepare the osmotic dehydrated product from the segments of aonla fruit. The varying fruit-sugar ratio and different concentrations of sugar syrup were taken. The segments were immersed in sugar syrup for 12,24,36 & 48 hours respectively and kept in water bath at different temperatures of 30,40 & 50 °C. The best samples prepared under different treatments were chosen for optimization of conditions for further study. The experimental set up conditions are as under:

a. Water Bath Temperature: 30, 40 and 50 °C

b. Immersion hours: 12,24,36 & 48 hours

c. Fruit/Sugar ratio: 1:4,1:5 and 1:6

d. Sugar Syrup conc.: 40 & 50 %

The segments so obtained were dried at 60 °C for one hour in a tray drier. Some samples were dried with tissue paper. The best conditions were selected and are as under:

i) 24 h, 1:4, 50% & 50 °C

ii) 48 h, 1:4, 50% & 50 °C

The texture analyzer studies of segments (Fig. 13) were undertaken for hardness, springiness, cohesiveness, resilience, gumminess, chewiness, adhesive force and adhesiveness. The segments were vacuum packaged and served during the nutrition week celebrated both at Ludhiana and Abohar.

Fig 13: Osmotically dehydrated aonla

Aonla beverage

Process technology has been developed to prepare aonla beverage (Fig. 14) with utmost care to retain desirable chemical characters after processing. For the preparation of product following formulation was used:

Aonla juice (20 %) + Sugar syrup (70 % - 25 ^{0}Brix)+Pineapple juice (10 %)

The following ingredients were also mixed as given below for 1300 ml of above mixture:

Black salt	:	20 g
White salt	:	20 g
Black pepper	:	20 g
Amchur powder	:	6 g
Dhania	:	6 g

After grinding these ingredients to a fine powder, these were well mixed with aonla juice mixture. The final form of the mixture is filtered using a muslin cloth before bottling to remove the sediment particles. After filtration, the final product aonla beverage **was** filled in bottles and sealed. After sealing, the bottles were sterilized in hot water.

Fig 14: Aonla beverage

Integrated dryer for some aromatic and medicinal plant leaves

R K Goyal, D M Kadam, M R Manikantan and O D Wanjari

Drying of basil in tray and tunnel dryer

Drying kinetics of basil leaves were studied in a laboratory model tunnel and tray dryers at 55, 60 and 65 C air temperature. Drying of basil leaves occurred in falling rate period. It was found that basil leaves dried faster in tray dryer. Six thin layer-drying models were fitted to the experimental moisture ratio data. Among the mathematical models investigated, the logarithmic model satisfactorily described the drying behaviour of basil leaves with high r^2 values. The effective moisture diffusivity (D_{eff}) of basil

leaves increased as the drying air temperature was increased and also the D_{eff} values were higher for tray dryer than the tunnel dryer. Effective moisture diffusivity of basil leaves ranged from 2.65 x 10^{-10} to 5.69x10^{-10} m^2/s. An Arrhenius relation with activation energy values of 33.21 and 39.03 kJ/mol for tray and tunnel drying of basil leaves respectively expressed effect of temperature on the diffusivity.

Design and fabrication of drying chamber

A forty tray drying assembly has been designed and fabricated (Fig. 15).

Fig 15: Drying assembly

Dehydration of fruit slices in tunnel dryer

R K Goyal, A R P Kingsly, M R Manikantan and D B Singh

Drying of apple in tray dryer

Drying kinetics of apple (control, blanching and blanching in 1% potassium meta bisulphite) in tunnel dryer were studied at 50, 60 and 70 C air temperatures. Drying of apple slices occurred in falling rate period. It was found that treated apple slices dried faster. Six thin layer-drying models were fitted to the experimental moisture ratio. Among the mathematical models evaluated, the logarithmic model satisfactorily described the drying behaviour of apple slices with high r^2 values. The effective moisture diffusivity (D_{eff}) of apple slices increased as the drying air temperature increased. The D_{eff} values were higher for treated samples than control.

Drying behaviour of apple slices

The effect of treatment and the time taken to reach the final moisture content is presented in Table 9. The final moisture content of samples dried under different conditions ranged from 9 - 15 % (d.b). It is evident that pre-treatments had effect on moisture movement from the samples. In all the drying temperature selected, the sample blanched with 1% KMS had shorter drying time than control, KMS and blanched samples. The drying air temperature has also an important effect on drying of apple slices. At the higher temperature of 70 ºC, the drying time was less for control and blanched samples.

Table 9: Drying time of raw apple slices

Sample	Drying time (min) at different drying temperatures		
	50ºC	60ºC	70ºC
Control	330	300	270
KMS	300	240	210
Blanched	270	240	210
Blanched with 1% KMS	240	210	180

Effect of pre-treatment on drying curves of raw apple dried at 50, 60, 70 C are presented in Figures 16, 17 & 18. The drying curves show that the moisture ratio decreased continuously with drying time. During the initial period of drying, the drying rate was similar in all treatments. After the removal of surface moisture the drying rate of pre-treated samples was higher.

Drying of apple slices occurred in falling rate period and no constant rate period was observed. The drying in falling rate period indicates that, internal mass transfer has occurred by diffusion.

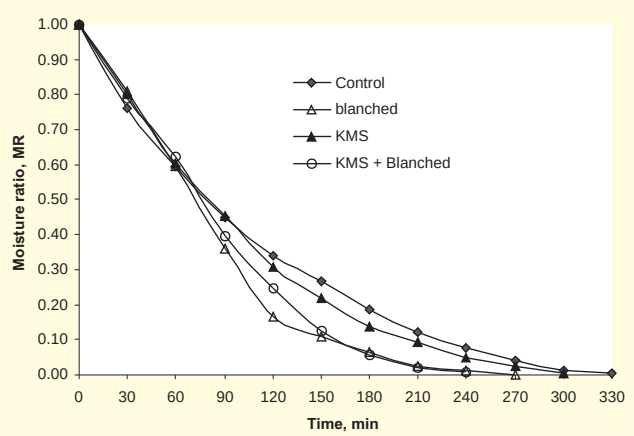


Fig 16: Effect of pre-treatment on drying time at drying air temperature of 50 ºC

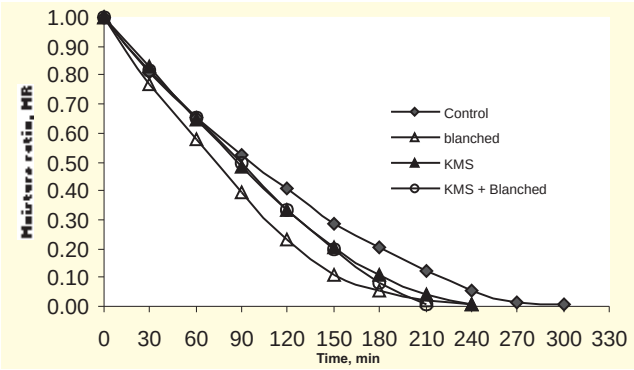


Fig 17: Effect of pre-treatment on drying time at drying air temperature of 60 ºC

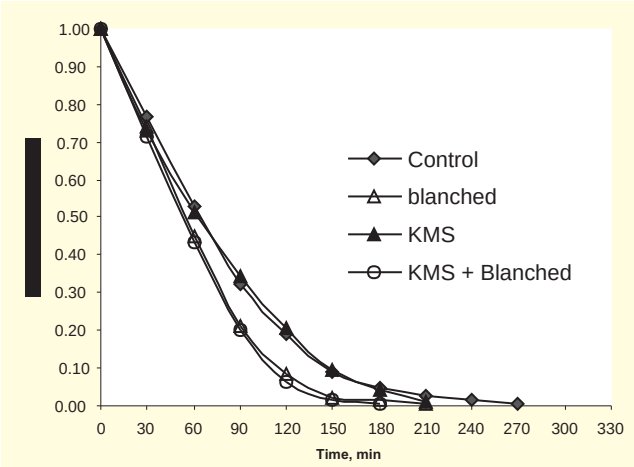


Fig 18: Effect of pre-treatments on drying time at drying air temperature of 70 ºC

Mathematical modelling of drying curves

The moisture ratio data of raw apple slices dried at different temperatures with different pre-treatments were fitted into the thin layer models. The values of r^2 , x^2, MBE and RMSE were calculated. In all cases, the value of r^2 was greater than 0.90, indicating a good fit (Madamba *et al* 1996, Erenturk *et al* 2004). The values of r^2 for the Page, Modified Page, Logarithmic and Wang and Singh model were above 0.99. But the Logarithmic model gave comparatively higher r^2 values in all the drying treatments (0.9998), and also the x^2 (0.023×10^{-3}), MBE (0.010×10^{-3}) and RMSE (0.0068) values were lower. Hence the logarithmic model may assume to represent the thin layer drying behaviour of apple slices.

Optimisation of osmo-convective dehydration of banana and pineapple

D Dhingra, D M Kadam and D B Singh

Studies on osmotic dehydration of banana slices

Response surface methodology was used to evaluate the effect of time (1, 2.5, 4 h), concentration of sugar syrup (50, 60, 70 %) and slice thickness (5,10,15 mm) on water loss and solute gain in an osmotic dehydration process of bananas (*Musa acuminata* L. cv. Dwarf Cavendish). The actual variables employed in the design and experimental data of osmotic dehydration of banana slices is presented in Table 10.

Water loss and solute gain were observed to be in the range of 0.065-0.242 kg water loss / kg fresh fruit, and 0.017-0.055 kg weight gained / kg fresh fruit. Second order polynomial equations were fitted to the experimental data. The analysis of variance indicated that the models developed for water loss (r^2=0.99) and solute gain (r^2=0.93) appeared to be adequate, possessing no significant lack of fit.

The analysis of effects revealed that all the three process variables had a significant overall effect on water loss. Time and slice thickness had the most

Table :10 Actual variables employed in the design & experimental data of osmotic drying of banana

Sr. No.	Time (h)	Sugar syrup concentration (%)	Slice thickness (mm)	Y_1 *	Y_2 *
1.	4	70	10	0.198	0.040
2.	4	50	10	0.123	0.040
3.	1	70	10	0.113	0.031
4.	1	50	10	0.065	0.017
5.	4	60	15	0.119	0.030
6.	4	60	5	0.223	0.055
7.	1	60	15	0.067	0.019
8.	1	60	5	0.126	0.023
9.	2.5	70	15	0.127	0.036
10.	2.5	70	5	0.242	0.054
11.	2.5	50	15	0.094	0.032
12.	2.5	50	5	0.158	0.051
13.	2.5	60	10	0.151	0.041
14.	2.5	60	10	0.141	0.036
15.	2.5	60	10	0.141	0.040

*Y_1= Water loss (kg water loss/ kg fresh fruit)
Y_2= Solid gain (kg wt. gained/kg fresh fruit)

significant effect ($p<0.001$), while syrup concentration was the least important ($p=0.01$). In case of solute gain, the effect of syrup concentration was observed to be non-significant. The second order polynomials can be used for deciding the combinations of the process variables to achieve desired levels of water loss and solute gain.

Studies on osmotic dehydration of pineapple (*Ananas comosus*)

Osmotic dehydration was carried out in the sugar solution having different concentrations. The effect of different parameters such as solution concentrations, slices thickness, process duration and fruit to solution ratios were studied. Blanching was not done prior to osmotic dehydration as it results in the loss of semi-permeability of cell membrane. To study the effect of osmotic solution concentration [40, 50, 60 % w/w sugar syrup] and process duration [0-300 min] on the mass transfer kinetics, slice thickness of 9 mm and the fruit to solution ratio of 1:4 were maintained. Similarly, to study the effect of slice thickness [6, 9 and 12 mm], the solution concentration was maintained at 50 % w/w and the fruit to solution ratio at 1:4. To study the effect of fruit to solution ratio [1:2, 1:4 and 1:6] the solution concentration was maintained at 50 % w/w and the thickness at 9 mm. Samples were taken at different time intervals i.e. 0.5, 1, 1.5, 2, 3, 4 and 6 h. To study the effect of each variable, experiments were conducted in triplicate at each condition. The seven treatment combinations are described in Table 11.

Table 11: Treatment combinations for osmotic dehydration of pineapple slices

Treatment No	Sugar syrup concentration (%w/w)	Slice thickness (mm)	Sample to syrup ratio (wt of sample / wt of syrup)
1	40	9	1:4
2	50	9	1:4
3	60	9	1:4
4	50	6	1:4
5	50	12	1:4
6	50	9	1:2
7	50	9	1:6

Effect of sugar syrup concentration on water loss and solute gain

Water loss and solute gain increased with an increase in sugar concentration (Fig. 19). The effect was studied at 40, 50 and 60 % w/w sugar solution with 9 mm slices and fruit to solution ratio of 1:4. The increase in water loss and solute gain might be due to the synergistic effect of sugar to develop high osmotic potential.

Effect of slice thickness on water loss and solute gain

The observed values of water loss and solute gain for the treatment nos. 2, 4 & 5 have been plotted in Fig. 20 It was observed that the thickness of the fruit samples had a negative effect on the water loss and solute gain.

Effect of fruit to syrup ratio on water loss and solute gain

There was an increase in water loss and solute gain with increase of fruit to solution ratio as shown in Fig. 21.

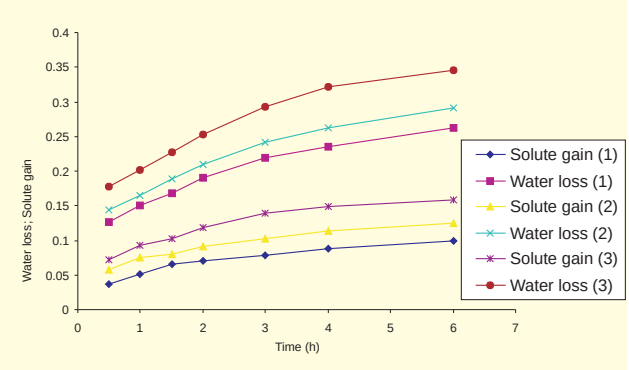


Fig 19: Effect of concentration (40, 50, 60% w/w) on water loss (WL) and solute gain (SG)

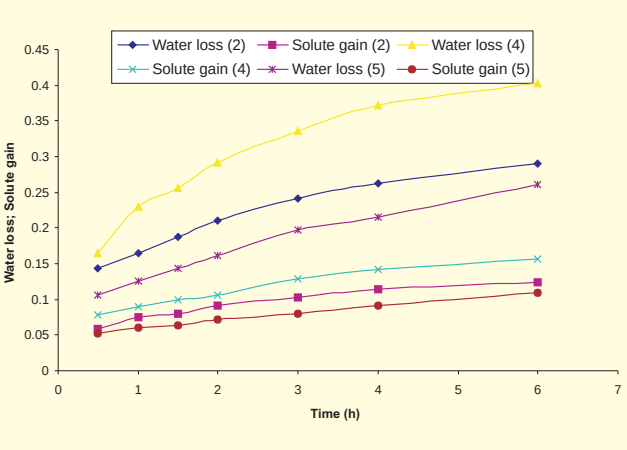


Fig 20: Effect of slice thickness (6, 9, 12 mm) on water loss (WL) and solute gain (SG)

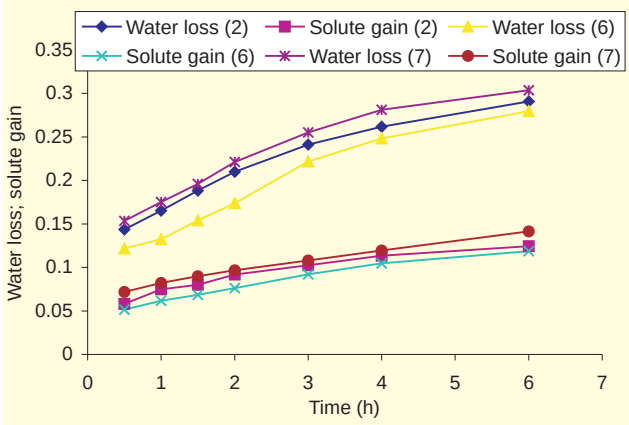


Fig 21: Effect of sample to syrup ratio (1:2, 1:4 and 1:6) on water loss (WL) and solute gain (SG)

The regression analysis of the experimental data of water loss and solute gain during osmotic dehydration of pineapple slices was carried out to observe the significance of the effect of various process parameters on water loss and solute gain during osmotic dehydration by using the software Statistica and SPSS. The relative effect of each process parameter was compared from the values corresponding to that of parameter.

Table 12 indicates that the osmotic solution concentration, fruit to syrup ratio and time had positive effects on the water loss and solute gain whereas slice thickness had a negative effect. Time and slice thickness had more pronounced effect on water loss, whereas time and syrup concentration were observed to have more pronounced effect on solute gain.

Table 12: Regression summary for water loss and solute gain (%) during osmotic dehydration of pineapple

	Water Loss, R^2 = 0.917, F (4,44)=120.89			Solute Gain, R^2 = 0.944, F (4,44)=186.93		
		B	p-Level		B	p-Level
Intercept		12.26**	0.0010		-2.14*	0.0799
Concentration	0.25	0.33**	0.0000	0.44	0.24**	0.0000
Thickness	-0.46	-2.00**	0.0000	-0.35	-0.64**	0.0000
Ratio	0.14	0.90**	0.0022	0.17	0.48**	0.0000
Time	0.78	3.01**	0.0000	0.76	1.24**	0.0000

**significant at 1%
* significant at 10%

Mathematical modeling

Penetration model and Magee models were used to study the mass transfer kinetics during osmotic dehydration of pineapple slices.

According to Penetration model,

$$WL(\%) \text{ or } SG(\%) = K x \sqrt{t}$$

For Magee model,

$$WL(\%) \text{ or } SG(\%) = A + B x \sqrt{t}$$

In all the experiments of osmotic dehydration, the values of R^2 were high in the case of Magee model. Magee model represented the experimental data with more accuracy. It had an excellent fit as compared to Penetration model with lower values of E % (relative deviation modulus).

Method of preparation of pineapple candy

The procedure for preparing pineapple candy is outlined in Fig 22

Pineapple
↓
Peeling & Coring
↓
Cubes/slices
↓
Blanching
(Hot water dip for 10 min)
(KMS & citric acid were added)
↓
Air Drying
↓
Prepare sugar syrup
(65 % w/w)
↓
Dip the slices in sugar syrup (Add KMS)
↓
Allow to stand for 1.5 2 days
↓
Drain the syrup
↓
Convective drying upto 15% m c (w b)
↓
Pineapple Candy

Fig. 22: Flow chart for making pineapple candy

The pineapple candy sample is shown in Fig 23

Fig 23: Pineapple candy

The analysis of the pineapple candy is presented in Table 13.

Table 13: Composition of pineapple candy

Composition	Stage Fresh	After 180 days
Acidity (%)	1.855	1.288
Ascorbic acid (mg/100g)	3.88	3.18
Carotene (µg/100g)	115.71	110.70
Reducing sugar (%)	18.80	14.32
Non-enzymatic browning	0.132	0.297
Colour Value		
L	80.70	57.70
a	-2.66	8.60
b	20.12	16.99

The overall acceptability of the pineapple candy was observed to be 8.2 on a nine point hedonic scale.

Development of processing technique for guava leather, intermediate moisture fruit and nutrient rich beverages

Ramesh Kumar, G Mandal, Satyavir Singh and M P Singh

Preparation and evaluation of whey based guava beverages intermediate

RTS beverages were prepared by utilizing the fruit pulp of guava cultivars Allahabad Safeda and deproteinized paneer whey in various treatment combinations (Fig 24). Guava RTS were prepared by using 10 and 15 % fruit pulp with 10, 12 and 14 Brix TSS. Whereas, whey based guava beverages were

Fig 24: RTS beverages of guava

prepared by blending10, 20 and 30 % guava pulp with 6, 8 and 10 % sugar. Recipes for preparation of both pure and whey based guava beverages were standardized by sensory evaluation. The results of sensory evaluation showed that the beverages formulated by 20 % guava pulp and 8 % sugar was rated highest among fruit flavoured whey beverages. In case of pure guava beverage, recipe containing 10 % pulp and 12 % sugar was adjudged to be the best in its overall rating. In general, pure guava beverages were preferred over its whey based RTS beverages. However, nutrient composition and colour retention was observed to be more in whey based guava beverages than in pure guava beverages.

Storage stability of guava beverages under different conditions

Storage study of different guava beverages was carried out under ambient and refrigerated conditions (10 ^{o}C). The best combination of both pure guava and whey based RTS was selected for this purpose and each RTS was subjected to four different treatment viz. control, sterilization (120^{o}C), carbonated and sulphited (0.01 % KMS). Treated beverages were then filled in 200 ml glass bottles and stored under the respective condition. The changes in chemical constituent, microbial load and sensory quality were determined during storage. The results revealed that browning increased with the progression of storage period. Total solids, proteins, ash and acidity increased during storage but the effect within processing treatments was not significant. Carbonated beverage retained maximum colour (7.4) and Vitamin C (18 mg/100g) than those sterilized or treated with preservative (KMS). Carbonated beverages of guava had a storage life of 3 months at room temperature. The study suggested that the RTS beverages maintained under refrigerated condition, showed minimum deviation in physico-chemical properties and microbial quality from their initial value. These beverages remained in acceptable condition for six months.

Osmo-air dehydration of guava

Guava fruits were harvested at mature ripe stage and cut into different sample geometry i.e. rings (6 mm thickness) cube (1x1x1cm^{3}), slice (2.5x1x1cm^{3}) and flake (1/8th part of fruit in conical shape) using a specially designed slicer. These were then osmosed in sugar syrup of 60 Brix followed by cabinet drying at 60 C.

Guava ring provided higher water loss and solid gain followed by cubic and slice geometry. Least water loss and solid gain were observed in guava flake during osmotic dehydration. However, the rate of dehydration during air drying was independent of sample geometry and is presented in Fig 25. The

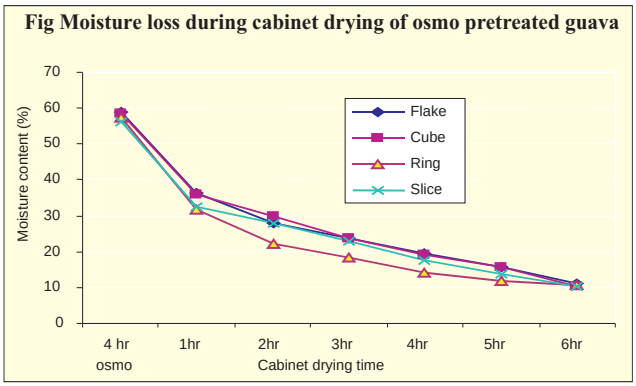


Fig 25: Moisture loss during cabinet dying of osmo pretreated guava

initial point of each curve is different on moisture axis which was primarily due to difference in moisture content on account of pre-osmotic treatment of different sample geometry. It can be seen that there is no constant drying period. The drying rate of guava without osmotic treatment was faster than for the treated ones. Slightly faster drying of osmo pre-treated guava ring observed in the present study may be due to the lower initial moisture content prior to air drying. The moisture content decreased rapidly during first hour of air drying and reached a steady state value of 10 to 12 % after 6 h of convective drying, irrespective of sample geometry. However, there was no important difference in drying rate among different sample geometry.

Sensory evaluation of osmo-air dried products of guava

Consumer acceptability for various osmo-air dehydrated products was evaluated for their commercial exploitation (Table 14). The results showed that guava ring and flake were adjudged to the best due to highest score obtained in their appearance, taste and texture. However, guava ring was preferred most by the consumer over its flake sample geometry. Control slice/flake (without osmotic treatment) was not liked by the consumer as the product turned brown after its air drying. Thus, the osmotic dehydration/seems to prevent colour discoloration during drying, resulting in products of superior quality with soft texture and good nutritional quality compared to air dried ones.

Table 14: Consumer acceptability of osmo-air dehydrated guava products

Dehydrated products	Appearance	Flavour	Taste	Texture	Overall acceptability
Guava ring	8.61	7.90	8.18	8.31	8.25
Guava cube	7.33	8.05	7.52	8.00	7.72
Guava flake	7.81	8.02	8.33	8.53	8.20
Guava slice	8.21	8.02	7.81	8.21	7.96
Control slice (without osmosis)	2.75	3.45	2.13	4.16	3.12

Assessing shelf life of intermediate moisture guava in different packing

Intermediate moisture fruit were prepared by osmo-air drying of guava rings or slices. These products were having 25-30 % moisture content and were packed in three different materials viz. 150 gauge MPP, 200 and 400 gauge LDPE pouches (Fig 26). Changes in chemical constituents like moisture,

Fig 26: Intermediate moisture fruit (ring) of guava

acidity, Vitamin C, reducing and total sugars were assessed during their storage under room and refrigerated conditions (10 C). The result exhibited no change in biochemical and sensory quality of guava IMF upto one month. After that a considerable browning (0.04 OD) and weakening of flavour (6.8) was recorded and the products had become unacceptable after two months of storage under ambient condition. Though, softening of tissue was observed at room temperature but this improved

their acceptability. Biochemical composition and sensory quality of cold stored guava IMF was maintained more or less near to their initial value and the products were highly acceptable even after six months of storage. Guava IMF was found to absorb moisture and percent moisture value increased from 19.22 to 22.72 % during six weeks storage. TSS and acidity increased while Vitamin C decreased during storage under both the conditions. A slight change in colour was noticed between 4-6 months under refrigerated storage. General increase or decrease was found to be almost similar for guava rings and slices. The products packed in MPP pouches were found to retain the maximum quality at the end of storage period.

Studies on packaging of selected fruit and vegetables

Ramesh Kumar, Rajbir Singh and D D Nangare

Tray wrap packaging of tomato

Packaging of tomato was done by tray over wrapping in heat shrinkable film (15). CFB trays of 16x10, 16x15, 16x20 and 36x24 cm^2 size were used for wrapping 6, 9, 12 and 24 fruits in 15 film. Control fruit were either unwrapped or packed individually in heat shrinkable film. Storage study was performed under ambient (30-40 °C) and low temperature condition (14 ± 1 C). Generally weight loss decreased with the increase in the number of fruits per tray and the maximum weight loss was recorded in individual shrink wrapped fruits under both the conditions. Individual shrink wrapping prolonged the shelf-life of tomato by 20 days under ambient condition and by 38 days under cold storage condition (Fig 27). The study also revealed that both colour development and fruit softening were significantly delayed by individual & tray wrap packaging. Among different tray capacity, over wrapping of nine tomatoes in a tray resulted in a maximum shelf life of 35 days under cold storage condition and it was significantly reduced to only 11 days when the same tray was stored under ambient

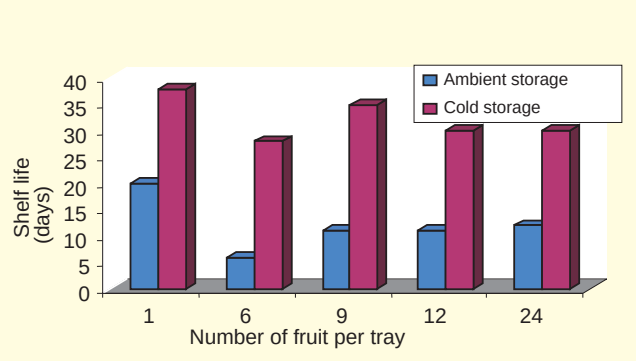


Fig 27: Shelf life of tray wrapped tomato as affected by storage environments

condition. Thus, individual fruit wrapping seemed to be an interesting alternative for sending tomatoes to distinct markets, especially when losses in trays are quite high under ambient conditions (Fig 28).

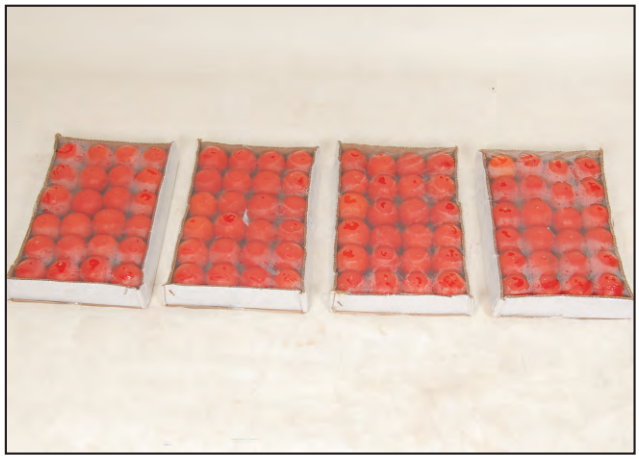


Fig 28: CFB tray wrap packaging of tomato

Effect of film thickness and tray wrap packaging on shelf life of kinnow fruits

Tray over wrapping was performed in the same way as for tomato with two different film thickness (15 and 25), trays (CFB and FP) and storage condition (RT and LT). CFB tray of 22x22, 22x30 and 30x30 cm^2 size were prepared for accommodating 4, 6 & 8 fruits per tray whereas circular trays of 15.5 and 23.0 cm diameter were used for wrapping 3 and 7 fruits in FP trays (Fig 29), respectively.

Fig 29: FP tray wrap packaging of kinnow fruits

Tray wrapping provided protection from dust and thus resulted in hygienic, attractive & intelligent consumer pack for retail marketing. FP tray wrapped fruits in a unit pack of seven can be kept for 86 days under cold storage condition and it was increased to 105 days when the number of fruit in unit pack was reduced to three (Table 15). Tray over wrapping with 25 film was most effective in reducing the weight loss but resulted in enhanced decay development. Substantial reduction in decay loss was observed when trays were over wrapped with 15 film . There was no decay loss upto 12 weeks of cold storage in small FP tray (3 fruits per tray) with 15 film thickness whereas large FP tray (7 fruits) under similar packing and storage condition had lost 8.68 % fruits. CFB trays were less effective in this respect; however, a unit pack of four fruit in such tray extended the shelf life of kinnow by 38 days under ambient condition and 77 days under low temperature condition. Thus, film wrapping of kinnow could be an alternative for controlling the water loss, spread of decay and retention of fruit shape without adverse effect on flavour and colour development.

Table 15. Storage life of kinnow as influenced by film thickness and tray wrap packaging

Number of fruits per tray	15µ Room temp.	Low temp.	25µ Room temp.	Low temp.
CFB tray				
1*	42	84	35	70
4	38	77	30	63
6	37	72	24	56
8	35	63	21	58
Foamed polystyrene tray				
3	45	105	36	95
7	37	86	30	77

* individually shrink wrapped fruit

Assessment of different methods for individual seal packaging of kinnow fruits

An experimental trial was conducted by evolving four different methods of individual fruit packaging viz shrinkwrap, seal-pack, clingwrap and control (unwrapped). Individual fruit packaging was performed by using specially manufactured poly film for respective purpose with different thickness. Shrink wrapping was done in hot tunnel while cling and seal packing were performed manually. Fruits thus packed were stored under room temperature and low temperature condition (5 C) after determining the initial biochemical composition of the fruit. The results obtained so far inferred that shrink and seal packaging were equally effective in controlling the weight loss (less than 1 % PLW even after 10 weeks of storage) but shrink packaging was found to have the advantage of causing least decay loss due to the formation of tight wrap around the fruit. Maximum PLW was recorded in unwrapped fruits under both the storage conditions (Fig 30 and 31). As a result, such fruits lasted only for 2 weeks under ambient condition and 6 weeks under low temperature conditions. Among different methods, cling wrap was least effective in reducing the weight loss but had a considerable effect in prolonging the shelf life of fruit compared to its unwrapped fruits.

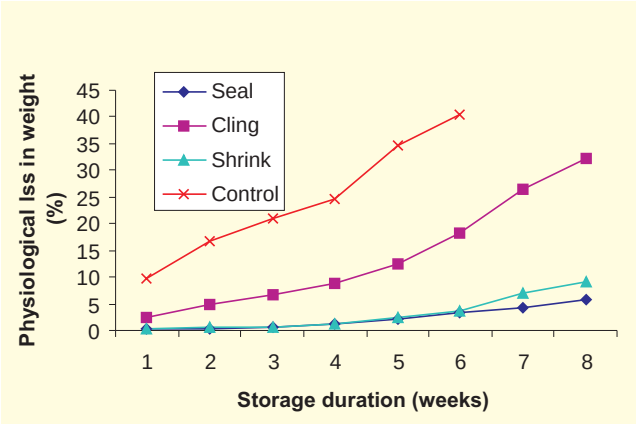


Fig 30: PLW of kinnow under ambient condition

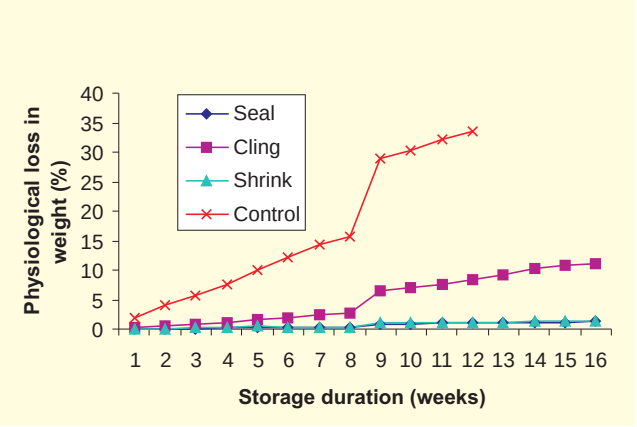


Fig 31: PLW of kinnow during cold storage

Studies on packaging and storage of pomegranate fruits

D B Singh, Dinesh Singh and A R P Kingsly

Studies on post harvest treatments of pomegranate var. Mridula :

Pomegranate has got large area under cultivation in arid and semi arid areas where high temperature and low humidity prevails, storage and packaging becomes very important aspect as for its quality maintenance is concerned. During storage, formation of black colour of the arils and fungal attack are important factors for consideration. Under arid and semi arid conditions fruits need proper post harvest handling including packing and suitable storages. Thus the effect of different post harvest treatments, packaging and storage of pomegranate on shelf life and quality were studied. The fruits of pomegranate variety Mridula after washing and drying were treated with sodium bicarbonate (1.0, 2.0 & 3.0 %), calcium chloride (2.0, 4.0 & 6.0 %), calcium carbonate (1.0, 2.0 & 3.0 %), carbendazim (0.05, 0.1 & 0.15 %), packed in CFB boxes and stored under ambient and cold conditions. It is evident from the data of post harvest treatments and storage at different environmental conditions for 4, 8, 12 ….. 48 days and presented in Table 16 that there was sharp increase in physiological loss in weight of fruits stored at room temperature. Whereas, the increase in PLW was found to be very slow in fruits stored at low temperature. The fruits treated with calcium chloride 4.0 % and carbendazim 0.1% showed very low increase in PLW. This was found to be more effective in high RH and relatively low temperature prevailing in cold chamber (LT) as compared to room temperature (RT).

Juice content of the fruits decreased significantly with increase in storage period under both the storage conditions. The fruits treated with calcium chloride 4.0 % and carbendazim 0.1 % showed low reduction in juice content as compared to control ones. This could be associated with the higher rates of respiration since acid forms the necessary respiratory substrate for the catabolic process in fruits. The initial rise in TSS of fruits and fall after wards were observed under both the storage conditions regardless of post harvest treatments. But the rate of increase in TSS was faster at room temperature than at low temperature. It could be due to higher temperature and low relative humidity, resulting in faster utilization of TSS and sugars at room temperature resulting in shorter shelf life of fruits. The changes in TSS were found to be slower in fruits stored at low temperature.

Vitamin C (ascorbic acid) of juice decreased continuously with progress in storage period regardless of post harvest treatments. The decline in vitamin C was found to be at faster rate at ambient conditions (higher temperature) than in cool

chamber. Comparatively, calcium chloride 4.0 % and carbendazim 0.1 % were found to retain maximum vitamin C. It is evident from the data presented in Table 16 and 17 that shelf life of pomegranate fruits stored at low temperature was better than at room temperature stored fruits. The shelf life of fruits treated with 4 % calcium chloride and carbendazim 0.1 % could be extended up to 30 days at room temperature and 48 days when stored at low temperature (Fig 32).

Fig 32: Fruits treated with calcium chloride 4.0% and stored at low temperature

Table 16: Effect of post harvest treatments and storage conditions on PLW of pomegranate fruits (Var. Mridula) at different storage periods.

Treatments	Storage conditions	*Days after storage*											
		4	8	12	16	20	24	28	32	36	40	44	48
Sod. Bicarbonate 1 %	RT	3.6	6.7	7.8	10.5	14.7	14.5	14.7	15.5	-	-	-	-
	LT	3.5	5.2	6.8	7.9	9.0	9.55	10.2	11.2	13.0	14.2	15.5	15.8
Sod. Bicarbonate 2%	RT	3.8	6.9	8.1	10.7	14.5	14.5	15.2	15.7	-	-	-	-
	LT	3.7	6.6	6.9	7.4	8.9	9.7	10.2	11.0	12.9	14.0	15.3	15.7
Sod. Bicarbonate 3%	RT	4.0	6.5	8.0	10.3	14.2	14.8	15.3	15.9	-	-	-	-
	LT	3.9	6.4	6.9	7.3	8.3	9.5	10.5	11.0	12.7	13.9	14.9	15.3
Cal. Chloride 2%	RT	2.3	4.9	5.5	8.7	10.5	11.3	12.2	12.8	-	-	-	-
	LT	2.3	4.8	5.0	5.7	6.2	7.8	8.8	9.0	9.5	10.1	10.8	12.8
Cal. Chloride 4%	RT	2.3	4.8	5.3	8.2	10.1	11.0	12.1	12.7	-	-	-	-
	LT	2.2	4.3	4.7	6.8	7.1	7.7	8.1	8.5	8.9	9.5	10.1	10.5
Cal. Chloride 6%	RT	3.7	5.5	6.8	9.9	10.8	11.9	12.9	13.8	-	-	-	-
	LT	3.5	5.0	5.9	7.0	7.9	8.5	8.9	9.4	10.1	10.7	11.2	11.9
Cal. Carbonate 1%	RT	3.0	6.3	6.9	10.2	14.7	14.5	15.2	15.7	-	-	-	-
	LT	3.9	4.9	5.1	7.7	7.9	8.5	8.9	9.7	9.9	10.2	11.0	11.2
Cal. Carbonate 2%	RT	3.2	6.7	7.1	10.6	14.7	14.9	15.2	15.9	-	-	-	-
	LT	3.2	4.8	5.2	7.6	7.8	8.0	9.1	9.9	10.2	10.5	11.1	12.0
Cal. Carbonate 3%	RT	3.2	6.7	7.0	10.5	14.8	14.8	15.3	15.8	-	-	-	-
	LT	3.3	4.5	5.5	7.3	7.8	8.2	9.3	9.8	10.5	11.1	11.7	12.2
Carbendazim 0.05%	RT	3.8	6.6	7.2	9.5	12.2	13.9	14.2	15.5	-	-	-	-
	LT	3.7	4.2	4.9	5.2	5.9	6.2	7.1	8.2	9.5	10.8	11.7	12.9
Carbendazim 0.1%	RT	2.8	5.1	5.7	8.8	11.1	11.8	12.2	12.9	-	-	-	-
	LT	2.7	3.0	3.5	3.9	5.5	5.9	6.8	7.5	8.1	8.0	10.7	10.9
Carbendazim 0.15%	RT	2.9	5.0	5.8	8.7	11.3	11.9	12.2	12.8	-	-	-	-
	LT	2.8	3.1	3.4	4.0	5.4	5.9	6.8	7.7	8.7	9.0	10.3	11.0
Control (untreared)	RT	3.8	6.9	8.8	9.9	12.7	14.0	14.8	15.7	-	-	-	-
	LT	3.7	5.2	6.8	7.9	8.9	10.8	11.0	11.7	12.2	13.3	14.9	16.5

RT - Room temperature, LT - Cold Chamber

Table 17: Effect of post harvest treatments and storage conditions on TSS, acidity and ascorbic acid of pomegranate fruits (Var. Mridula) at different storage periods.

Treatments	Storage conditions	TSS (Brix)				*Juice (%)*				Acidity (%)				Ascorbic acid (mg/100g)			
		Days after storage				Days after storage				Days after storage				Days after storage			
		Ini	16	32	48	Ini	16	32	48	Ini	16	32	48	Ini	16	32	48
Sod. b	RT	17.50	18.60	17.70	17.33	54.30	51.0	48.3	42.5	0.47	0.34	0.27	0.24	26.8	20.5	18.0	15.2
icarbonate 1%	LT	-	18.22	17.97	17.36	-	51.5	49.0	43.7	-	0.40	0.38	0.33	-	21.0	19.7	16.7
Sod.	RT	17.50	18.68	17.72	17.41	54.30	51.2	48.5	42.7	0.47	0.37	0.29	0.25	26.8	20.7	18.3	15.0
Bicarbonate 2%	LT	-	18.23	17.93	17.32	-	51.7	49.2	43.9	-	0.41	0.37	0.35	-	21.2	19.4	16.2
Sod.	RT	17.50	18.64	17.73	17.33	54.30	51.7	48.9	43.0	0.47	0.33	0.28	0.26	26.8	20.2	18.2	15.3
Bicarbonate 3%	LT	-	18.24	17.95	17.44	-	51.9	49.7	44.1	-	0.40	0.35	0.32	-	21.0	19.2	16.4
Cal. Chloride	RT	17.50	18.32	17.81	17.33	54.30	52.2	50.0	45.3	0.47	0.33	0.29	0.27	26.8	20.3	19.3	16.1
2%	LT	-	18.05	17.93	17.43	-	53.1	51.2	47.9	-	0.41	0.34	0.33	-	21.5	19.4	16.7
Cal. Chloride	RT	17.50	18.35	17.84	17.34	54.30	52.1	50.1	45.9	0.47	0.37	0.30	0.29	26.8	23.2	22.5	18.5
4%	LT	-	18.09	17.92	17.48	-	53.2	51.7	48.5	-	0.42	0.40	0.35	-	24.1	23.7	20.2
Cal. Chloride	RT	17.50	18.31	17.81	17.39	54.30	52.0	50.0	45.6	0.47	0.33	0.27	0.26	26.8	20.2	19.7	16.0
6%	LT	-	18.00	17.91	17.43	-	53.2	51.6	48.3	-	0.40	0.39	0.33	-	21.4	19.7	16.8
Cal. Carbonate	RT	17.50	18.60	17.62	17.21	54.30	51.0	48.1	42.7	0.47	0.32	0.26	0.23	26.8	20.3	18.2	15.5
1%	LT	-	18.31	17.93	17.33	-	51.9	49.2	43.8	-	0.40	0.38	0.34	-	21.1	19.8	16.6
Cal. Carbonate	RT	17.50	18.61	17.61	17.22	54.30	51.1	48.0	42.2	0.47	0.33	0.27	0.24	26.8	20.2	18.4	15.3
2%	LT	-	18.33	17.92	17.39	-	51.8	49.0	43.2	-	0.41	0.37	0.34	-	21.3	19.9	16.7
Cal. Carbonate	RT	17.50	18.59	17.59	17.21	54.30	51.3	48.2	42.1	0.47	0.32	0.28	0.25	26.8	20.2	18.7	15.4
3%	LT	-	18.31	18.91	17.32	-	51.7	48.0	43.0	-	0.40	0.38	0.034	-	21.2	19.9	16.4
Carbendazim	RT	17.50	18.32	17.91	17.32	54.30	51.2	48.7	42.0	0.47	0.39	0.34	0.26	26.8	22.2	22.1	18.3
0.05%	LT	-	18.02	17.99	17.50	-	51.9	48.1	43.2	-	0.42	0.40	0.37	-	24.1	23.7	21.0
Carbendazim	RT	17.50	18.34	17.82	17.31	54.30	52.5	50.3	46.1	0.47	0.40	0.30	0.28	26.8	23.2	22.1	18.4
0.1%	LT	-	18.07	17.91	17.32	-	53.3	51.8	48.9	-	0.41	0.39	0.36	-	24.0	23.6	20.0
Carbendazim	RT	17.50	18.08	17.83	17.28	54.30	52.4	50.2	45.3	0.47	0.38	0.32	0.26	26.8	23.1	22.0	18.5
0.15%	LT	-	18.02	17.90	17.33	-	53.3	51.0	48.5	-	0.39	0.37	0.33	-	24.2	23.6	20.5
Control	RT	17.50	18.61	17.75	17.33	54.30	51.0	47.3	41.8	0.47	0.34	0.28	0.22	26.8	20.6	118.3	15.2
(untreared)	LT	-	18.21	17.99	17.39	-	51.2	48.2	42.9	-	0.40	0.37	0.32	-	21.0	19.3	16.2

RT - Room temperature, LT - Cold Chamber

Development of technology for value added products from *ber*

D B Singh, A R P Kingsly and M P Singh

Ber (*Zizyphus mauritiana* L.) is an ideal fruit for arid and semi arid regions and tropical and sub tropical climate where most of the fruit crops cannot be grown either due to lack of irrigation facilities or adverse soil and climate conditions. Ber is a delicious, nutritious fruit and has therapeutical value. The tree yields 50-200 kg fruits annually but the harvest season is limited to 4-5 weeks depending on the variety. A large surplus during glut gives low returns due to perishable nature of the fruit, lack of simple technology for efficient processing of the fruit. Technology for processing of ber fruits for preserves and osmo air dried products has been developed.

Screening of *Ber* cultivars suitable for processing and value addition

Six year old six cultivars of *ber* (Umran, Mundia, Goma Kirti, Gola, Banarasi Karaka, and Ilaichi) planted at CIPHET, Abohar were evaluated for two years (2003-04, 2004-05) for yield, chemical composition and potential for processing and value added products like preserves etc. The physico-chemical composition is given in Table 18.

The study revealed that maximum yield (75 kg/tree), vitamin C (118 mg/100g), TSS (21.15 ^{0}B) and pulp stone ratio (14.3) was recorded in cultivar Umran (Fig 33) and found suitable for making preserves and dehydrated products.

Fig 33: Fruits of Umran variety suitable for processing

Table 18: Physico-chemical characteristics of *ber* cultivars.

Cultivars	Maturity Season	Fruit Weight (g)	Yield /tree (kg)	TSS (Brix)	Acidity (%)	Pulp Stone Ratio	Ascorbic acid (mg/ 100g)
Umran	Late (March)	25.0	75	21.5	0.200	14.3	118
Mundia	Mid (Feb. end to March Ist week)	17.0	60	19.00	0.721	10.3	115
Gola	Early (Feb.)	12.0	56	19.5	0.301	8.7	112
Goma Kirti	Mid (Feb. end to March Ist week)	12.5	60	19.3	0.277	99.0	113
Banarasi Karaka	Mid (Feb. end to March Ist week)	17.5	60	18.5	0.310	10.5	108
Ilaichi	Late (March)	8.0	60	21.0	0.500	9.0	140

Development of *ber* destoner

A destoner was developed to remove the *ber* seeds as shown in Fig 34 . The destoning efficiency was 100 %. The loss in whole fruit was around 15 %, but these fruit remains can be used for the preparation of *ber* powder using the standardized technology.

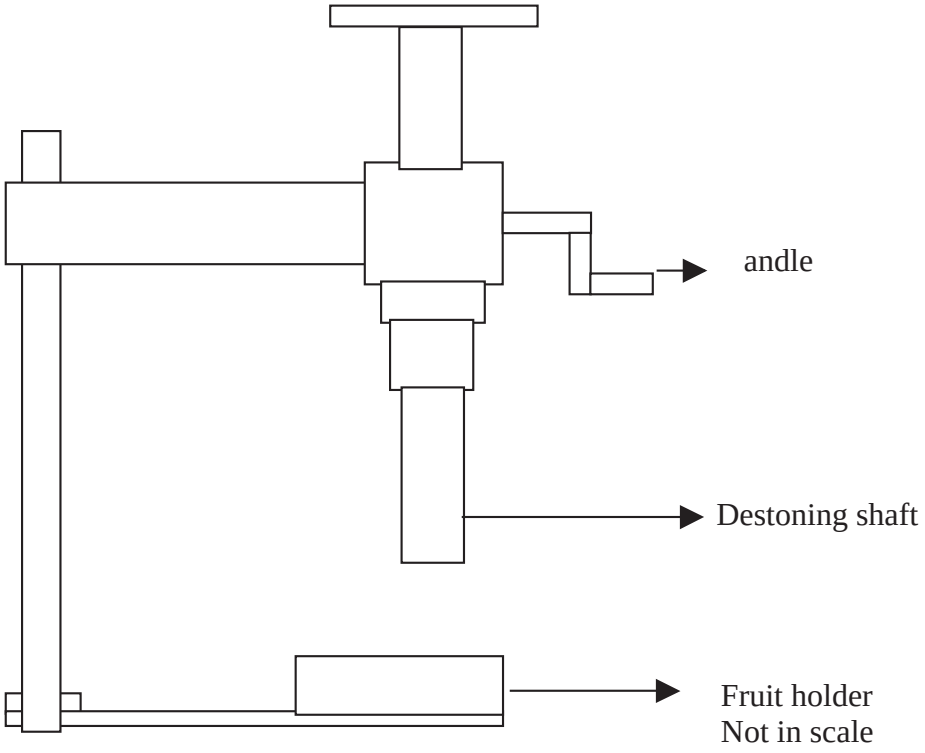


Fig 34: Schematic of Ber destoner

Length of destoning shaft	12 cm
Diameter of destoning shaft	1.5 cm
Length of movement of destoning shaft	5.5 cm
Average time taken to destone ber fruit	8.83 s

Development of technology for making *ber* preserves

Fully matured and ripe *ber* fruits were selected for the preparation of preserve. Preserves were prepared in eight shapes namely, whole fruits with peel, whole fruits without peel, destoned fruits with peel, destoned fruits without peel, cubes with peel (2 cm), cubes without peel (2 cm), rings with peel, rings without peel (Fig 35 and 36). The prepared preserves were packed in glass jars and stored at room temperature (30 ± 2^0 C) and low temperature ($8 - 10^0$ C). The effect of different treatments on TSS, pH, acidity, ascorbic acid, reducing and total sugar and enzymatic browning was studied during storage. The product was evaluated for its taste, colour, flavour and crispness. All the products had reasonable acceptability. However destoned ber fruits without peel in the form of cubes and rings scored maximum value (7.5, 7.0 and 7.2 respectively).

Chemical constituents of ber preserves at different storage period and temperature

Initially preserves were found to contain TSS in range of $65 - 70^0$ Brix and vitamin C (ascorbic acid) in the range of 43.4 to 50.8 mg/100g. Different forms of *ber* preserves prepared were packed in glass jars and stored at two environmental conditions i.e room and low temperature for detailed studies for quality parameters for chemical constituents mainly for acidity and ascorbic acid at 60, 120 and 180 days of

storage. There was reduction in acidity percent with storage period. The product without peel showed maximum reduction in acidity. Product stored at both the conditions showed similar trend in reduction of acidity up to 120 days of storage. After 120 days of storage, reduction was rapid in room temperature, where as, preserves stored at low temperature retained desirable acidity to its original value.

Product (preserves) without peel contained more ascorbic acid. Similarly there was gradual decrease in vitamin C content with storage period up to 120 days in both the environmental conditions. However after 120 days all preserves stored at low temperature showed less reduction as compared to product stored at room temperature. Preserves without peel (whole fruit, cubes and rings) as shown in Fig 35 and 36 contained ascorbic acid in range of 33.5 to 38.5 mg/100g. There was permissible value for enzymatic browning in all the products. However it was minimum (0.180-0.210) in products without peel. The products without peel had minimum enzymatic browning. Enzymatic browning increased with storage period. Increase was moderate in products stored at low temperature. After 180 days of storage it was minimum in products without peel and stored at low temperature (in range of 0.180 to 210 O.D).

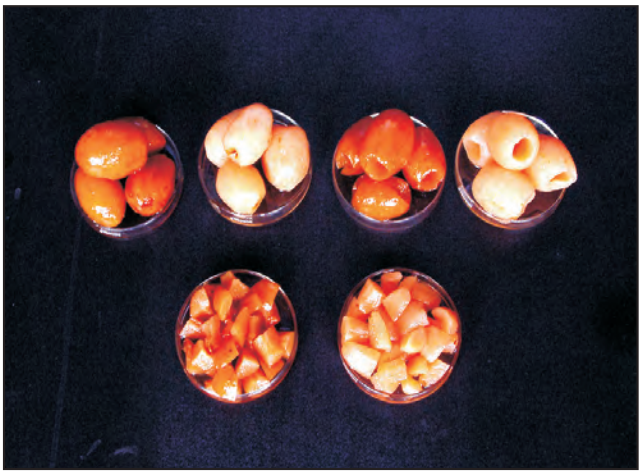


Fig 35: Ber preserves (whole, destoned, cubes)

Fig 36: Ber preserves (rings)

Colour changes in ber preserves at different storage period and conditions

Colour is an important parameter in deciding the quality of processed product like *ber* etc. Values for "L" indicating brightness of the product was found in preserves made from *ber* without peel. There was moderate change (decrease) in brightness in both the storage conditions up to 120 days of storage. However after 120 days there was rapid decrease in brightness when stored up to 180 days when compared to low temperature. Similarly "a" value indicating red colour was more in products of *ber* with peel. With storage period there was decrease in red colour value. However, it was moderate up to 120 days of storage in both the storage conditions. But after 120 days product stored at ambient conditions there was rapid reduction in red colour value when compared to low temperature (Table 19).

Development of technology for making osmo air dried *ber* products

Fully mature and ripe *ber* fruits were selected for the preparation of osmo air dried products. Preserves were prepared in two shapes namely cubes and rings. Cubes with peel (2 cm), cubes without peel (2 cm), rings with peel, rings without peel were uniformly sliced. The prepared preserves were dried in cabinet dryer at 50, 55, and 60^0 C till the product reached /maintained moisture 20 $\pm$ 1% (wet basis). For reaching desired moisture level cubes and rings without peel took minimum time. However, among drying modes, drying at 60^0 C took least time (320 min) in case of rings without peel.

Table 19: Chemical constituents of *ber* preserves at different storage period and condition

Treatments	Storage Conditions	Acidity (%) Storage Period			Ascorbic acid (mg/100g) Storage Period			Enzymatic Browning (O.D. 440 nm) Storage Period		
		60	120	180	60	120	180	60	120	180
Whole fruits with peel	RT	1.42	1.40	1.3	42.5	30.5	26.2	0.352	0.370	0.392
	LT	1.43	1.39	1.36	43.2	33.5	28.5	0.321	0.350	0.372
Whole fruits without peel	RT	1.32	1.31	1.29	41.2	31.2	29.3	0.170	0.178	0.210
	LT	1.33	1.33	1.30	43.5	38.2	33.5	0.166	0.170	0.206
Destoned fruits with peel	RT	1.37	1.38	1.32	40.0	35.2	28.3	0.306	0.342	0.382
	LT	1.39	1.38	1.37	42.1	39.5	30.3	0.299	0.330	0.350
Destoned fruits without peel	RT	1.49	1.48	1.46	46.2	40.2	27.2	0.171	0.187	0.200
	LT	1.52	1.49	1.47	48.5	44.5	34.2	0.159	0.177	0.188
Cubes with peel	RT	1.39	1.34	1.33	39.5	33.2	28.5	0.368	0.389	0.395
	LT	1.39	1.33	1.22	40.2	39.2	34.2	0.352	0.372	0.387
Cubes without peel	RT	1.21	1.20	1.20	41.0	38.2	29.2	0.170	0.179	0.199
	LT	1.22	1.21	1.22	43.2	40.2	38.2	0.158	0.160	0.183
Rings with peel	RT	1.39	1.38	1.37	39.2	34.2	29.7	0.271	0.280	0.299
	LT	1.40	1.39	1.38	40.2	36.2	32.5	0.269	0.277	0.287
Rings without peel	RT	1.21	1.23	1.20	41.5	35.5	30.2	0.169	0.173	0.199
	LT	1.23	1.22	1.22	44.5	41.2	38.9	0.158	0.172	0.180
CD at %										
Tr.		0.410	0.510	0.352	0.470	0.318	0.510	0.468	0.512	0.472
SC		0.205	0.310	0.420	0.234	0.312	0.317	0.234	0.241	0.290
Tr. X SC		0.581	0.561	0.612	0.660	0.272	0.318	0.662	0.661	0.372
SP		0.251	0.261	0.361	0.288	0.291	0.298	0.289	0.280	0.310
Tr. X SP		0.711	0.688	0.600	0.815	0.725	0.510	0.811	0.811	0.601
SC X SP		0.353	0.352	0.352	0.407	0.318	0.289	0.405	0.325	0.274
Tr. X SC X SP		0.100	0.221	0.189	0.115	0.189	0.210	0.114	0.280	0.182

Tr.=Treatment, SC=Storage Conditions, SP= Storage Period, RT = Room temperature, LT=low temperature

Development of pomegranate aril extractor

A K Thakur, D B Singh and Sitya Vir Singh

In the last few years there has been an increasing demand of novel pomegranate derived products such as minimally processed pomegranate seeds (arils), jams, single strength juices, jellies, concentrates, seeds in syrup, anardana etc. One of the primary difficulties in pomegranate processing is peeling, that makes the separation of its arils difficult and tedious, even manual separation of arils is annoying. A hand held device was developed and tested in order to break the pomegranate fruits. This was a part of principles to be used in the development of continuous pomegranate aril extractor. The device as shown in Fig. 37 holds the fruit in between the holders which is having fixed knives. After holding the fruit, the holders are rotated in opposite direction which enables to create a shear on the fruit and breaks it in two parts. The advantage is that the arils become loose as an effect of the shear breaking.

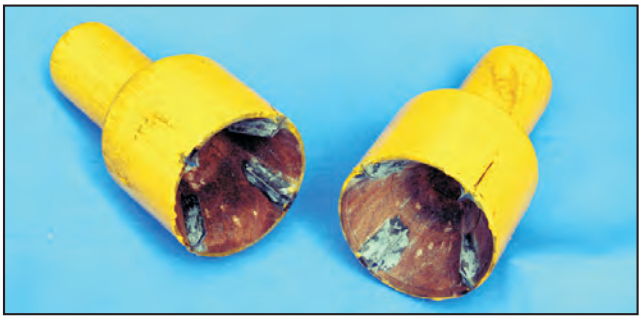


Fig 37: Hand held device to break pomegranate fruit

Evaluation of polymeric - film packaging for enhancing quality and shelf-life of apple

A K Thakur, Ramesh Kumar and V K Saharan

Apple is the fourth major fruit crop of the country with annual production of 1.42 million tonnes. This crop is considered to be relatively storage-stable with respect to the other fruit crops. However, the practical shelf life of apples at retail stores is only from 7-8 days. It is possible to increase the shelf life of apple during storage and retail marketing by applying the packaging technology. Packaging of apples is needed not only to provide containment for ease of handling but also to preserve post storage quality during distribution and in certain cases to add value during marketing. Packaging systems may benefit quality retention through protection from handling abuse (bruising) and moisture loss and lowering down the metabolic process. The project was undertaken for shelf-life enhancement of apples during storage. The following packaging treatments were given to fruits for the storage studies:

- Single fruit under shrink wrap of 15 micron
- Single fruit under shrink wrap of 25 micron
- Single fruit in LDPE zip lock bag
- Tray-shrink wrapping of 3 fruits with 15 micron (Polystyrene tray)
- Tray-shrink wrapping of 3 fruits with 25 micron (Polystyrene tray)
- Three fruits in LDPE zip lock bag
- Fruits without any packaging (control)

One lot was stored under cold store condition at temperature 7.0±1 ºC and humidity 90±2 %. Another lot was stored under room condition of varying temperature (29-35 ºC) and humidity (60-67 %). It has been observed that the shrink wrap (shown in Fig 38) of individual fruit with 25 micron showed good result and can increase the shelf life by 7 to 10 days as against the fruits having no package (Fig 39).

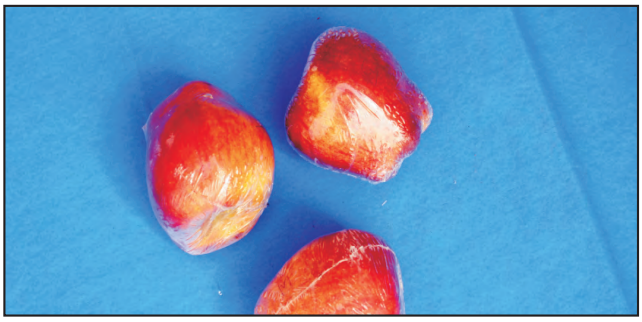


Fig 38: Individual shrink wrap apple

Fig 39: Difference in quality between shrink & non-shrink film packaging

Studies on processing of guar for production of guar gum

R K Vishwakarma, S K Nanda and U S Shivhare

Survey of guar industries

Surveys were conducted in Rajasthan and Haryana to study the conventional method of processing guar seed. The Jodhpur district of Rajasthan state is the main center for processing of guar. There are about 125 guar split manufacturing units in Jodhpur. All industries are using same type of machine and process for dehulling and splitting of guar seed. The capacity of plants varied between 3000 to 5000 tons per year. A total of 16 guar-processing industries were surveyed in Rajasthan and Haryana. A typical layout of guar processing unit is presented in Fig 40.

In industrial method of processing the guar seed is first cleaned. Then it is fed at the center of horizontal burr (stone) mill. The upper plate of the burr mill rotates at 500-600 rpm whereas the lower plate is fixed. Diameter of the plate is usually 61 cm and the coarse textured stone (14-16 grade carborundum) is used. Three to four burr mills are used depending upon the capacity of plant and difference in sizes of seeds. In this machine the guar seed is splitted in two halves. Some portion of germ is also separated during splitting. No pre-treatment to the seed is given prior to splitting. Then splits, unsplitted seeds and germ are separated using cylindrical grader.

The splits are then passed through a germ separator (pin mill), where germ is removed from splits. It consists of two mild steel plates of 53 cm diameter. One plate is fixed whereas the other plate rotates at 3000 rpm. Three rows of pins of high carbon steel are mounted on fixed plate and four rows of pins are mounted on the moving plate. The material is fed through the center of the machine. Shear removes the germ from the splits, which comes out from the screen and carried away using blower.

After removal of germ, the splits are heated in a kiln. It consists of a hollow mild steel cylinder placed horizontally. Diameter of cylinder towards the entry side of splits is 61 cm and towards discharge side is 66 cm, thus a slope of 1^0 from horizontal is formed and hence material is conveyed towards discharge. Length of cylinder is 300 cm. It rotates at 30 rpm. The splits are fed inside of the cylinder. Outer surface of the cylinder is heated using oil fired furnace or firing wood. The material remains inside the cylinder for around 1.5 minutes and heating takes place due to conduction. Temperature of the cylinder is not controlled. Heating is said to be completed when change in colour of splits starts.

The hot splits are then fed to dehulling machine. Generally two dehulling machines in series are used and some times three machines are also used. The material is fed to first machine where partial dehulling of the splits takes place. Then partly dehulled splits are again fed to the other dehulling machine where dehulling is completed. Dehulling machine consists of a mild steel cylinder of 37 cm diameter on which blades of high carbon steel are fixed along the length of cylinder. A wire mesh screen (made from wire of 3-4 mm thick galvanized iron) covers the cylinder. Clearance between tip of the blade and screen is about 1.25 cm. The cylinder rotates at 1400 rpm. Since the hull is loosened during heating, cutting action, impact and friction between splits and blade and shear and friction between splits causes dehulling. Hull and broken come out from screen whereas partly dehulled splits are fed to another machine of same type where complete dehulling takes place.

After dehulling, the splits are cooled quickly to avoid heat shock on splits. Then the splits are fed to vibratory screen cleaner where broken, and hull are separated and cleaned guar gum splits are then conveyed for packaging. The process flow diagram of the industrial process is presented in Fig 41.

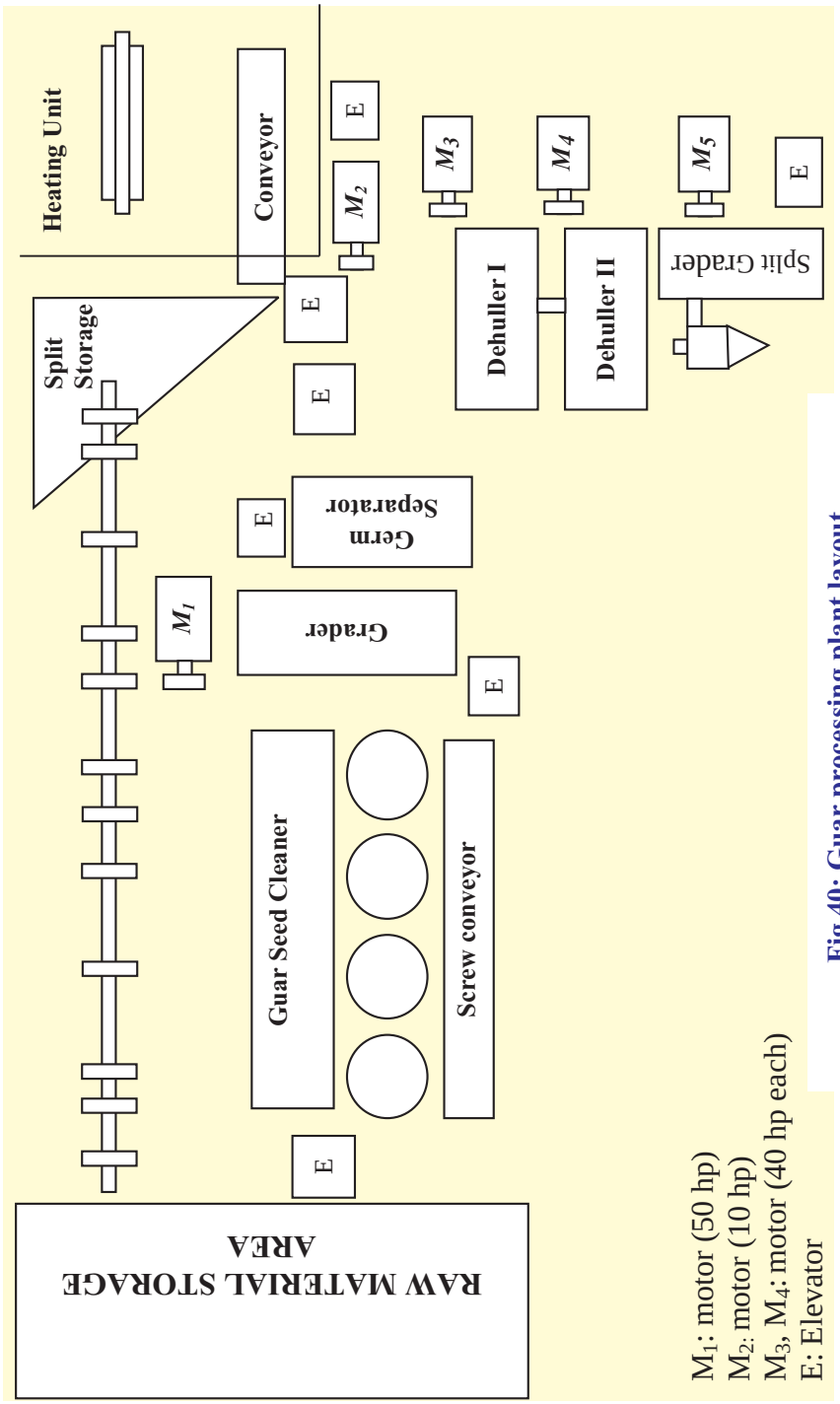


Fig 40: Guar processing plant layout

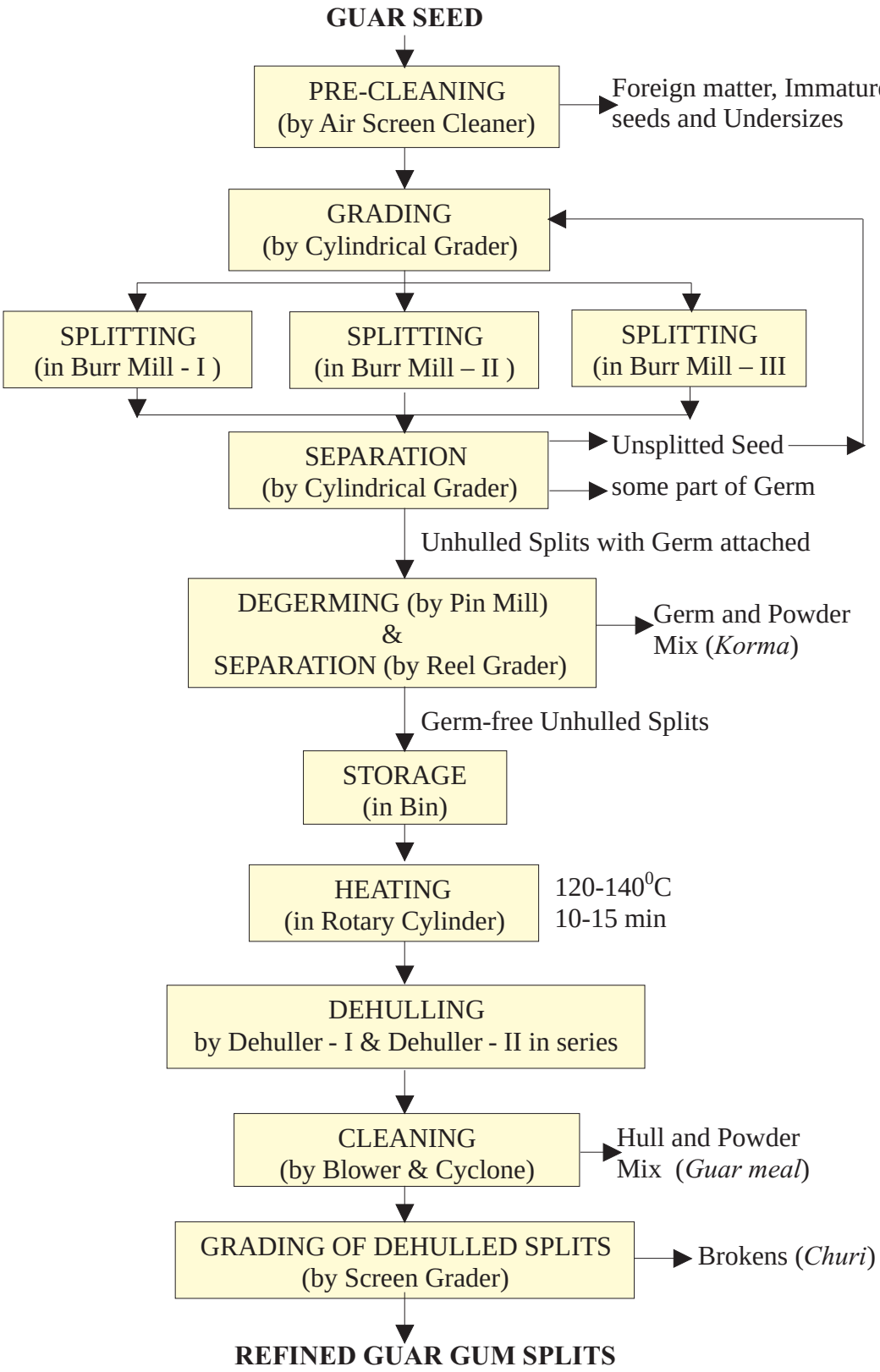


Fig 41: Flow diagram for industrial processing of guar seed

Endosperm obtained after dehulling, splitting and separation is called guar gum splits. These splits are usually cleavage shape. The splits are then ground to fine powder of different particle sizes depending upon their uses. Attrition mills, hammer mills or ultra fine grinders are used in the industry. The moisture content of guar gum splits is usually adjusted to 10% prior to grinding. Some times wet grinding of the splits is also done to get specialized products.

During survey, the information related to problems associated with guar industries were also collected.

Physical properties of guar seed

Physical properties of the guar seed of two varieties namely RGC-936 and HG-365 were determined and are reported below:

1000-grain weight: The 1000-grain weights of the guar seed of two varieties were determined at four levels of moisture content ranging from 5-20% (d. b.). The results are presented in Fig 42.

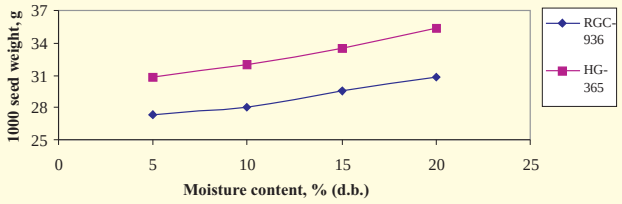


Fig 42: Effect of moisture content on 1000 seed weight of guar seed

The 1000-grain weight of both varieties increasesd with increase in moisture content. The 1000-grain weight of variety HG-365 is significantly higher than that of variety RGC-936 at all moisture contents. This difference is due to the reason that grain size of variety HG-365 is bigger than that of RGC-936.

Bulk density: The bulk densities of two varieties of guar seed were determined at 4 levels of moisture content. The results are presented in Fig 43. Initially the bulk density of guar seed variety RGC-936 was 836.09 kgm^{-3} at 8.18 % moisture content (d. b.) and that of variety HG-365 was 854.79 kgm^{-3} at 9.21 % moisture content (d. b.).

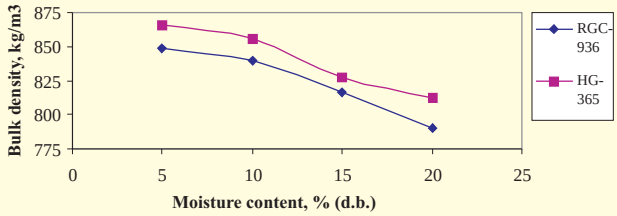


Fig 43: Effect of moisture content on bulk density of guar seed

The bulk density of both varieties decreased with increase in moisture content. The bulk density of variety HG-365 is significantly higher than that of variety RGC-936 at all moisture contents. This difference is due to the reason that grain size of variety HG-365 is bigger than that of RGC-936.

Angle of repose: The angle of repose of two varieties of guar seed was determined at four levels of moisture content. Besides these, the angle of repose was determined at initial condition of seed to verify that addition or removal of water has any adverse effect on angle of repose. Initially the angle of repose of guar seed variety RGC-936 was 26.82 degree at 8.18 % moisture content (d. b.) and that of variety HG-365 was 27.10 degree at 9.21% moisture content (d. b.). The results are presented in Fig 44.

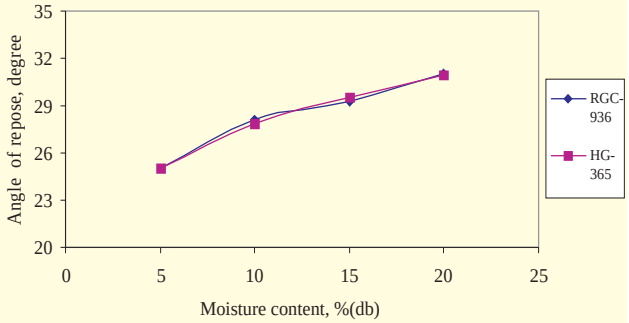


Fig 44: Effect of moisture content on angle of repose of guar seed

The angle of repose of both varieties increased with increase in moisture content, whereas there is no significant difference in angle of repose of both varieties.

Besides these properties dimensions of seed, coefficient of internal friction, coefficient of external friction with respect to three surfaces (Ply board, M.S. sheet and G.I. sheet), colour of grain, and rheological behaviour of both varieties of seed at four moisture contents were determined.

Performance evaluation of existing milling machineries for dehulling of guar seed

Following milling machineries were evaluated for their ability to dehull the guar seed:

CIAE Dhal Mill
Grain Pearler
Satake type Rice Polisher

The cleaned and graded seed of variety RGC-936 was used for experiments. The moisture content of the seed was determined and found to be 10.41% (w. b.). Following pre-treatments were given to test the selected milling machines.

(i) No moisture adjustment (control)

(ii) Soaking in water for 15 minutes and dehulling instantly (after removing surface moisture)

(iii) Soaking in water for 15 minutes and dehulling after conditioning the grain for 24 and 48 hours

(iv) Soaking in water for 30 minutes and dehulling instantly (after removing surface moisture)

(v) Soaking in water for 30 minutes and dehulling after conditioning the grain for 24 and 48 hours

The dehulling time was varied from one minute to 10 minutes to observe the performance of the selected milling machines. The machines were tested at their normal machine parameters. Sample size for dehulling was taken as 10 kg for CIAE dhal mill and grain pearler and 200g for Satake type rice polisher. None of the machine at any pretreatment mentioned above was able to dehull any guar seed even after 10 minutes of operation.

The EMC of guar seed and guar gum splits was studied at 10, 20, 30 and 40^{0}C and 30, 45, 60, 75 and 90% relative humidity. Moisture absorption behaviour of guar seed of variety RGC-936 was studied at 20, 30, 40, 50 and 60^{0}C. This study was done to determine optimum time and temperature of the grain for soaking the grain while treating with enzymes for dehulling. The moisture absorption rate increased with temperature. The absorption rate increased rapidly upto one hour of soaking and then became constant.

Patent: A process was developed to dehull the guar seed. The seed is dehulled with a dehulling machine after a specific pretreatment. In this process, the hull was removed neatly without damaging the kernel (Fig 45). The process is being filed for obtaining patent.

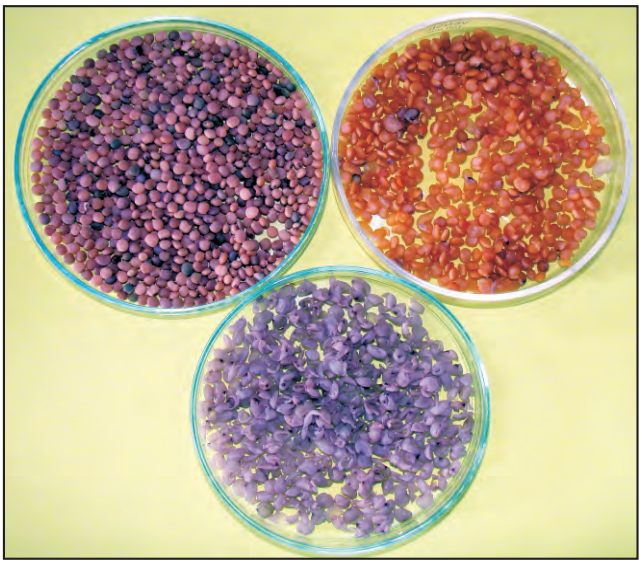


Fig 45: Sample of dehulled guar seed by new process

Shelf life studies of fortified sattu

Mridula D, Rita Jain and O D Wanjari

Water absorption capacity of bengal gram samples roasted at different temperature and time combination (160, 180, 200, 220 ^{0}C and 45, 60, 75 s time) was determined. Results showed the significant effect of roasting temperature and time on water absorption capacity of bengal gram. Water

absorption increased from 181.89 % to 261.86 % when roasted for 45 to 75 s time at 160 ^{0}C but at 180 ^{0}C water absorption capacity slightly increased at 60 s roasting time but again decreased from 284 % to 270.38 % at 75 s roasting time. At 200 and 220 ^{0}C roasting temperature, water absorption capacity decreased with increase in roasting time (Fig 46) .

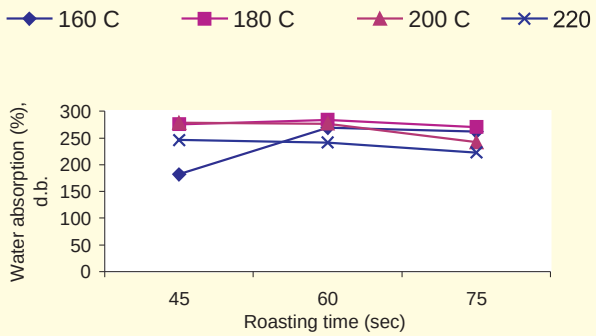


Fig 46: Effect of roasting on water absorption capacity of bengal gram

Acid insoluble *ash* was determined to know the presence of sand in roasted bengal gram samples. The acid insoluble ash content of different samples of roasted bengal gram was in the range of 0.018 to 0.034 % (d.b.) as compared to maximum permissible limit of 0.20 % as per IS 14613: 1998.

Roasting affected the protein solubility (%) of bengal gram roasted at different time and temperature combinations. It was in the range of 50.96% (220 ^{0}C; 75 sec) to 84.92% (160 ^{0}C ; 45 sec) (d.b.).

Fabrication of low cost flour mixing unit

A low cost screw type flour mixing unit (Fig 47) was developed to mix the dry ingredients/ premix containing high protein flour or other material in the bulk flour/ main ingredient of the formulations. The approximate cost of the flour mixture is Rs. 8000/- (including motor).

The flour mixing unit was operated and tested at 285 rpm for uniform mixing of two materials using both the hoppers. It was tried to match the feed rate of

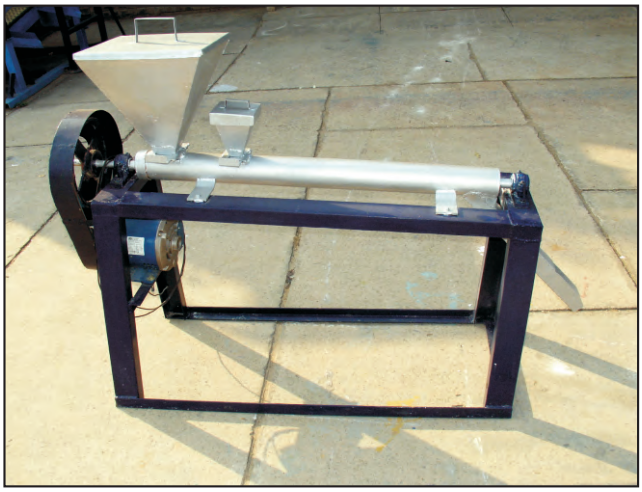


Fig 47: Screw type flour mixing unit

materials in appropriate proportion i.e. 90 % flour in hopper A and 10 % premix containing dark (red) colored material in different proportions in hopper B. Three combinations of inlet opening size of both the hoppers were selected to standardize the opening size of both the hoppers for efficient mixing (Table 20). As the feed rate of both the hopper's were matched with inlet opening size of A and B hopper at 20 x 20 mm and 10 x 10 mm, respectively, this inlet opening size of A and B hopper's of flour mixer found optimum for efficient mixing of premix with main ingredient. The retention time of flour in the mixing chamber was about 6 seconds.

Table 20: Combinations of hopper openings & feed rate

Inlet opening size of Hoppers (mm)		Feed rate (kg/ h)		Output of flour mixer (kg/h)
Big hopper (A)	Small hopper (B)	Big hopper (A)	Small hopper (B)	
20 x 20	15 x 15	183.83	25.42	203.4
20 x 20	10 x 10	183.24	20.16	199.08
13.3 x 13.3	7.5 x 7.5	90.72	10.8	100.24

In order to test the mixing efficiency of flour mixer, the premix (flour + red coloured material) was mixed with the main flour samples, selecting the standardized inlet opening size of both hopper's, which was 20 x 20 mm and 10 x 10 mm for A (big) and B (small) hopper's, respectively. Three types of premix, containing 5 %, 2.5 % and 1.25 % coloured material, were mixed with the main flour and colour of these samples was determined to know the uniformity of the colour of the mixed flour samples. The colour of the randomly selected mixed samples, collected from the four different points of the same batch, was determined using Hunter colour lab as L*, a*, b* values. From the colour (L*, a*, b* values) values of these samples of the same batch of the different premix, it revealed that there was no significant difference ($p > 0.05$) in the quality of the final product as far as colour is concerned.

Development of fortified *sattu*

In order to develop fortified Bengal gram *sattu*, it was prepared by using the bengal gram (variety PBG-5) roasted at 220 ^{0}C for 60 s and barley (variety - VJM 201) roasted at 220 ^{0}C for 75 s. The roasted flour samples of bengal gram and barley were taken in three different proportions 100:0, 75:25 and 50:50 and fortified (as per FDA standard for wheat flour) with 0.64 mg of thiamin (thiamin chloride), 0.40 mg of riboflavin, 5.3 mg of niacin (nicotinic acid), 212 mg of calcium (calcium carbonate) and 2.87 mg of iron (ferrous sulphate) per 100 g of material. The fortified bengal gram and barley based *sattu* samples were packed in LDPE bags and laminated aluminium foil bags and stored in the month of February 2007. The moisture content in fresh fortified samples was 3.16, 3.21, 3.33, 3.37, respectively in bengal gram based (control), fortified bengal gram sattu , fortified bengal gram and barley based sattu (75:25), and fortified bengal gram and barley based sattu (50:50), respectively. Alcoholic acidity in these samples was 0.12, 0.12, 0.14, 0.14 %, respectively. FFA level in these samples was 0.08, 0.06, 0.06, and 0.06 %, respectively. Total microbial load in these samples was 4 (NA), 6 (GYE), 37 (NA), 7 (GYE), 24 (NA), 6 (GYE), 28 (NA), 9 (GYE) x 10^{-3} cfu/g, respectively. Protein digestibility in these fresh samples was 80.61, 80.58, 78.62, 76.77 %, respectively.

Energy efficient pulse milling technology

R K Goyal, R K Vishwakarma, O D Wanjari, M R Manikantan and Mridula D

Effect of oil temperature as pre-milling treatment on dehulling efficiency

The response surface methodology was used to predict dehulling efficiency and dehulling loss. Dehulling efficiency increased with time of heating as well as temperature of heating. The optimum conditions for dehulling of pigeonpea grains selected with response surface methodology were as follows: time of heating: 145 seconds; temperature of heating: 90 ^{0}C. Under these conditions, the experimental dehulling efficiency of pigeonpea was close to predicted value (72.3 %).

Determination of dhal standards

In order to prepare standards for pigeopea dhal, five samples each of grade I and Grade II dhal were procured from the local market and their different attributes are mentioned in Tables 21, 22, 23, 24, 25, 26 and 27.

Table 21: Dimensions (in mm) of Grade I dhal

	Katani Dhal			Gulbarga Dhal			Shriram Dhal			Double Hans Dhal			Unknown Dhal		
	L	W	T	L	W	T	L	W	T	L	W	T	L	W	T
Mean:	5.85	4.67	2.15	5.46	4.42	2.09	5.47	4.42	1.95	5.64	4.47	1.91	5.49	4.48	1.98
S.D.	0.36	0.29	0.15	0.38	0.20	0.14	0.41	0.41	0.21	0.38	0.25	0.16	0.44	0.30	0.19

Average dimensions of grade I dhal were observed to be :

Length: 5.58 $\pm$ 0.42 mm
Width: 4.49 $\pm$ 0.31 mm
Thickness: 2.01 $\pm$ 0.19 mm

Table 22: Dimensions (in mm) of Grade II dhal

	Rajdhani Dhal			Mayur Dhal			Double Hans			Sriram Dhal			Undranded Dhal		
	L	W	T	L	W	T	L	W	T	L	W	T	L	W	T
Mean:	5.17	4.14	1.83	5.37	4.39	1.92	5.19	4.25	1.86	5.07	4.16	1.82	4.94	4.04	1.77
S.D.	0.41	0.25	0.17	0.46	0.27	0.17	0.45	0.26	0.17	0.45	0.25	0.17	0.44	0.23	0.16

Average dimension of grade II dhal were observed to be :

Length: 5.15 $\pm$ 0.46 mm
Width: 4.19 $\pm$ 0.28 mm
Thickness: 1.84 $\pm$ 0.17 mm

Student t - test suggests that all three dimensions of grade I dhal are significantly greater than that of grade II dhal.

Table 23: 1000-cotyledon weight (g) of dhal

S. No.	Brand name	Grade of dhal	1000-cotyledon weight, g	Average 1000 - cotyledon weight, g
1	Sri Ram Brand	I	35.534	
2	Gulbarga dhal	I	37.249	
3	Double Hans Brand	I	38.896	37.405 $\pm$ 3.490
4	Katani Dhal	I	42.377	
5	Unknown Brand	I	32.968	
6	Sri Ram Brand	II	30.725	
7	Mayur Brand	II	28.154	
8	Unknown	II	32.332	30.53 $\pm$ 2.207
9	Rajdhani	II	29.256	
10	Double Hans Brand	II	32.185	

Table 24: Bulk density of dhal (kg/cm^3)

S. No.	Brand name	Grade of dhal	Bulk Density (kg/m3)	Average bulk density (kg/m3)
1	Sri Ram Brand	I	908.902	
2	Gulbarga dhal	I	887.144	
3	Double Hans Brand	I	908.798	890.740 $\pm$ 28.409
4	Katani Dhal	I	839.565	
5	Unknown Brand	I	909.293	
6	Sri Ram Brand	II	913.856	
7	Mayur Brand	II	909.414	
8	Unknown	II	914.463	912.604 $\pm$ 3.167
9	Rajdhani	II	916.477	
10	Double Hans Brand	II	908.812	

Table 25: Whole cotyledon percentage in samples of dhal

S. No.	Brand name	Grade of dhal	Whole cotyledon (% by number)	Average whole cotyledon (% by number)	Whole cotyledon (% by weight)	Average whole cotyledon (% by weight)
1	Sri Ram Brand	I	93.26		95.49	
2	Gulbarga dhal	I	90.94		92.85	
3	Double Hans Brand	I	94.68	93.60±3.82	96.58	95.53±2.85
4	Katani Dhal	I	99.70		99.86	
5	Unknown Brand	I	89.41		92.86	
6	Sri Ram Brand	II	79.32		88.06	
7	Mayur Brand	II	88.74		92.59	
8	Unknown Brand	II	82.27	82.17±5.49	86.68	87.35±3.63
9	Rajdhani Brand	II	79.21		82.48	
10	Double Hans Brand	II	81.33		86.94	

Table 26: Percentage cotyledons having germ

S. No.	Brand name	Grade of dhal	Cotyledon having germ (%)	Average
1	Sri Ram Brand	I	13.94	
2	Gulbarga dhal	I	02.75	
3	Double Hans Brand	I	10.22	11.95±10.50
4	Katani Dhal	I	29.81	
5	Unknown Brand	I	03.02	
6	Sri Ram Brand	II	00.00	
7	Mayur Brand	II	00.00	0.21±0.43
8	Unknown	II	00.00	
9	Rajdhani	II	00.00	
10	Double Hans Brand	II	01.03	

Table 27: Proximate composition of pigeonpea dhal samples (%)

S. No.	Brand Name	Grade of dhal	Moisture content (%)	Protein (%)	Fat (%)	Ash (%)
1	Sri Ram Brand	I	9.28	23.33	1.99	3.78
2	Gulbarga dhal	I	8.55	22.19	1.58	3.26
3	Double Hans Brand	I	10.16	22.81	1.51	4.02
4	Katani Dhal	I	8.58	22.03	2.82	3.15
5	Unknown Brand	I	9.05	22.11	2.55	3.87
6	Sri Ram Brand	II	10.70	22.23	1.54	4.00
7	Mayur Brand	II	9.47	22.67	2.12	3.89
8	Unknown Brnad	II	9.36	23.25	1.82	4.29
9	Rajdhani Brand	II	10.21	22.49	2.65	4.16
10	Double Hans Brand	II	11.41	22.05	1.15	3.85

Inference: Standards of grade I and grade II dhal in terms of physico-chemical properties show that grade I dhal is significantly superior in terms of quality parameters like physical dimensions, bulk density, cotyledon percentage, germ and fat content. Among all the brands, Katani grade I dhal was the best.

Design and development of mini dhal mill

A dehusking roller with three different grades of carborundum has been fabricated (Fig 48). The grades of carborundum are

I 24 (0.3-0.5 mm)
II 30 (0.22-0.49 mm)
III 36 (0.16-0.25 mm)

The capacity of the mini dhal mill with above roller was 100 kg/h.

Installation of Pilot Plant

Following works were completed:

i) Construction of building

ii) Civil work for foundation

iii) Procurement of electrical cable, thimbles, gland, earthing wire and PVC pipe

iv) Fabrication of elevated platforms

v) Installation of machines

Components of pilot plant are presented in Figures 49, 50 and 51.

Fig 48: Mini dhal mill

Fig 49: Partial view of pulse milling pilot plant

Fig 50: Partial view of pulse milling pilot plant

Fig 51: Pulse milling pilot plant

Improving in CAP (cover and plinth) storage of wheat to minimise grain tempering and quality

D.S. Uppal, S K Aleksha Kudos, V K Bhargava, V R Bhagwat and Dilip Jain

A solar energy based thermal model has been developed to predict the temperature of wheat grain within the CAP storage. A periodical analysis is presented for hourly variation of grain temperature at different depth of the wheat grain from surface in the storage of CAP.

Description of Cover-and-plinth storage

Cover and plinth storage is an improvised arrangement for storing food grains in the open area. A typical CAP storage is shown in Fig.52. It is generally provided on a raised platform, where grains are protected from rat and dampness of

Fig 52: A typical arrangement of covered and plinth storage of wheat grain of Food Cooperation of India

ground. The grain bags are stacked in a standard size on wooden dunnage. The stacks are covered with 250-350 micron LDPE sheets from the top and all four sides. Wheat grains are generally stored in such CAP storage for 6-12 month periods. It is the most economical storage structure and is being widely used by the Food Corporation of India for bagged grains.

The most commonly constructed size for 1500 ton with 3000 bags of 50 kg of CAP storage are with the length and breadth of 8.55 and 6.30 m respectively. The sides and ridge heights are 4.50 and 6.00 m respectively (Fig.53). During sunshine

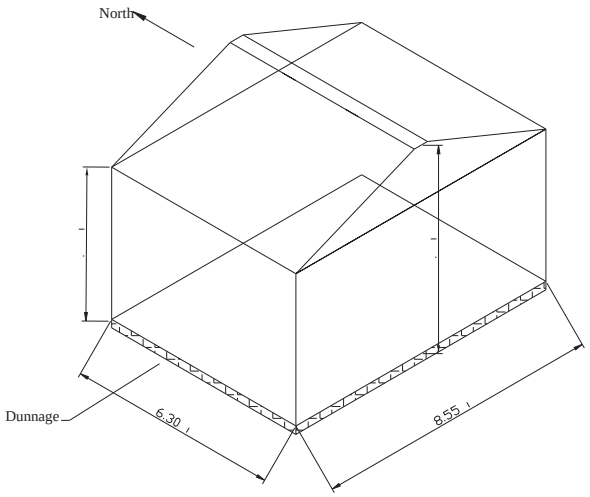


Fig 53: Schematic diagram of CAP storage of wheat grain in most commonly constructed size for 150 ton with 3000 bags of 50 kg.

hours, solar radiation falls on different surfaces of the CAP storage and absorbed by its black cover, which heats up the black plastic cover material. The heat absorbed by the plastic cover is conducted into the enclosed wheat grains and heat up the whole lot of wheat grain in the CAP storage.

A mathematical model was developed on the basis of following assumptions:

i) Movement of water and vapour in the CAP is negligible,

ii) Wheat grains stacked in bags are considered as a single entity,

iii) Analysis is time dependent periodic condition,

iv) Temperature distribution inside the wheat grain storage is characterized by one dimensional heat conduction equation, and

v) CAP storage is east west oriented.

The mathematical model was solved for Delhi (latitude 28° 35' N, longitude 77° 17' E and altitude 216 m from mean sea level) considering the representative climatic conditions of northern India (Delhi, Haryana, Punjab, Uttar Pradesh). The monthly hourly average solar intensity and ambient temperature were used for computation of grain temperature. Solar intensities on the different surfaces of the CAP storage were computed by using the method given by Lui and Jordon (1962). The various input parameters are given in Table 28.

Table 28: Input parameters used for numerical computation

Parameters	Values
C_g, C_p	1757, 2000 J/ kg K
K_g, K_p	0.156, 0.05 W/m K
h_g	2.8 W/m^{2}K
h_i	0.58 W/m^{2}K
v	5 m/s
p	0.9, 0.2
p	0.9, 0.2
g p	863, 500 kg/m^3
l_p	350 m

Variation in grain temperature with black plastic cover

The CAP storages are prepared for storing the wheat grain after harvest in the month of March. A typical hourly variation in temperature profile on wheat grain under CAP storage with black plastic cover for April has been presented in Fig. 54. On the abscissa of this figure hourly time starts from 6:00 a.m, therefore, the temperature lies at 12:00 noon is represented as 7 h from the starting point. Hourly temperature profiles of grain are presented from 0 to 20 cm of the depth from surface at the interval of 1 cm. It is observed that the maximum temperature

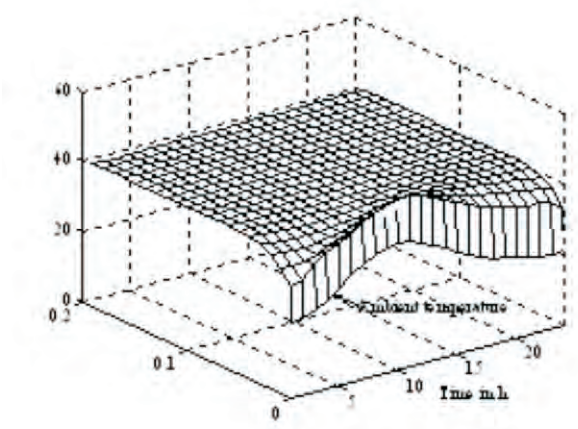


Fig 54: Hourly temperature profile of wheat grain under CAP storage for April

variation in wheat grains occurs around the surface of the CAP. The hourly variation in grain temperature becomes negligible after 20 cm of depth from all around the CAP. The temperature becomes constant after 20 cm of depth from the surface of CAP for the day. However, the mean grain temperature is higher than the ambient temperature throughout the day.

The monthly average ambient and inner grain temperatures are presented in the Fig. 55. It can be observed that around 10 to 12 °C rise in grain temperature from the mean monthly ambient temperature throughout the year. The temperatures of grains during the month from May to September

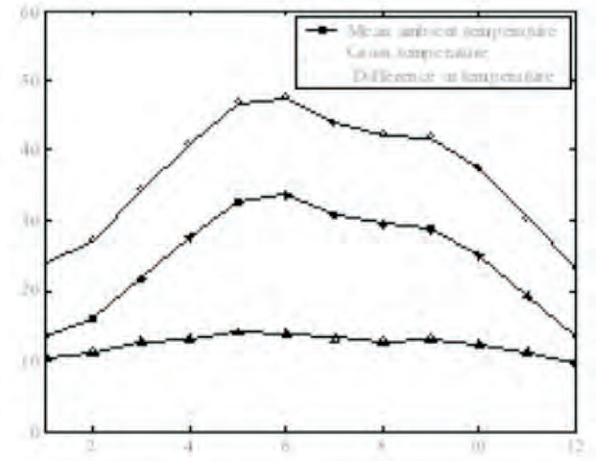


Fig 55: Monthly variation in wheat grain temperature under CAP storage

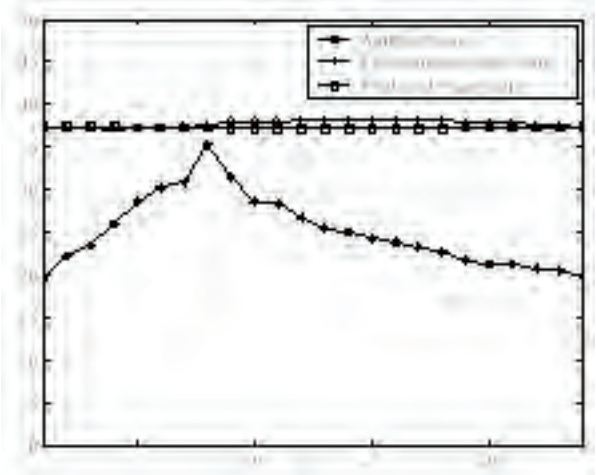


Fig 56: A typical diurnal variation in grain temperature under CAP storage for October, experimental validation

are above 40 °C, which indicate that there should be a modification in CAP structure for cooling the grain.

Validation of model

The developed mathematical model was validated with the experimental data recorded on a scale down CAP storage structure constructed at the CIPHET, Ludhiana. The experimental CAP was constructed in length 2 m, breadth 2 m and height 1.5 m for around 250 quintal of wheat grain. The bag size in scale down model was 10 kg of wheat grain. The ambient and grain temperature had been recorded with data-logger for the month of October and November. Thus, the solar radiation and ambient temperature of Ludhiana were used to compute the grain temperature for the available CAP storage. The predicted and experimental grain temperatures for October are presented in Figs. 56. It can be seen that the predicted values of grain temperatures were in fair agreement with the experimental observations. Thus the developed mathematical model can predict the grain temperature under such CAP storage for any location with the available solar intensity and ambient temperature with the realistic accuracy.

Effect of white colored polythene cover

To reduce the effect of solar radiation, a white color plastic cover with low absorbance and transmittance is proposed. The temperature of grain assuming with the white colored plastic cover are computed for the peak summer months i.e. May, June and September. The hourly temperature profile of grain for the month of May, June and September with considering the white cover ($'_p$ = 0.2) and black ($'_p$ = 0.9) are presented in Fig. 57. The hourly variations of temperature for different depth (0, 1, 2, 20 cm) from surface are also presented in these figures. It can be observed from Fig. 57 that the temperature of wheat grain on the surface of the CAP storage as well as inside (core) are reduced by 6-8 °C compared with black cover sheet. This is mainly due to low absorption of the solar radiation on cover resulted in reduction in temperature. Therefore, a white color cover of low absorbance and transmittance is a better option for Food Corporation of India to reduce the grain temperature in CAP storage.

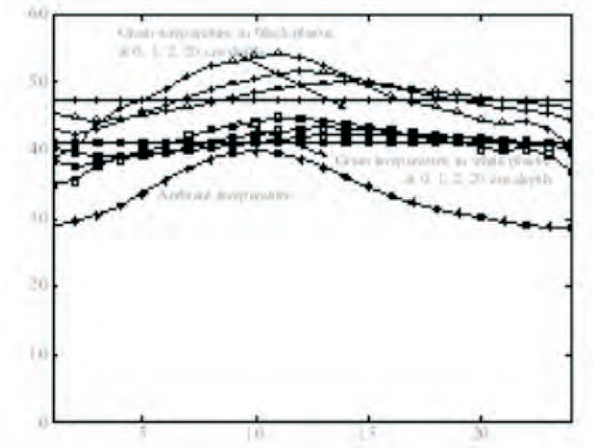


Fig 57: Effect of white plastic on diurnal variation in grain temperature under CAP storage in June

Studying the effect of marginal quality water on quality and shelf life of selected fruits

Satyendra Kumar, R P Sharma, D D Nangare and V K Garg

The study was conducted to determine the effect of salinity on fruit yield, quality and shelf life of pomegranate and guava using drip irrigation. Different quality water for irrigating experimental plants was prepared by blending good quality (canal water) and saline (under ground) water. The share of saline water in irrigation water varied from 0 to 100 % at 25% interval. Effect of salinity on soil surface and plant growth was quite visible. Under the treatment of 100 % saline water (pH 7.70, EC 19.50 dSm^{-1}) irrigation, tip burning of pomegranate leaves (Fig 58) was observed. Guava plants did not show any adverse effects of this saline water.

Fig 58: Tip burning of pomegranate leaves

Evaluation of biodegradable plastic mulching on yield and quality of vegetables

Rajbir Singh, DD Nangare and Satyendra Kumar

Effect of biodegradable mulch film on okra

The growth and green fruit yield of okra was affected with the use of different mulching film. Fruit yield of okra was found highest in black ordinary film (242.7 g/plant and 37.8 kg/plot) followed by black biodegradable film (229.2 g/plant and 35.9 kg/plot). The lowest fruit yield was observed in control (125.2 g/plant, 19.7 kg/plot) whereas the fruit yield was only 138.4 g/plant and 21.1 kg/plot in transparent biodegradable film (Fig 59) which showed poor performance in okra. The degradation behaviour of biodegradable film (black and transparent) in the field is presented in Table 29 and it is clear from the table that transparent film degraded in the field early compared to black biodegradable film where as ordinary film could not degrade.

Fig 59: A view of transparent biodegradable film in okra

Table 29: Bio-degradability score of biodegradable film in okra

Type of mulch film	July	August	September	October	November
Black biodegradable film	9	8	6	5	3
Transparent biodegradable film	9	8	5	4	1
Ordinary polymer film	9	9	9	9	8

Effect of biodegradable films in strawberry

The effect of mulching with different plastic film affected the growth and development of strawberry (Table 30). Plant growth in terms of plant spread and leaf area was affected with the use of different film. Maximum plant spread and leaf area was observed in ordinary plastic film followed by black biodegradable film (40 µ). The lowest leaf area and plant spread was observed with black biodegradable film (20 µ). Similarly, the use of different film as mulching affected the fruit weight and yield. Maximum fruit yield was observed with the use of black plastic film (151.4 g/plant) followed by black biodegradable film (40 µ). Least fruit yield was observed in black biodegradable film (20 µ).

Table 30: Effect of different mulching films on growth and yield of strawberry

Treatment	Plant spread (cm)	Fruit weight (g)	Fruit yield(g/plant)*
Black film (O)	21.2	13.1	151.4
BD black (20µ)	18.4	11.4	117.3
BD black (30µ)	19.7	12.1	128.1
BD black (40µ)	20.4	12.7	144.5

***Fruit yield upto February harvest**

The degradation of biodegradable film is presented in Table 31. In general, it was observed that thicker the film, the degradation is slow and thinner the film, the fast is degradation. It is clear from the Table 31 that thinner film degraded in the field early compared to black biodegradable film which has higher thickness, where as ordinary film could not degrade. It is interesting to note that there was a storm on 12th February, 2007, which had affected the biodegradability of different films greatly. The thinner films of 20 and 30 µ were damaged with the rains and wind and the score was observed to be around 3 & 4 respectively after the storm. However, the storm had affected all the film but the damage was more in thinner films. Even the storm has affected the ordinary film but the damage was more in biodegradable films.

Table 31: Biodegradability score of biodegradable film in strawberry

Treatment	November	December	January	February	March
Black (O)	9	9	9	7	6
BD (20 µ)	9	8	6	3	1
BD (30µ)	9	9	8	4	2
BD (40µ)	9	9	9	6	4

***BD: Black biodegradable film**

Soil solarization for vegetable nursery and its demonstration at farmer's field

Rajbir Singh and Dinesh Singh

Solarization during hot summer months can increase soil temperature to certain level, which is lethal to many pathogens, weeds and nematodes. It leaves no toxic residue, improves soil structure and enhances availability of essential plant nutrients and can be easily used by the farmers. Studies were conducted at research farm of CIPHET, Abohar to determine the effect of solarization on nursery production of vegetables like tomato, capsicum, cauliflower. Solarization resulted in increase of 10.6 ^{0}C in average temperature at different soil depth compared to non-solarized beds (Table 32). Maximum temperature differences were observed in upper 5 cm soil depth, which decreased with increase in soil depth.

Table 32: Soil temperature at three depths during solarization

Treat-ment	Soil temperature					
	5 cm		10 cm		15cm	
	Max	Mini	Max	Mini	Max	Mini
T_1	46.2	34.1	41.9	34.8	38.2	35.0
T_2	56.8	37.7	50.1	38.2	44.7	37.8
T_3	56.2	36.8	49.3	37.9	44.2	37.5

T_1 : Control; T_2 : Solarization; T_3 : Solarization in FYM added beds

The mean maximum and minimum air temperature during this period were 38.7 and 28.6 °C respectively.

Solarization treatments significantly reduced the emergence of weed population and weed dry matter production compared to control. Solarization of nursery beds proved more effective and statistically superior with respect to higher germination, seedling survival. Further, solarization resulted in to better shoot length and root length of different vegetables. There was 19.4 to 28.4 % higher shoot length and 17.7 to 23.1 % higher root length in different

Table 33: Effect of soil solarization on seedling vigour of different vegetable crops

Crop	Shoot length (%)		Root length (%)	
	T_2	T_3	T_2	T_3
Cauliflower	19.4	22.7	23.1	26.2
Capsicum	18.6	20.2	17.7	19.2
Tomato	25.2	28.4	18.2	20.1

* Increase (%) in growth vigour of seedlings grown in solarized soil treatment compare to control

vegetables in solarized beds (Table 33). In general, both shoot and root length was higher in solarized plots amended with the FYM mainly due to higher nutrient availability in the beds. This clearly confirm that use of FYM in nursery beds can further help in providing appropriate nutrition for higher growth and seedling vigiour. This clearly advocate that addition of FYM in the nursery beds prior to solarization had further beneficial effects on all these parameters.

The study clearly suggested that solarization for nursery production is a good option for sterilization, which can be equally effective to chemical fumigation. Solarization technique being environmental safe can be used in high value crops, vegetables, flowers, greenhouse etc.

Effect of irrigation, fertigation levels and mulching on growth and yield of Bt cotton in semi-arid region

Rajbir Singh and Satyendra Kumar

The experiment was conducted in cotton to determine the effect of irrigation and mulching Fig 60 on growth and yield of Bt-cotton. Data presented in Table 34 shows the biodegradability of the biodegradable film (both black and transparent). It clearly revealed that transparent biodegradable film degraded in the field early than black biodegradable film (Fig 61).

Fig 60: Mulching treatment in cotton

Table 34: Biodegradability of the film

Type of film	Degradation	Months						
		June	July	Aug	Sept	Oct	Nov	Dec
Black	Degradation	9	8	7	6	5	4	3
	Lesions	9	8	6	5	4	3	2
	Strength	9	7	6	5	5	2	1
	Average	**9**	**7.7**	**6.3**	**5.3**	**4.7**	**3.0**	**2.0**
Transparent	Degradation	9	8	7	5	4	1	1
	Lesions	9	6	4	3	3	2	1
	Strength	9	7	5	2	1	1	1
	Average	**9**	**7**	**5.3**	**3.3**	**2.7**	**1.3**	**1.0**

Score of biodegradable film (Assessment scale form 1- 9); !:bare soil; 9:100% soil cover

Fig 61: Degraded mulch film in soil after completion of the crop

The use of mulches influenced the weed growth in the cotton field and maximum weed population and weed dry matter was observed in control (121

population and 829.3 g/m^2 weed dry weight) where the weed population and weed dry matter was least in black polymer film (15, 140.7g/m^2) closely followed by black biodegradable film (23, 171.5g/m^2). The mulching treatment also affected the cottonseed yield and highest cotton yield was observed in black polymer film (3217 kg/ha) followed by black biodegradable film (3048 kg/ha). The cotton yield in transparent biodegradable film (2678 kg/ha) was observed to be close to straw mulch (2690 kg/ha), where as the cotton yield in control (without mulch) was least (1425 kg/ha).

Organic production of vegetables in polyhouse

Rajbir Singh, Satyendra Kumar, D D Nanagare and V K Saharan

Vermicompost preparation with different waste materials

Experiments have been done to utilize different contents of farm waste with cattle dung. The vermicompost co-coefficient (Vc) clearly shows that use of farm waste (kitchen waste, vegetable and fruit waste, crop waste) help in decomposition process and subsequently higher nutrient content (Table 35). Highest increase in nutrient concentration was found in treatment consisting of vegetable waste + cow dung (1:1) followed by crop straw +cow dung (1:1). The worm growth was also observed in vegetable waste. The experiment on production of vermicompost in different seasons revealed that maximum vermicompost production was during rainy season (July-September) followed by summer (April June) and least in winter (November-January). The capacity of vermicompost production was reduced to half during winter. The population of worms also were higher during rainy (215%) followed by summer (157%) and least in winter (more mortality).

Table 35: Vermicompost coefficient under various treatments

Treatments	VC_c	VC_n	VC_p	VC_k	Gain in worms
T_1	1.02	2.19	1.31	1.26	271.4
T_2	1.03	2.27	1.41	1.28	298.5
T_3	1.06	2.22	1.37	1.25	331.5
T_4	1.04	2.15	1.21	1.18	357.2
T_5	1.02	2.03	1.28	1.23	348.1
T_6	1.01	1.91	1.33	1.26	329.2

T_1: cotton stick + mustard straw + cow dung (1:1:2);
T_2: cotton stick + pulse straw + cow dung (1:1:2);
T_3:crop straw + cow dung (1:1);
T_4: vegetable waste +cow dung (1:1);
T_5: vegetable waste + cow dung (2:1);
T_6: vegetable waste cow dung (3:1);
T_7: cow dung only

Vermicompost preparation from farm waste

Inoculation of composting material with *E. foetida* and microbes helped increase the rate of composting as shown by the lower C concentration on day 60 and 90 (Table 36), and increase in the N concentration of compost. Earthworm promotes suitable microclimatic conditions that consequently affect C losses from substrates through microbial respiration in the form of CO_2. Earthworm activities in substrate material accelerate microbial mediated mineralization of plant metabolites, and therefore contribute efficiently in stabilization of the waste materials.

Table 36: Organic and total N during vermi composting of maize and wheat straw inoculated with *E. foetida*

Treatments	C:N ratio of the vermicompost				
	0	30	45	60	90
T_1	80.64	47.97	31.89	23.02	17.35
T_2	81.29	31.02	18.36	14.80	12.57
T_3	78.28	36.70	25.79	18.23	15.77
T_4	80.79	32.02	20.59	15.11	12.69
T_5	78.59	50.41	27.72	23.89	17.84

T_1: Maize straw+cow dung+*A. chrococcum*+*P. striata*;
T_2: Maize straw+cow dung+*A. chrococcum*+*P. striata* +*E. foetida*;
T_3: Wheat straw+cow dung+*A. chrococcum*+*P. striata*;
T_4: Wheat straw+cow dung+*A. chrococcum*+*P. striata* +*E. foetida*;
T_5: Pure farmyard manure

The vermicompost of T_2 and T_4 had lower C : N ratio compared to T_1 and T_3. The C: N ratio reflect the spectra of changing carbon and nitrogen concentration of the substrate material during composting/vermicomposting process. The loss of carbon as carbon dioxide in the process of respiration and production of mucus and nitrogenous excreata, consequently lower the C: N ratio. Studies reveal that the C:N ratio, which is one of the most widely used indices for comost maturation, decrease sharply during vermicomposting. In treatment T_5 (pure farm yard manure) there was no inoculation of *A. chroococcum, A. awamori and E. foetida,* yet it had a naturally occurring microflora like *A. chroococcum* and *A. awamori,* whose counts were lower than in the other treatments, because bacteria, fungi and mainly earthworms were not inoculated. As a result of this there was lower enzyme activity and a higher C: N ratio.

Effect of vermicompost on fruit yield

Vermicomposting (VC) has influenced the marketable fruit yield of strawberry significantly over control (Table 37). Plants receiving inorganic fertilizers only had lower marketable fruit yield (219.7 g/plant) than those receiving different doses of vermicompost. Marketable yield showed progressively increasing trend and highest marketable yield (315.1 g/plant) was observed when plants received vermicompost @ 10 t ha^{-1}, which was however, at par with those receiving vermicompost @ 7.5 t ha^{-1}. Another experiment was conducted to determine the effect of pre-harvest foliar application of Ca and B on physiological disorders, fruit yield and quality of strawberry. Results indicated that pre-harvest foliar application of Ca, B or Ca+B influenced the occurrence of physiological disorders, incidence of grey mould, yield and quality of strawberry at harvest significantly. Fruits harvested from plants, which were sprayed either with Ca or Ca+ B had lesser incidence of albinism (6.7 and 6.5 %), and grey mould (1.3 and 1.2 %) significantly than those harvested from plants sprayed either B alone or in control. Although, B alone could not influence the incidence of albinism and grey mould, but it reduced fruit malformation (3.4 and 3.1 %) significantly, whereas application of Ca alone could not do so. Further, pre-harvest application either of Ca or B or Ca+B could not influence the individual berry weight, but marketable fruit yield differed significantly among the treatments (Table 38). The lowest marketable fruit yield (149.3 g/plant) was recorded in plants under control, and the highest (179.2 g/plant) in plants sprayed with Ca + B. Similarly, fruit receiving Ca or Ca +B had lower TSS, higher acidity and ascorbic acid content at the time of harvest. Further, after 5 days storage at 10 °C and 85 % RH, fruit receiving either Ca or Ca+B had lower TSS, higher ascorbic acid content and acidity. The studies clearly indicated that pre-harvest foliar application of Ca + B can be recommended for reducing the incidence of fruit malformation and higher productivity in strawberry.

Table 37: Effect of vermicompost doses on fruit weight, yield and ascorbic acid content of strawberry

Treatment	Fruit weight (g)	Total fruit yield (g/plant)	Marketable fruit yield (g/plant)	Ascorbic acid content (mg/100g pulp)
Inorganic nutrients	11.7	298.5	219.7	47.3
2.5 t VC	12.5	319.4	256.2	48.1
5.0 t VC	13.0	337.6	291.7	49.3
7.5 t VC	13.4	351.4	311.3	50.8
10.0 t VC	14.2	354.8	315.1	51.7

Table 38: Effect of foliar application of Ca and B on physiological disorders, grey mould and fruit yield of 'Chandler' strawberry fruits

Treatment	Albinism incidence (%)	Fruit malformation (%)	Grey mould (%)	Fruit weight (g)	Marketable fruit yield (g/plant)
Calcium spray	6.7	10.9	1.3	11.9	168.4
Boron spray	14.8	3.4	4.8	11.4	161.3
Ca+ B spray	6.5	3.1	1.2	11.7	179.2
Control	15.1	12.4	5.2	11.2	149.3

Development of vermin-drain

A novel process has been developed to drain the excreta and body wash of earthworms and collect in the bottom followed by treatment with the

microorganisms (N-fixing & PSB) for enrichment of the nutrient solution. The vermin-drain was also used to determine its effect on okra in a separate experiment. The vermin-drain is also used in the experiment in polyhouse in tomato. The vermiwash developed through this method was having following properties: pH-7.92; EC:0.25 ds/m, organic carbon:0.005%, Total N:0.01%, available P:1.65 % and K: 25ppm. The application of vermin-drain in okra showed that it increased okra fruit yield to the tune of 133.4%, which was equivalent to 100 kg N/ha. The experiment on large-scale production of vermin-drain is under progress.

Vermi-drain application as liquid fertilizer

Pot and field experiments were conducted to evaluate the effect of vermin-drain application on growth and green fruit yield of okra. Undiluted vermin-drain application was detrimental to germination of okra crop as evident from 0 % germination in the treatment. Dilution with the water enhanced the germination progressively from 62.5 to 100 % with increase in dilution from 1:1 to 1:9. The germination of seedlings in 1:9 dilution was equal to that of control treatment. The biomass production followed the same trend of germination, recording least values with 1:1 dilution. The fresh and dry biomass production increased significantly up to 1:3 and 1:9 dilution respectively, however, the highest biomass was recorded in the control.

Post germination application of vermin-drain and urea at seedling stage on 15th day after sowing revealed that plant height and biomass production was higher. The plant height and biomass production were least in vermin-drain as the plants had scorching effect on leaves, which might be due to higher concentration of nitrogen indicating that undiluted application of vermin-drain has toxic effect on plant growth.

The results of field experiment (Table 39) indicated that vermin-drain application along with irrigation water (T_3) significantly increased the plant height, number of branches and leaves/plant over 100 kg N (T_2) and the control. Higher plant height and number of branches and leaves have resulted in higher dry matter accumulation, which might be due to more accumulation of photsynthates.

Significantly higher yield attributes like fruit weight and number were also recorded in vermin-drain application along with irrigation water (T_3) which might be ascribed to profound influence on nitrogen and other nutrients.

Table 39: Effect of different treatments on growth and green fruit yield of okra in field

Treatments	Plant height (cm)	No. of branches	Leaves/plant	Stem thickness (mm)	Dry matter (g/plant)	Green fruit yield (t/ha)
T1	91.7	4.2	14.2	20.1	90.2	6.11
T2	142.2	6.2	20.5	22.4	161.7	9.92
T3	157.6	6.7	21.7	22.8	182.5	10.43

T_1: Control; T_2: 50 kg N (recommended dose); T_3: Vermi-drain applied along with irrigation water (1:100) on vegetative growth and yield attributes of the crop owing to increase in nutrient accumulation and their translocation towards the fruit yield. The green fruit yield was significantly more in vermin-drain application with irrigation water (T_3) over nitrogen application and the control, which could be attributed to higher number of fruits and fruit weight. The superior performance of okra in terms of higher green fruit yield with vermin-drain was attributed to its nutrient content. The results indicated the potential for recycling of vermin-drain as liquid fertilizer along with irrigation water and thus chemical inputs can be economized.

Location model for agro- processing plants in view of diversification of agriculture in Punjab.

D.K. Bharti, D. Dhingra, M.S. Meena and Ashwani Kumar

The study highlights some important facets of food and feed industry in Punjab viz their composition, employment and income generation and fixed investment per unit. A comparative study of these industries has been done. The growth performance of food and feed industries in last one decade has been

analysed with respect to number of units, employment, fixed investment and value of production. The required data for this study has been collected from the Directorate of Industries, Punjab, Chandigarh.

Present status

The food processing industries of Punjab mainly comprises of ice cream producing units, pickles, flour mills, rice mills, dal mills, bread, biscuits, cakes and pastry, confectionary products, oil and oil cakes, spices processing, aerated water, cattle feed and poultry feed. The food processing industries of the state are dominated by flour mills (3975) followed by rice mills (2305) and oil and oil cakes (552) as per the requirement of these commodities for human need. The pictorial representation of these industries in the state is presented in Fig 62.

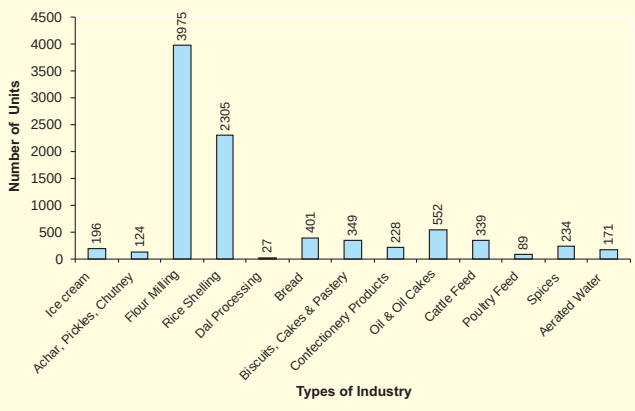


Fig 62: Composition of Food Processing Industries in Punjab (2004)

Employment generation per unit was highest by rice mill (16.7) followed by dal mill (9.5) and cattle feed (8.3) due to their more labour intensive work (Fig 63). Return on per rupee fixed investment is important in any business to attract entrepreneurs. Among the food and feed industries value of production per rupee investment is highest in poultry feed (8.25) followed by dal mills (6.60), flour mills (4.63) and rice mills (4.55). This may be attributed to their longer period of peak operation and demand in the market Fig 64.

Investment requirement per unit by these industries vary greatly due to their land and

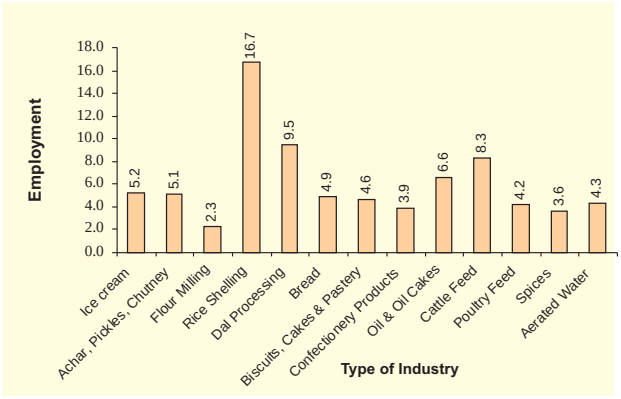


Fig 63: Employment /Unit (2004)

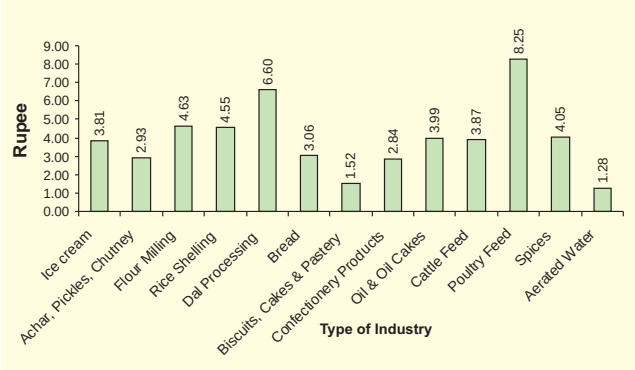


Fig 64:Value of Production / Rs. Fixed Investment (2004)

machinery requirements. Investment requirement per unit was highest in rice mills (Rs. 26.11 lakh) followed by cattle feed (Rs. 11.78 lakh) and dal mills (Rs 8.81 lakh) and is presented in Fig 65 Competition in these industries is increasing due to increasing demand of quality products.

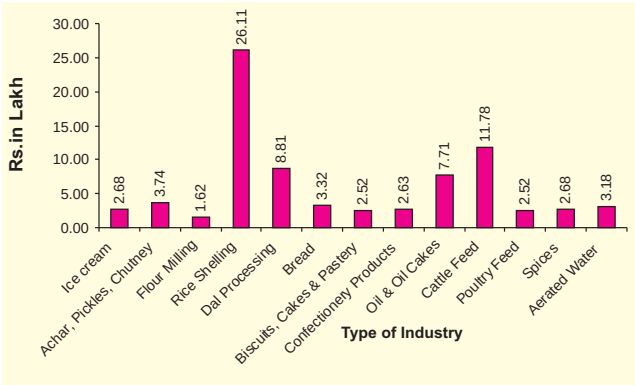


Fig 65 : Fixed Investment per Unit

Growth of food processing industry

Total number of food processing units has grown to 8990 in 2004 from 7246 in 1995, achieving a moderate 24 per cent growth in a decade (Fig 66). The total number of employment in these units has grown by 49 per cent during the same period from 42025 in 1995 to 62568 in 2004 (Fig 67). This may be attributed to increase in the scale of production capacity in these industries. In comparison to increase in number of units and employment the increase in total fixed investment has been tremendous with about 288 per cent growth in one decade. The total fixed investment jumped from Rs. 20065 lakh in1995 to Rs. 17959 lakh in 2004 (Fig 68). Total value of output in these industries also grew with the same accelerated pace with about 263 per cent growth during the above period. The total value of production was Rs. 100570 lakh in 1995 which touched Rs 364684 lakh in 2004 (Fig 69) This shows that increase in fixed investment has played important role in enhancing the total value of production during the above period.

The analysis of the performance of food processing industries highlights that the employment per unit in these industries has grown moderately from 5.80 person per unit in 1995 to 6.96 person per unit in 2004. Output per rupee of fixed investment during the same period has been negative. It was rupees 5.06 per rupee of fixed investment in 1995 decreased to rupees 4.63 per rupee of fixed investment in 2004. This may be because of rise in fixed investment due to increase in internal and export competition and demand of quality products in domestic and international markets. Fixed investment per unit has increased from rupees 2.90 lakh in 1995 to rupees 8.93 lakh in 2004 (Fig 70). Even then the output to the order of 4.63% can be considered higher compared to many non farm industries.

The performance of food processing industries in last one decade has been appreciable in terms of value of production but employment growth was very moderate during the period indicating advent

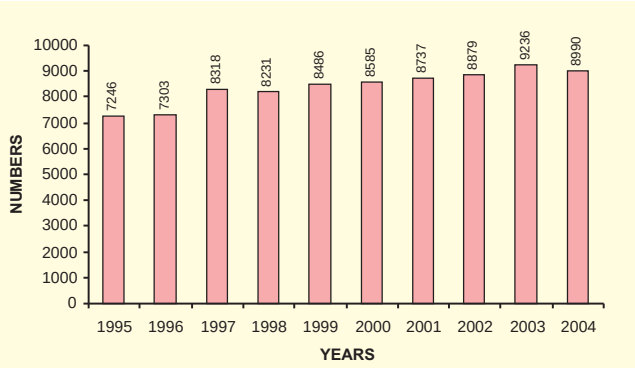


Fig 66: Growth in Number of Food Processing Units

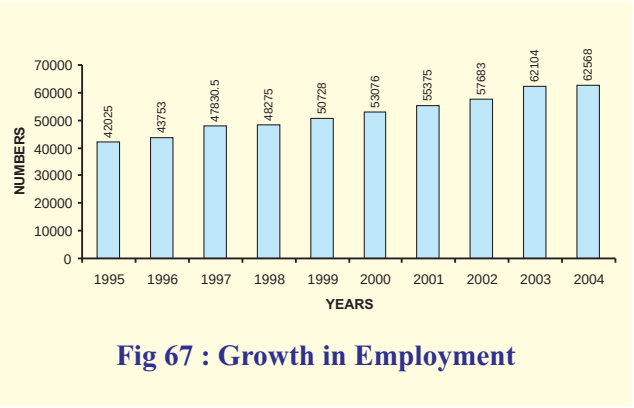


Fig 67 : Growth in Employment

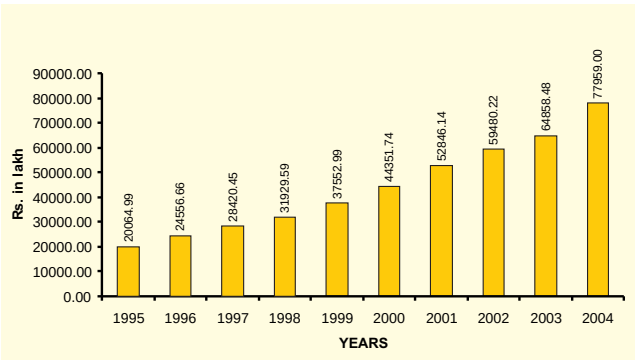


Fig 68 : Growth in Fixed Investment

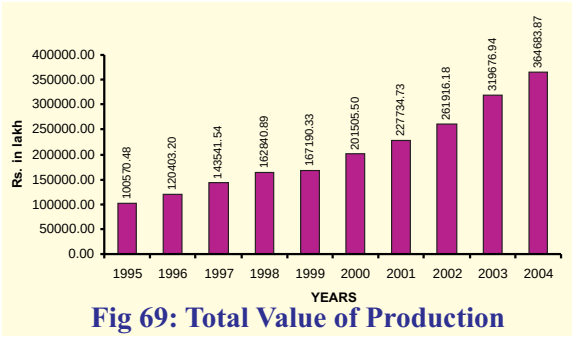


Fig 69: Total Value of Production

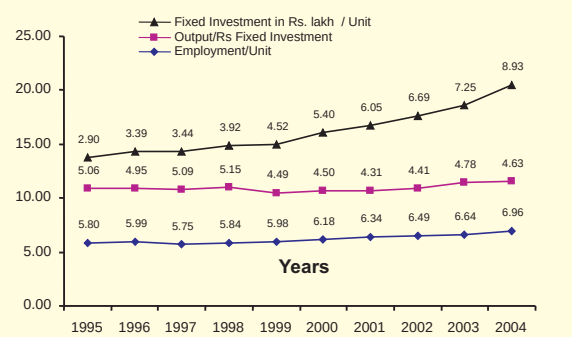


Fig 70: Performance in Food Processing Industries in Punjab

of modern machines requiring less labour. The return per rupee of fixed investment in last one decade has decreased and the fixed investment per unit has increased about three times in the above period.

Human resource development for post-harvest enterprises

M S Meena, D Dhingra, D K Bharti and M P Singh

The accessible population for this descriptive study was small rural agro-processors of Ferozepur district of Punjab state (India). The random sampling technique was applied to draw the samples. Data were solicited from eighty small agro processors by personal interview with the help of structured schedule during 2006. Likert-type-scales were developed for constraints assessment, perception towards techno-economic feasibility of post-harvest enterprises, awareness level about government schemes and importance of skill development.

All agro processors had rural background and most of them belonged to middle age category (28 to 43 years). Single operation unit (flour units or atta chakki) was prevalent. Processing was the main occupation followed by agriculture. Less than half of the respondents (46.25 %) were educated up to middle standard. Non-institutional credit system was adopted for the credit requirement. Television was considered main source of information followed by radio. They preferred learning by doing method as instructional method of training followed by field visit and videotape. Skill development was perceived important on all the areas namely post-harvest management, processing, interpersonal communication and dissemination of information. A significant and positive change was observed after skill development. Respondents perceived the constraints on *"Sometimes"* basis in adoption of post-harvest technologies on socio-economic, technological, farming, marketing and extension aspects. It was noticed that respondents were *"Slightly Aware"* about government schemes to boost the food processing sector. Perception towards techno-economic feasibility of post harvest enterprises was evaluated. A significant change was observed in perception of agro processors. Age of respondents revealed that a number of early adopters could be increased if much attention is paid to age group (28 to 43 years).

Determination of thermal diffusivity of fish during ice storage

Dilip Jain

Thermal diffusivities of Indian major carp *Catla* and *Rohu* fish were determined by using One-Dimensional Fourier equation applied to a cylinder. Time-temperature records were used to determine the thermal diffusivity. The value of thermal diffusivities of fish cooling with ice were ranged from $6.6012 - 3.2475 \times 10^{-8}$ $m^{-2} s^{-1}$ and $6.6481 - 5.4267 \times 10^{-8}$ $m^{-2} s^{-1}$ for *Catla* and *Rohu* fish respectively (Fig.71). It was observed that the thermal diffusivity decreases with increase in the weight of fish. A logarithmic model could adequately describe the relationship between thermal diffusivity ( ) and weight of fish (*m*). The logarithmic model for *Catla*

fish is = [8.143.exp(-4.073.m_f)+3.039]x10^{-8} m^{-2} s^{-1} with the coefficient of determination r^2 0.9949 and standard error e_s 0.088 and for *Rohu* fish = [3.623.exp(-5.04.m_f)+5.412]x10^{-8} m^{-2} s^{-1} with r^2 0.9996 and e_s 0.0006.

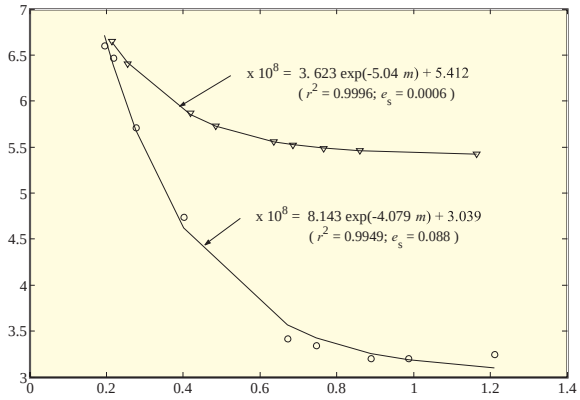


Fig 71 : Thermal diffusivity of freshwater fish, ○Catla fish; ▽Rohu fish

Determination of specific ice requirements for fish storage in ice

The specific ice requirement in a closed container (modified mobile cool chamber, Fig.72) for fish cooling and storage has been studied with the help of the thermal analysis outlined on the principle of steady state condition of temperature. Experimental validation has been done with the mobile cool chamber developed for storage of iced fish and short distance transportation. The specific ice requirement for cooling and storage of *rohu* fish was 1 kg[ice]/kg[fish] for first day and 0.77 kg[ice]/kg[fish] per day for consequent days of storage in the insulated chamber with filling ratio of 0.7. For the definite volume of chamber, the specific ice requirement increased with increase in mean ambient temperature and decreased with increase in filling ratio of cool chamber. The specific ice requirements for lowering the temperature of fish from 10, 20, 30 and 40 °C to 0 °C were 0.1074, 0.2148, 0.3223 and 0.4297 kg [ice]/kg[fish], respectively. Which can establish a thumb rule that for each 10 °C of fish temperature approximately 0.110 kg [ice] / kg [fish] is required to lower the temperature of 0 °C of fish.

It was observed that the specific ice requirement for fish cooling increase linearly with increase in mean ambient temperature. Which is obvious due to higher temperature results in more heat load and heat loss in surrounding. The dependency of specific requirement of ice ($_{ice}$) for fish on filling ratio ( ), mean ambient temperature (T_a) and duration of storage in days (d) is establish in multiple correlation as $_{ice}$ = 3.3166 + 0.1310 T_a + 0.7516 d - 17.1649 + 9.6977 ^{2}. The coefficient of correlation was 0.8924 and standard error, 1.3931.

Fig : 72 Mobile cool chamber for storage and transportation of iced fish

Fish texture during ice cooling and storage

The textural parameters of Indian major carp *Rohu* fish during iced storage have been studied during iced storage for the duration of eight days. Textural parameters, viz. skin hardness, toughness and stiffness has been evaluated on a texture analyzer for the different day of iced fish. The abruptly reduction in skin hardness (bio-yield point) and toughness was observed after fifth day of storage. The skin hardness ranged between 86.911 and 95.656 N within five days of storage and thereafter reduced within the range from 48.714 to 65.920 N. The stiffness ranged between 3.1474 4.6340 N mm^{-1} and toughness, 588.9 713.2 N mm for five days. After five days of storage, the stiffness and toughness reduced in the range of 2.0030 2.8111 N mm^{-1} and 415.0 526.3 N mm respectively.

The visco-elastic behavior of fish, the force-time relationship has been described with the modified Maxwell model $F_t = C_0 + C.\exp(t/T_{rel})$ (Fig. 73). Where F_t is the force at any time t, C_0 is the force at equilibrium, C is decay force and $T_{rel,}$ is relaxation time.

The results of skin hardness curve were fitted to modified Maxwell model. The modified Maxwell model could satisfactorily described relationship between skin hardness and compression time for iced fish The coefficient of modified Maxwell model as the function of time of storage (days)are $-C_0$ =173.8exp(-0.884d)+5.311exp(0.182d), C =163.9exp(-0.8773 d)+4.951exp(0.1759d) and T_{Rel} = 39.83exp(-0.5868d)+ 4.714exp(0.1683d).

During this storage period the pH of fish flesh was also determined. The pH increased from 6.10 to 6.90 during the period of storage. Exponential regression presents the relationship between fish flesh stiffness F_s and pH as F_s = 4603 exp(-1.129 pH) with coefficient of determination 0.9695 and standard error 0.167.

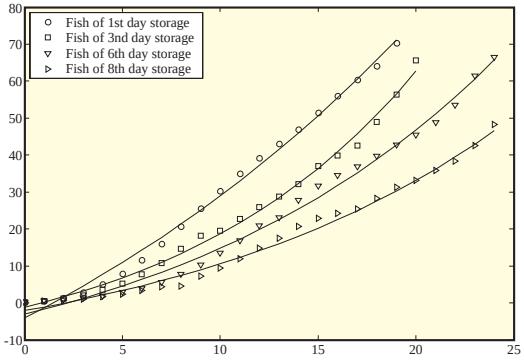


Fig. 73 : Visco-elastic behaviour of fish

AICRP ON POST HARVEST TECHNOLOGY

RESEARCH ACHIEVEMENTS

Development of suitable packaging technology for solid, granular and liquid jaggery

A vacuum packaging machine was procured by the Anakpalle (ANGRAU) centre. Experiments were initiated with double layer packing material for vacuum packaging studies with jaggery cubes of different sizes viz. 125 g, 250 g and jaggery powder at different moisture levels (5-6, 6-7 & 7-8 % for cubes and 1.5, 2.0 & 2.5 % for powder) and similarly normal packaging studies were taken up with mono and double layer packing material. Liquid jaggery was also taken up for studies with similar packing materials under normal packaging studies with different total solid levels (total solids 60, 65 & 70 %).

Development of a high capacity chilli dryer

The chilli dryer was tested using ripe chillies by the Bapatla (ANGRAU) Centre. Design improvements/ modification of plenum chamber was required to overcome the non-uniform distribution of hot air in the dryer. Two options have been considered to supply the uniform air flow through the trays. Recirculation of hot air is also being incorporated. Required modifications to improve hot air distribution in the plenum will be incorporated by the manufacturer M/s. Mathesis Engineers Pvt. Ltd., Hyderabad. Complete instrumentation system to control fuel burning has been planned to economize the use of gas or diesel.

Development of cashewnut grader and cashewnut sheller

The cashewnut grader and cashewnut sheller were fabricated by the Bapatla (ANGRAU) centre. Preliminary trials were conducted at M/s. Farm Steel Products Pvt. Ltd., Industrial Estate, Vijayawada and at M/s. Bharat Cashew Mfg. Co., Vetapalem to evaluate the performance of the cashew nut sheller. It was found that certain modifications are to be made for increasing the efficiency. The conveying and elevating equipment were also fabricated for attachment to the grader and to the sheller for semi mechanization along with the attachment of the blower for separation of cashew nut shells from the cashew nut kernels during shelling operation.

Performance evaluation and improvement of walk-in type polyhouse solar dryer for chilies

Bapatla (ANGRAU) centre has developed a polyhouse solar dryer of size 7.5 x 4 x 3 m in financial collaboration with ITC-ILTD, Guntur to dry about 10 quintals of ripe chillies. The dryer essentially consist of an arch type poly house to hold chilies on two different tiers made of G.I. wire fixed to a frame assembled by nuts and bolts. The whole frame structure is covered with a UV stabilized 150 gsm cross laminated semi transparent polyethylene sheet with ventilators at bottom and top to facilitate movement of air. The drying time was 5 to 8 days to reduce moisture from 75 % to 10 % (wb) in comparison with 15 to 20 days required to dry chilies in traditional open yard sun drying. The drying time was reduced by 30-60 %, with added advantage of high retention of colour, quality, value addition to the produce as there is no scope for dust, dirt and contaminants with the drying carried in the closed chamber. Based on the success of this unit, the Government of Andhra Pradesh has announced subsidy to promote 16 (sixteen) units in Guntur and Prakasam districts.

Standardisation of slaughter and dressing techniques for cattle, sheep, pigs and poultry

Altogether 21 pigs, one buffalo, two sheep, eight goats and 102 turkeys were slaughtered and dressing was carried out by the Chennai (TANVASU) centre during the period under report. The carcass yield, yield of edible as well as inedible offals and post-harvest losses were recorded for these slaughtered animals in the proforma designed for the purpose. The data on time, labour and water requirement for

hygienic slaughter of pigs and turkeys were also recorded.

Effect of pre-slaughter rest and fasting on the carcass yield in cattle, sheep, pigs and poultry

Effect of pre-slaughter rest and fasting on the live weight and the carcass yield including various edible and inedible offals were analysed by the Chennai (TANVASU) centre for buffaloes, pigs, sheep, goats and turkeys. Altogether one buffalo, 25 pigs, 2 sheep, 8 goats and 25 turkeys were provided pre-slaughter rest for 24 hours. Effect of pre-slaughter rest and fasting on the live weight and the carcass yield, including yield of various edible and inedible offals of the animals was calculated. Also during the period under report, altogether one buffalo, 8 pigs, 2 sheep, 8 goats and 20 turkeys were slaughtered immediately and their carcass yield, including various edible and inedible offals was calculated. The pH, ERV, WHC and microbial load were analyzed for the meat after 24 hours of chilling.

Effect of stunning methods on the quality of beef, mutton, pork and chicken

Effect of type of stunning on the bleeding efficiency of buffaloes and pigs was studied during the period under report by the Chennai (TANVASU) centre. Seven pigs and 5 buffaloes were stunned with capacity bolt pistol. Electrical stunning was adopted to stun 9 pigs prior to slaughter. Three pigs were also slaughtered without prior stunning. The bleeding time and the bleeding efficiency in terms of yield of blood for the pigs were recorded for comparison. The bleeding time and the bleeding efficiency in terms of yield of blood for all the pigs and buffaloes were recorded. The data on meat quality characteristics such as pH, acid malachite green test and microbial load was also recorded.

Assessment of post harvest losses in cattle, sheep, pigs poultry carcasses during chilling and freezing

The post harvest losses of buffaloes, pigs and turkeys were assessed and recorded during storage at chiller (2-4 ^{0}C) and freezer (-18 to 20 ^{0}C) temperatures by the Chennai (TANVASU) centre. During the period under report, the post-harvest losses for one buffalo, 12 pigs 5 goats and 62 turkey carcasses were assessed during storage at chiller and freezer temperatures. The data on meat quality characteristics such as weight loss, pH, and microbial load (total viable count and psychrophilic count) were recorded.

Development of a continuous type mechanical dehusker for coconut

Capacity of the cylinder and concave type coconut dehusker was found to be about 600 nuts per hour in comparison to 120-150 nuts per hour by the pneumatically operated coconut dehusker. The breakage of the coconut was 1.5 % and the dehusking efficiency was 90%. Cost of operation is Rs. 250 per 1000 nuts compared to Rs. 300 in the conventional method. One unit of a continuous type mechanical dehusker for coconut was installed by the Coimbatore (TNAU) Centre at ARS, Bhavanisagar for intensive evaluation with coconuts available at the farm.

Optimization of process parameters in canning of milky mushroom (*Calocyba indica*)

Mushrooms canned for the private entrepreneur M/s Blue Hills Agrotech., Coimbatore in 3% saline were found by Coimbatore (TNAU) Centre to retain the nutritional qualities up to 8 months of storage period. Release proposal for Management of Technology on canning of milky mushroom has been prepared and submitted to Director of Research, TNAU, Coimbatore.

Adoption of improved turmeric boiler for boiling arecanut

With the start of the arecanut boiling season, the arecanut boiler which was fabricated by Coimbatore (TNAU) centre as per the need of the farmers, was evaluated for its performance in the field of a farmer in Thondamuthur of Coimbatore. Boiling with the improved arecanut boiler was taken up at two processing units. The results were encouraging in

terms of less time and less fuel. The quality of the boiled arecanut in terms of the puncture resistance was assessed and the force required varied from 7.8 to 54 N. Change in the colour was significant in the improved method (using steam) as compared to the traditional method. The textural character, crushing strength for the boiled arecanut kernel was found to range from 287 to 800 N and 171 to 787 N, along the axial and longitudinal directions respectively. The weight reduction after boiling was found to be 4 % in the steam boiling process as compared to 7.5 % in the traditional method of boiling.

Developing technologies for processing and preservation of drumstick (*Moringa oleifera*)

Drumstick pieces processed and preserved at Coimbatore (TNAU) centre by curing process (10 % saline alone ands in combination with 1 % acetic acid) and by canning process (in 1, 2, 3 % saline and tomato pulp from local and hybrid variety tomatoes) were found to be good, without any fungal attack even after one year of storage. Experiments were conducted to analyze the microbial load of the canned products, to assess their suitability for consumption. R1 and R2 bacteria population ranged from 2 to 3 x 10^6 cuf/g for brine, 1 x 10^6 cuf/g for tomato pulp and 3 to 8 x 10^6 cuf/g for gravy with masala. In all the samples tested, fungi growth was not observed.

Further, drumstick was separated by steam blanching and gravy was prepared with onion and tomato, masala powder (3 different combinations as available commercially) and other spices used for cooking. Ready to use gravy was added with sodium benzoate @ 250 ppm as preservative and packed in polyethylene pouches. The sealed pouches were pasteurized at 80 - 90 ^{o}C for 5 minutes and stored at room temperature. Experiment was conducted to analyze the microbial load in the stored samples.

Green house tunnel drying of chilies

The drying of chilies in green house tunnel dryer was repeated to confirm the results and also for storage studies by Coimbatore (TNAU) centre. On first day the moisture removal was 10 to 16 % at 30 ^{O}C atmospheric temperature. During the second day at 25 ^{O}C the percentage moisture removal was 10 to 30 % in different trays. The subsequent percentage moisture removals were 13 - 27, 25 45 and 48 - 53 % during 3rd, 4th and 5th days respectively. In all the days the increase in temperature inside the green house was found to be 3 to 6 ^{0}C. The RH inside and outside the green house were 53 and 57 % respectively. The collector efficiency ranged from 39.68 to 61.97 % with the average collector efficiency being 50.56 %. The maximum overall efficiency of 32.16 % was obtained at 15.00 hours and the minimum value of 24.21 % was at 10.00 hours of a day. The average overall efficiency was 28.02 %. The well-dried product was kept under storage study. The colour value of chilli samples dried in tunnel dryer was better with more pungency. Oleoresin content was found to be higher (6.5 %) with respect to other drying methods. The capsaicin content was 0.56 % in solar tunnel dryer followed by 0.1 and 0.22 % in mechanical and sun drying.

Engineering properties (viz. size, bulk density, porosity, angle of repose and coefficient of friction) of pepper were studied. The diameter varied from 4.14 to 5.84 mm for fresh pepper and from 3.14 to 3.78 mm for dried pepper. The bulk density of fresh pepper was 138.47 kg/m^3, which later on decreased to 94.44 kg/m^3 after drying. The porosity of pepper upon drying increased from 13.49 to 16.23 % with decrease in moisture content. The angle of repose was 41.43 ^{O} and 37.62 ^{O} for fresh and dried pepper respectively. Coefficient of friction was high (1.74) on hard board surface and was least (1.48) on aluminum surface. Fresh green pepper separated from the spikes was spread uniformly in trays as single layer as well as 1 and 2 cm bed depths. The pepper dried from initial moisture content of 233.33 to 10 % (db) in 22, 30 and 36 hours for single layer, 1 cm and 2 cm bed depths respectively. The decrease in moisture ratio and drying rate were recorded and drying rate was determined.

Development of a cashewnut sheller

Fabrication of the experimental model of a cashewnut sheller has been completed by the Kharagpur (IIT) centre. Operational trials were conducted with the new centrifugal type cashew nut sheller developed to facilitate the shelling operation at much reduced impeller speed and minimizing the machine vibration associated with high speed operation. The machine is driven by a 2-h.p. variable speed dc motor. Different treatments to cashew nut have been tried to facilitate shelling at as low impeller speed as possible.

Development of technology for enhancing shelf life of betel leaves

Kharagpur (IIT) centre compiled the data collected during different trials on storage of betel leaves for designing a storage structure to enhance the shelf-life betel leaves based on the experimental findings. Observations on chlorophyII contents were recorded at regular interval. The centre has undertaken a consultancy on Long distance marketing of Preserved betel leaves (Client: Private party, viz. Nonakuri Bazar, Tamluk, East Midnapore). An entrepreneur, viz. M/s Haldia Logistics Pvt Ltd, Kolkata, has come forward to adopt the technology for enhancing shelf life of fresh betel leaves by scientific storage and packing for transportation.

Production of Spirulina powder and extraction of nutraceuticals

BG-11 medium for Blue-Green algae was prepared and inoculated with *Spirulina platensis* culture that was already maintained in the laboratory by Kharagpur (IIT) centre. Light was provided in the form of white fluorescent lamp in the cultivation chamber, with 15 hours dark and 9 hours light periods. The culture was grown at room temperature. Mixing of the culture was done manually by rotating the culture flask 3 to 4 times daily. BG-11 media with different pH (viz. 8.0, 8.5, 9.0 and 9.5) were used in order to optimize the pH for the growth of Spirulina plantensis in BG-11 medium. The result obtained form this experiment are to be compared with the results of previous experiments to find out the best growth condition in terms of pH for maximum yield of *Spilulina platensis* with regard to its biomass and nutrient composition. Review of literature for different method of drying of Spirulina biomass, viz. spray drying, hot air drying, sun drying etc., is in progress. Experiments on different drying methods (re-circulatory air drying, sun drying and freeze drying) of Spirulina biomass and its effects on nutrient composition are going on. Analysis of nutrient composition for Spirulina powder, already prepared by freeze method, is being done.

Management of safe storage of pulses

A study conducted by Kharagpur (IIT) centre on the effect of different concentration of Malathion against insect pests of stored pulses showed that with 1 % concentration the insect mortality ranged from 15 to 20%. At 2 % concentration the insect mortality ranged from 28 to 35 % respectively. Insect pests observed in stored grain seeds included *Callosobruchus chinensis, Callosobruchus maculates* and *Callosobruchus analis*. Effect of different concentrations (viz. 0.5, 1.0, 1.5 and 2.0 %) of Bio Pesticides, viz. Bioneem and Bio-2001 against insect pests of pulses was studied at Jhargram. It was observed that with 2.0 % concentration of Bioneem, insect mortality ranged from 26.0 to 30.0 %. Better results were observed in case of Bio2001, effecting an insect mortality ranging from 42 to 48 % with 2 % concentration.

Management of safe storage of spices in humid hot region of West Bengal

Effect of different concentrations of Biopesticides viz. Bioneem and Bio-2001 were carried out by Kharagpur (IIT) centre in godown against insect pests of coriander, viz. (1) *Araecerus fasciculatus* (2) *Teneboides mauritanicus* (3) *Lasioderma serricorn* and (4)*Tragoderma granarium*. It was observed that with 2 % concentration of Bioneem, insect mortality was 12 % in *Araecerces fasciculatus*, 16 % in *Tenebiodes*

mauritanicnus, 22 % in *Lasioderma serricorn* and 24 % in *Trogoderma granarium* respectively after 4th day of treatment. Treatment with 2 % concentration of Bioneem showed residues of active ingredient (Azaderectin) which ranged from 0.0006 to 0.0009 ppm in coriander seed

Effect of different doses of Aluminium phosphide against insect pests of stored coriander was also studied. It was observed that by treatment with aluminium phosphide at the rate of 2 g/t the insect mortality ranged from 30 to 45 %. At the rate of 8 g/t insect mortality ranged from 98 to 100 % after 4 days of treatment in airtight condition.

Development of hand operated aonla pricking machine

HAU (Hisar) centre has developed a hand operated aonla pricking machine. The capacity of the machine is about 15 to 20 kg/hour and the approximate cost of the machine is Rs 2000/-. Further evaluation is in progress. The prototype has a potential of commercialization in the aonla growing areas.

Post harvest management of apples (Pantnagar)

Sensory evaluation of dried apple pomace powder and statistical analysis of data is being made by Pantnagar (GBPUA&T) centre. To get a better combination of better mixographic properties, more combinations of pomace and flour to get proper ratio is under progress for utilization of apple pomace for food purposes. The biscuits prepared within the range obtained from the numerical optimization had sensory scores ranging from 7.5-8.57. Hardness, fracturability and overall acceptability value were also within the desired range set as constraints. Production of alcohol/acid was attempted using fermented apple pomace. Estimation of alcohol was done through GC method for samples from inoculated and natural fermentation experiments. The results are being compared with those obtained through chemical method.

Studies on post harvest management of milk

An exhaustive survey was conducted by Pantnagar (GBPUA&T) centre in Bageshwar and Dehradun districts of Uttaranchal to obtain data covering various milk societies of the district. The data was collected from Union, farmers and secretaries of societies on personal interview basis. The milk production per society ranged from 2 liters to 150 liters in Bageswar district and from 15 liters to 300 liters in Dehradun district in accordance with the seasonal variation. Collection and analysis of data are under process.

Development of gur and khandsari based value added products and energy foods

In order to improve the quality of jaggery chocolate in respect of taste and texture, some additional ingredients were tried at Pantnagar (GBPUA&T) centre. Use of coffee was found effective to subside the smell of jaggery in the chocolate. Texture of the chocolate was improved by using *kakavi* in place of matured fresh jaggery. A chocolate die of improved shape and size has been fabricated and attractive wrapper for the proper packaging of product has also got printed. Five samples of jaggery chocolate, using kakavi, whole milk powder, coco-powder, butter and coffee as ingredients, were prepared, packed in aluminium foil and stored in a airtight container during whole rainy season. The container was opened in the month of September and it was found that the samples could retain their quality and taste well.

Storage of jaggery in cold hilly climate

On the demand of the farmers/traders of hilly region an improved four component gur storage bins were developed and evaluated at Pantnagar (GBPUA&T) centre. Bins have been fabricated for the use of farmers/ traders of cold hilly region.

Utilization of apricot (*Prunus armeniaca*) for dehydration, kernel oil extraction and preparation of value added products

Solan (YSPUH&F) centre evaluated 3 types of oil extraction methods, viz; oil press (portable power ghani), baby oil expeller (4 bolts) and table oil expeller. The commercial oil yield through table oil

expeller was recorded as (37.5-39.0 %) against a yield of 31.5-32.5 % obtained through baby oil expeller and only 28.5 to 30.5 per cent through oil press (portable power ghani). Thus, the use of table oil expeller was optimized for extraction of oil from apricot kernels. A new product from apricot oil, viz. facial cream, has been developed. The cream being rich in linoleic acid was found most suitable for dry skin in checking loss of moisture.

Development of technology for garlic

The garlic peeling machines (batch and continuous type) were evaluated by Udaipur (MPUAT) centre. The capacity of batch type machine was recorded as 30 kg/h with 96-98 % efficiency, while the continuous type machine had 8-10 kg/h capacity with 70% efficiency. Garlic peeler is presented in Fig 74.

Fig 74 : Garlic Peeler developed by Udaipur Centre

Operational Research Project on Agro Processing Centres

Procurement of equipments for setting up an Agro Processing Centre (APC) in a nearby village, namely 'Magulia' is in progress by the Kharagpur centre. Arrangements have been made for installation of a motorized grain puffing machine at the Agro Processing Centre named "Grami Agro (Pvt) Ltd." located at Jhargram. The machine will be used as a demonstration unit of showing the puffing of rice as well as other grains to the interested entrepreneurs. This APC is already producing muri-rice using pressure parboiling and the same rice is to be used for making muri with the demonstration unit.

A site for establishment of Agro-processing centre was finalized and the M.O.U. signed between Professor N.G. Ranga Krishi Vigyan Kendra, (NGO), Vinayashram, Guntur (A.P.) and Post Harvest Technology Centre, Bapatla on behalf of the Acharya N.G. Ranga Agricultural University, Hyderabad. The proposed post-harvest equipment at Agro-Processing Centre are mini modern rice mill, mini dhal mil, flour mill and spice grinding machine. A mini modern rice mill, mini dhal mill were installed at Professor N. G. Ranga KVK Vinayasharam. The APC was inaugurated on 12-09-06 (Fig 75).

Fig 75 : Inauguration of new Agro-Processing Centre at Acharya N.G. Ranga Agricultural University, KVK, Vinayashram established by Bapatla centre of AICRP on PHT

At Uadaipur centre with the liaison of Forest Department, DIC and NGOs/SHG, the new APC at village Ghanli (Mavli) is being promoted. Activities and progress of existing APCs are being monitored by the respective centres.

Assessment of Post Harvest Losses

Assessment of the Post Harvest Losses of about 48 major crops and commodities in 120 districts of India (14 agro-climatic) zones is in progress through data collection by enquiry as well as by actual observation by all the 33 centres under AICRP on PHT. From every district 2 Blocks, 5 villages from each Block and 10 farmers from each village have been randomly selected as sample population for collection of data by enquiry. Post harvest losses of the crops/commodities have been collected by observation with regard to 2 sample population at farm level harvesting and post harvest operations as well as during storage at farm/ trader/ godown/ processing unit level.

A software was developed for AICRP on PHT by IASRI, New Delhi for entry and compilation of data collected through enquiry and also for that through observation systematically in a computerized form for further analysis. Based on its preliminary evaluation conducted at PC Unit, further modification / improvement by IASRI have been carried out. The software was demonstrated and distributed on 09-12-06 for use to the REs at the 26th Workshop of AICRP on PHT at Bhubaneswar. Collection of data by enquiry and by observation was in progress at the centres which was completed / terminated after the end of February 2007. Data entry in the software provided by IASRI is in progress at all the centres under AICRP on PHT.

26th WORKSHOP OF AICRP ON PHT

The 26th Workshop of AICRP on PHT was held at OUAT, Bhubaneswar during December 6-9, 2006. The inaugural session (Fig 76) was chaired by Dr. Nawab Ali, DDG (Engg.), ICAR, New Delhi with Dr. B. Senapati, Vice-Chancellor, OUAT, Bhubaneswar as the Co-chairman. Dr. Srijukta Surendranath Naik, Hon'ble Agriculture Minister, Govt. of Orissa graced as the Chief Guest while Dr. S.M. Ilyas, Vice-Chancellor, NDUA&T, Faizabad was the Guest of Honour.

Fig 76 : Lighting of lamp at inauguration of 26th Workshop of AICRP on PHT

Technical Session - I on Sensitization on Food Processing under Indo-US Knowledge Initiative in Agriculture and also the Technical Session-II on Presentation of Agro-Processing Centre (APC) activities by the Centres were held on the first day. During 7th and 8th December, the Research Engineers presented the progress reports of their respective centres in the Technical Session - III. During Technical Session - IV on Presentation of progress in Assessment of Post Harvest Losses was made by the Centres, followed by the Technical Session - V on Commercialization of Technologies/Success Stories and the Business Session. On the last day, two concurrent sessions were conducted, viz. Technical Session - VII on progress report of the A. P. Cess funded ad-hoc Projects and Training Session on post harvest loss data entry software. The Plenary Session was conducted on 9th December 2006.

CCM OF AICRP ON PHT

The Coordination Committee Meeting of All India Coordinated Research Project on Post Harvest Technology was organized during February 26 to 28, 2007 at CIPHET, Ludhiana. The meeting was co-hosted by Punjab Agricultural University, Ludhiana centre. Dr. Pitam Chandra, ADG (PE) ICAR, New Delhi chaired the meeting and Dr. R.T. Patil, Director CIPHET was co-chairman. Dr. S.K. Nanda, Project Coordinator (PHT) coordinated the meeting.

Research engineers and scientists from 32 centres and one sub-centre of AICRP on PHT from all over the country participated in the meeting. The centre at Jodhpur (CAZRI) was not represented in this meeting. The research engineers of the respective centres presented the technical programme for 2007-08. The research programmes and budget requirement in the forth coming eleventh plan were discussed for each centre.

COMPLETED ADHOC PROJECTS

Thermal modeling of jaggery/gur drying under natural and forced air convection a solar approach based on heat and mass transfer

Mass transfer during heating and boiling the sugarcane juice to prepare jaggery was studied at IIT, Delhi. and the convective mass transfer coefficient for convection heating of juice was determined. Sun drying and poly-house drying behaviour of jaggery was studied under natural and forced convection over a drying period of 3 days and the convective mass transfer coefficient was determined (1.29 W/m^2 K to 1.41 W/m^2 K in natural convection and 1.30 to 1.46 W/m^2 K in forced convection). Time and temperature dependent exponential model was used to predict convective and evaporative heat transfer coefficients.

Studies on effect of thermohygrometric condition on quality of fermented sausages developed from buffalo meat

Experimental studies were conducted at AMU, Aligarh on the effect of edible offal (heart, kidney and liver) incorporation on quality and shelf-life of semi dry fermented sausage (SDFS) of buffalo meat. The cost of edible byproducts was estimated as 33% of the cost of lean meat. Incorporation of edible byproducts increased the nutritive value of the product. The product developed was microbiologically safe under refrigerated conditions (4 ^{0}C) up to 60 days. Sensory evaluation on the basis of sensory attributes (viz. colour, flavour, texture, taste, mouth feel and juiciness) suggested that products remained acceptable. The edible byproducts/ offal incorporation in SDFS is recommended for economic reason and also for improving in nutritional quality of the products.

Modified flush door shutter solid core type for special use as toilet door and commercial door having higher protection using jute skin as face, jute stick/wood particle board as filler

Jute stick particle boards using phenol formaldehyde (PF), urea-phenol formaldehyde (UPF), and melamine formaldehyde (MF) resins were prepared in the laboratory of NIRJAFT, Kolkata and evaluated. The particle boards developed passed the boiling water test and also exhibited good mechanical properties. Results indicate that PF resin has good interaction properties with jute due to its higher (2-4 times) and quicker (3-4 times) absorbency than MF and UPF resins.

Development of snack foods based on extrusion of dewatered potato meal

A simplified process for production of potato flour based on mechanical dewatering of potato meal has been developed at G. B. Pant University of Agriculture & Technology, Pantnagar. The process is expected to require 75 % less energy compared to the conventional method of drying. The optimum conditions for making extruded snacks based on dewatered potato meal are given as - feed moisture content 16% (d.b.), die temperature 180^{0}C, screw speed 130 rpm, and feed rate 4 kg/h of dry mass. The dewatered and extruded potato flour can be used in various product formulations like cutlets, *tikki, stuffed paratha, sev, gulab jamun*. etc and can be used as a substitute for potato flour for production of extruded snacks. Extruded potato flour can also be used as thickener in different recipes like soup and vegetable curries.

Utilization of annually renewable kenaf/ mesta fibres for making reinforced polypropylene composites for industrial applications

PP/mesta fibre compound was prepared by Shriram Institute for Industrial Research, Delhi using grafting of maleic anhydride (MAH) on

polypropylene (PP) by melt mixing technique. Pre-weighed amount of PP was melt mixed with MAH in presence of dicumyl peroxide (DCP) initiator, lubricant and antioxidant at 180 ^{0}C for 5 minutes at constant rotor speed of 60 rpm in a rheocord. The chopped mesta fibre were then added alongwith antioxidant for their melt mixing. The un-reacted MAH was removed by soxhlet extraction using water as solvent. For preparing PP/ mesta fibre comosite sheet, the fibre compound was shredded into small pieces and kept in oven for drying at 100$\pm$5^{0}C for four hours. The sheets were prepared at molding machine at 200$\pm$5^{0}C and maximum load of 20 T compression. The optimum conditions for grafting of MAH onto PP are MAH content: 0.7-0.8 phr, DCP: 0.1 phr at temperature of 180 ^{0}C. 1 % NaOH treated fibre was found better for preparing composite. 10 phr of MAH-PP compatibiliser was found optimum to achieve best physico-mechanical properties. Fibre loading of 40 phr was optimized for making composite. The performance of mesta fibre-PP composites vis-à-vis glass fibre-PP composites was found comparable with respect to various physico-mechanical properties including tensile, flexural, and impact strength, water absorption, specific gravity and hardness value.

AICRP ON APPLICATION OF PLASTICS IN AGRICULTURE

RESEARCH ACHIEVEMENTS

- Plastic low tunnel technology has been successfully adopted by a progressive farmer Mr. Sanjeev Ahuja of Village Khuban Tehsil Abohar (Dist. Ferozepur) with technical support from AICRP team. He had grown summer squash in plastic low tunnel in one acre area and protected it from damage due to hailstorm and earned about Rs 40,000/acre.

- Bamboo frame greenhouses were evaluated in two villages namely - Dhaspad and Palauali in Almora district, located in mid-hills of NW Himalayas (altitude 1800 m). The sizes of the greenhouse were between 40 to 80 m^2 based on the land and water availability in the vicinity. The ventilation by means of doors and windows along with shade nets (75 %) was provided to control the temperature and humidity. The shape of the greenhouse was kept as even span with length:width ratio greater than 2.2. Orientation of the greenhouse was east west in order to receive the maximum sunlight during winter. The farmer contributed in procurement and erection of frames using bamboo poles (75, 63 and 50 mm), labour and other fixing material. The UV stabilized film (200 micron and 200 gsm) was provided by the project. The crop sequence of vegetable pea (December-March; season I) - summer squash (March-June; season II), Tomato (July November; season III) was selected. The yield was increased by 35.1%, 57.0% and 96.4% in the greenhouse respectively in the case of Vegetable pea, Summer squash and Tomato. The B-C ratio varied between 1.67 and 2.2 for different greenhouses.

- Strawberry was found to be grown successfully in the Kashmir valley, but its production in April coincides with other temperate fruits, which leads to less remuneration. Study have been undertaken to investigate the possibility of off-season cultivation of the strawberry under greenhouse condition for better profit to the growers as compared to open field condition where usually heavy snowfall occurs. The runners of strawberry (cv. *Canfutra*) were transplanted on 15th October 2005 and the first fruit under polyhouse was harvested on 17th March, about 45 days early than in open field (2nd May 2006). The peak harvesting started under polyhouse from 27th March while open field gave peek harvesting on 4th of May. The black mulch was superior over the hay mulch in term of earliness and yield. The first harvesting of the ripened fruits in black plastic mulch started 2 and 16 days before the hay-mulch in polyhouse and open field, respectively. Average yield per plant inside the polyhouse was about 2.5 times than obtained in open field.

- A study on variations in uniformity coefficient, discharge and area covered by sprinkler irrigation system on hill slope was conducted. The discharge and area covered by each sprinklers was reduced significantly with increase in height of the sprinklers with respect to source. Such information is very useful and needs to be taken care while designing the irrigation system on hilly slopes. However, water application uniformity did not vary among the sprinklers, which indicates the system was working well without much head loss within the system. The irrigation covered five terraces. The initial soil moisture content of the first, third and fifth terraces were found to be 28.60, 28.37, and 27.04 %, respectively. After application of irrigation the moisture content of these terraces rose to 34.13, 33.75 and 31.92 % registering an increase by 5.53, 5.38 and 4.88 % respectively, over the initial values.

- Gravity fed micro sprinkler irrigation system

was installed on six plots (7.5 × 2m) in Hawalbagh (Almora) and connected to a LDPE film lined tank (capacity 42 m^3) by low discharge natural spring With the 2.5 m gravity head available, an average discharge of 17 lph for single micro-sprinkler was obtained with coefficient of variation of 35% and radius of throw was only 50 cm with 20% overlap against desired 50%.

- Experimentation was conducted to find out optimal length of micro tube for gravity fed micro tube irrigation system. The set up was laid over 200 m^2 plot with 7 laterals with length ranging from 12.3 m to 27.0 m. The gravity head of 10.4 m at the first lateral was available. Observation on discharge was made at four different points each point at equal distance on lateral, with five lengths of micro tube (50, 75, 100, 150, and 180 cm) The average discharge from one micro tube was 3.20 lph, which varied between 1.45 to 5.95 lph.
- Study was conducted to monitor the effect of fertigation on yield and quality of capsicum and cauliflower. Cauliflower (var. Pusa Snow Ball K-1) and capsicum (var. Heera) were transplanted on 8 September 2005, 6 January 2006, and harvested on Nov 18, 2005 and July 8, 2006, respectively. The data pertaining to yield attributing characters and curd yield as affected by different doses of nutrients. With increase in fertilizer dose from 50 per cent of recommended dose to 150 per cent of recommended dose, the yield of cauliflower increased steadily from 300.4 q/ha to 496.4q/ha. Similarly, the highest yield of capsicum was observed in treatment having 150 per cent of recommended dose (464.3 q/ ha).
- A portable design of FRP carp hatchery was developed under at the Bhubaneshwar Centre has been commercialised and installed at more than 15 locations including research organisations, NGOS, Government Departments, and farmer's field.
- In order to reduce the seepage loss from the fishponds and increase water temperature during winters, a polyhouse covered LDPE lined pond was studies at Bhubaneshwar. Polyhouse plastic-lined pond showed 4.50-6.25 °C more water temperature than open fishpond (Table 4.3). Fish growth was increased by 114.5% with additional cost involvement of Rs 30/ m^2 per year (including maintenance) as compared to control pond during winter season at Bhubaneswar. The net benefit from increased fish growth is Rs 30/ m^2/season along with advantages of preventing the brood stock from cold shock and rearing of common carp seed during winter season. The total cost involved in construction of the system is Rs 85-90/m^2 and life of the system is 3-5 years.
- Plastic packaging of *ber* fruits have been tried to enhance the shelf life. *Ber* fruits (Umran variety) were hand picked manually at recommended stage of maturity (3rd 4th week in March) from PAU Farm, Ladhowal. HDPE & LDPE films (100 & 150 guage) with perforation levels of 0.25, 0.5 and 1.0% as well as non-perforated films were used to pack the fruits. The packed fruits were stored at 7°C-refrigerated temperature, under evaporative cooled and ambient conditions. Non-perforated films performed better as compared to perforated films under ambient and refrigerated conditions. Packaging with HDPE film (100 gauge) had shelf life of 29 days as compared to 15 days (2 weeks) for unpacked fruits kept under similar conditions. However under ambient conditions, LDPE (200 guage) was found the best among tested treatments with maximum shelf life of 10 days. Under evaporative cooled condition, perforated and non-perforated film could be stored for 2 weeks as compared to only 4 days under ambient conditions. Unpacked fruits can be stored for 8 days under evaporative cooled condition.
- A study has been undertaken to optimize the polythene film wrapping technique and observe

its effect on storability of kinnow and capsicum at Abohar. Shrink and seal packaging were most effective in controlling the weight loss of kinnow. The wrapped fruits were found to be firmer than control fruits. Individual fruit packaging also reduced the problems of decay by preventing secondary infection and made easy to discard the spoiled fruit, which in turn extended the shelf life. Among different method, cling wrap was least effective in preventing the decay but had a considerable effect in extending the shelf life by one week over its unwrapped control fruits. Capsicum stored with cling wrap decayed at a faster rate. Initial decay was higher in shrink-wrapped fruits but seal pack pods surpassed it during the later part of storage. Shrink-wrapped fruits were firmer as compared to all other packing treatment. However, it was observed to increase during later part of storage due to tissue desiccation. Such behaviour was believed to be due to water loss from the produce. As far as change in visual colour is concerned, it became greenish yellow on 6^{th} day, yellowish orange on 12^{th} days, orange on 15^{th} day and red on 18^{th} days in case of unwrapped fruit, whereas shrink wrapped produce was still green in colour by this time

LIST OF ON-GOING RESEARCH PROJECTS

A. FOOD GRAINS AND OILSEED PROCESSING

1. Development of equipment and devices for live fish holding and short distance transportation for retail marketing (*AP Cess funded project*)

   Dilip Jain & Hardial Singh

2. By-product utilization and value addition of mustard seeds

   S K Tyagi, D. Mridula & V R Bhagwat

3. Technology for utilization of selected coarse cereals to value added products

   R K Gupta, D Mridula & M R Manikantan

4. Dehydration of fruit slices in a tunnel dryer

   R K Goyal, A R P Kindsly, M R Manikantan & D B Singh

5. Energy efficient pulse milling technology

   R K Goyal, O D Wanjari, R K Vishwakarma, M R Manikantan & Mridula Devi

6. Evaluation of lac based can coating for internal coating of cans used for packaging and handling of edible oils and fats.

   R K Gupta, O D Wanjari, S K Tyagi & R K Vishwakarma

7. Integrated processing of sunflower seed for quality oil obtaining edible grade meal and diversified uses of by products (TMOP)

   R K Gupta, O D Wanjari, S K Tyagi, R K Vishwakarma, M R Manikantan & D Mridula

8. Development of aonla processing plant.

   R K Goyal, A R P Kingsley

9. Development of integrated dryer for some medical and aromatic plant leaves.

   R K Goyal, M R Manikantan, D M Kadam & O D Wanjari

10. Shelf life studies of fortified sattu.

    Mridula Devi, Reeta Jain & O D Wanjari

11. Studies on processing of guar (*Cyamopsis tetragonoloba*) for production of guar gum.

    R K Vishwakarma, S K Nanda & U S Shivhare

12. Development of process and equipments for seed extraction, dehulling and oil expelling of Jatropha at farm level.

    R K Gupta, Dr. R.K. Vishwakarma, V.K. Bhargav & S. Balasubramanian

13. Extrusion processing of fruits for development of novel value added products.

    R K Goyal, Mridula Devi, A R P Kingsley & D B Singh

14. Production of potato flour and starch and it's use for product diversification and value addition.

    Sanjeev Kumar Tyagi, Mridula Devi, D Dhingra & Rajbir Singh

15. Powdering technology for preservation and value addition of selected agricultural commodities

    S K Tyagi, Deepak Raj Rai, Rajbir Singh & ARP Kingsley

16. Evaluation of screw press mechanism for oil expelling as effect of process parameters for high value crops.

    Dilip Jain, S Balasubramanian, Rajesh Vishwakarma

17. Development of wet chilli based value added product.

    Dilip Jain, Mridula Devi & R K Jangra

18. Processing and utilization of beetroot and carrot for value addition in health foods.

    Mridula Devi, S K Tyagi, Dilip Jain & D R Rai

19. Development of technology for health foods from legumes and millets using food extrusion system

S Balasubramanian, R K Gupta

B. AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL

1. Assessment of losses during storage of rice in C warehouses in AP

V K Bhargav, D S Uppal, S K Aleksha Kudos, Ravinder Naik & I C Chadda

2. Development of a community level evaporatively cooled potato storage structure for Potato, Kinnow & Tomato

S N.Jha, S Chopra, Aleksha Kudos, Dalip Jain & D S Uppal

3. Improving in CAP (Cover and Plinth) storage of wheat to minimize grain tempering and quality

D S Uppal, S K Aleksha Kudos, V K Bhargav, V R Bhagwat & Dilip Jain

4. Evaluation of evaporative cooled room (ECR) for cultivation of mushrooms and their shelf life assessment.

H S Oberoi, M R Manikantan, D S Uppal, S Kapoor & P K Khanna

5. Optimization of fermentation parameters for bioethanol production using whey and vegetable wastes through genetically engineered microbial strains in a pilot scale fermenter.

H S Oberoi, V K Bhargav, D Dhingra & B S Chadha

6. Utilization of paddy straw and kinnow waste for bioethanol production

H S Oberoi & D S Uppal

7. Development of a nondestructive technique for evaluation of quality of apple.

S N Jha & D R Rai

8. Development of post harvest processing and machinery for Makhana processing & value addition. (Collaborative research project between CIPHET, Ludhiana & Research Centre for Makhana, Darbhanga {ICAR RCER})

S N Jha, Janardan Jee & B K Jha

9. Tenderization and instrumental quality evaluation of goat meat.

K Narsaia, S N Jha & D B Singh

10. Development of microencapsulator for immobilization of microorganisms and enzymes.

K Narsaia & H S Oberoi

11. Application of modified atmosphere packaging and storage to fresh vegetables

Deepak Raj Rai & Shyam Narayan Jha

12. Identification and evaluation of appropriate packaging for minimal processing of selected fruits and vegetables

Deepak Raj Rai, K Narsaiah & D K Bharti

13. Production of amylases, proteases and pectinases using agricultural and horticultural residues as supplements.

R R Harinder Singh Oberoi, K Narsaiah D Dhingra & Jatinder Singh

14. Post harvest management and value addition in coriander and cumin seed spices.

V K Bhargav, R K Vishwakarma, R K Goyal

15. Pelleting and singulating of selected seed spices.

V K Bhargav

C. HORTICULTURAL CROPS PROCESSING

1. Development of technology for value added products of ber

D B Singh, A R P Kingsley & M P Singh

2. Regulation of bahar (Flowering and fruiting) in pomegranate for control of fruit cracking under arid ecosystem.

D B Singh & ARP Kingsley

3. Application of greenhouse for drying onion slices

D D Nangare (on study leave), D M Kadam, Rajbir Singh & Satyendra Kumar

4. Development of lac-based coating formulations for extending shelf life of fruits and perishable food products.

   (Collaborative Project between ILRI, Ranchi and CIPHET, Abohar)

   Dinesh Singh, P C Sarkar (PI ILRI, Ranchi)

5. Development of processing technology for guava leather intermediate fruits and nutrients rich beverages

   R K Jangra, Satya Vir Singh, Gautam Mandal & M P Singh

6. Optimization of modified atmosphere-packing (MAP) techniques for enhancing quality and shelf life of apple.

   R R Sharma, Dinesh Singh, H S Bhatia & V K Saharan

7. Studying the effect of marginal quality water on quality and shelf life of selected fruits.

   Satyender Kumar, R R Sharma, D D. Nangare & V K Garg

8. Studies on package and storage of pomegranate fruit.

   D B Singh, Dinesh Singh &. A P R Kingsley

9. Biological control of post-harvest diseases of Kinnow *(Citrus nobilis x Citres deliciosa)*

   Dinesh Singh, R R Sharma, S Srivastava, (ILRI, Ranchi)

10. Studies on packaging of selected fruits and vegetables

    (Ramesh Kumar, Rajbir Singh & D.D.Nangare)

11. Organic production of vegetables inside polyhouse

    Rajbir Singh, D D Nangare, Satyendra Kumar & V K Saharan

12. Effect of irrigation, fertigation levels and mulching on growth and yield of Bt cotton in semi-arid region

    Rajbir Singh, D D Nangare & Satyendra Kumar

13. Evaluation of biodegradable plastic mulching on yield and quality of vegetables

    Rajbir Singh, D D Nangare & Satyendra Kumar

14. Studying the effects of coloured plastic mulches and shade nets on bahar regulation and fruit cracking in pomegranate (Punic granatum)

    D B Singh, R R Sharma, Rajbir Singh & D D Nangare

15. Vegetable production in naturally ventilated polyhouse

    Rajbir Singh, D D Nangare & Satyendra Kumar

16. Soil solarization for vegetable nursery production and its on-farm demonstration

    Rajbir Singh & Dinesh Singh

17. Post harvest quality maintenance of strawberry by *aloe vera* treatments.

    D B Singh, ARP Kingsly & Rajbir Singh

18. Mass transfer during storage of fruits.

    Satyavir Singh

19. Development of devices tools for guava processing.

    Satyavir Singh, A K Thakur & R K Jangra

20. Development of peeler and naringin extraction from kinnow peels.

    Satyavir Singh

21. Development of pomegranate aril extractor.

    A K Thakur, D B Singh & Satyavir Singh

22. Process development for production of quality raisins from Perlette grapes

    A K Thakur & Vinod Saharan

D. TRANSFER OF TECHNOLOGY

1. Development of mobile agro-processing unit for food grains and spices

   P Barnwal, D Dhingra, D R Rai, D K Bharti, D M Kadam, Satnam Kaur & Ashwani Kumar

2. Human resources development for post- harvest enterprises at rural level

   M S Meena, D K Bharti, D Dhingra & Satnam Kaur

3. Location model for agro processing plants in view of diversification of agriculture in Punjab

   D K Bharti, D Dhingra, M S Meena & Ashwani Kumar

4. Optimisation of osmo-connective dehydration of banana, pineapple and mango.

   D Dhingra, D M Kadam & D B Singh

5. Design, development and evaluation of banana hand cutter

   D M Kadam & D Dhingra

6. Market access and constraints in marketing of R & D oriented new value added products in northern India.

   D K Bharti, D Dhingra, M S Meena & D M Kadam

7. Video production on training opportunities at CIPHET

   M S Meena & D S Uppal

8. Establishment of linkage of documentations for transfer of post harvest technologies.

   M S Meena, D S Uppal, Rajbir Singh & M P Singh

9. Development of belt dryer for fruit slices.

   D Dhingra, D M Kadam & D K Bharti

PAPERS PUBLISHED IN JOURNALS

S.No.	Title	Journal	Author
1.	Modeling of color values for nondestructive evaluation of maturity of mango.	*Journal of Food Engineering* (2007) 78(1): 22 – 26.	S N Jha , S Chopra and A R P Kingsly
2.	Physical and mechanical properties of mango during growth and storage for	*Journal of Food Engineering* (2006) 72(1) : 73-76	S N Jha , A R P Kingsly and S Chopra
3.	Mathematical modeling for expression of juice from citrus fruit and whey during *paneer* pressing.	International Agricultural Engineering Journal, (2006) 15(1): 25 - 29.	S N Jha
4.	Nondestructive determination of firmness and yellowness of mango during growth and storage using visual spectroscopy.	*Biosystems Engineering,* (2005) 94(3): 397 - 402	S N Jha, A R P Kingsly and S Chopra
5.	Nondestructive methods for quality evaluation of dairy and food products.	Beverage & Food World (2007) 34(1): pp80 - 83	S N Jha
6.	Determination of physical properties of pads for maximizing cooling in evaporative cooled store.	Journal of Agricultural Engineering (2006) 43(4): 92 - 97.	S N Jha and S K A Kudos
7.	Selection of bricks and cooling pad for construction of evaporatively cooled storage structure.	*Journal of Institution of Engineers (I) (2006)* (AG) 87: 25-28	S N Jha and S Chopra
8.	Convective flat -plate solar heat collector for cauliflower drying.	*Biosystems Engineering* (2004) 93 (2): 189 - 198.	Dattatreya M Kadam and D V K Samuel
9.	Optimisation of pre-treatments of solar dehydrated cauliflower.	*Journal of Food Engineering,* 77 (3): 659 - 664.	Dattatreya M Kadam, D V K Samuel and Rajender Parsad

S.No.	Title	Journal	Author
10.	Impact of Processing treatments and packaging materials on some properties of stored dehydrated cauliflower.	*International Journal of Food Science and Technology*. Doi: 10.1111/j.1365 - 2006.01372.x	Dattatreya M Kadam, D V K Samuel Pitam Chandra and Harman S Sikarwar (online)
11.	Effect of Packaging Materials and Ethylene Absorbent on Shelf Life of Bell Pepper.	*Journal of Agricultural Engineering (2006)* 43 (3); 126 -130.	Dattatreya M Kadam and Jarnail Singh
12.	Drying kinetics of fluidised bed drying of garlic slices	*Journal of Institution of Engineers (2006) 87 : 3 - 6*	D Dhingra, S Paul
13.	Optimisation of drying of french marigold flowers	*Intl. Agril. Engineering Journal (2006) 15(1) : 11-15*	I Singh, D Dhingra, S Paul
14.	Impact assessment of training on food processing and preservation aspect.	*Indian Journal of Extension Professionals, (2006) (1) 1: 128-130.*	M S Meena, R Singh & H R Meena
15.	Effect of roasting on texture, colour and acceptability of soybean for making sattu.	American Journal of Food Technology, (2007) 2(4): 265-272	D Mridula, R K Goyal, V K Bhargav and M R Manikanatn
16.	Effect of roasting on texture, colour and acceptability of bajra for making sattu.	Agricultural Engineering Journal, (2006) 43 (4): 65 - 70.	D Mridula, M R Manikanatn R K Goyal and O D Wanjari
17.	Effect of Mustard Meal on Quality of Noodles.	Ind. J. Nutr. Dietet, (2006) 43 (7) : 305 - 311	D Mridula, S K Tyagi and O D Wanjari
18.	Effect of incorporation of full fat Soy flour on quality of biscuits.	Beverage and Food World, (2006) 33 (8): 35-36	D Mridula & O D Wanjari
19.	Associates of risk factors in ICDS and non-ICDS 'at risk' under fives of Varanasi city".	Ind. J. Nutr. Dietet, (2006) 43(12): 539-45.	D Mridula, C P Mishra and P Srivastava

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20.	Firmness of farm fresh tomatoes at different stages of harvest.	New Agriculturist (2006) 17(1-2): 105 - 109	R K Goyal and Himanshu Walia
21.	Physico -chemical characteristics of different tomato cultivars.	New Agriculturist (2006) 17 (1-2): 115-120.	R K Goyal and Himanshu Walia
22.	Thin layer drying kinetics of raw mango slice.	Biosystems Engineering, (2006) Vol 95 (1): 43-49.	R K Goyal, A R P Kingsly, M R Manikantan and S M Ilyas
23.	Moisture sorption isotherms of pigeonpea (*Cajanas cajan*) grain and its dehulled splits (dhal).	American Journal of Food Technology, (2007) 2(4): 228-237.	R K Vishwakarma, Goyal R K and V K Bhargav
24.	Effects of pretreatments and drying air temperature on drying behaviour of peach slices.	International Journal of Food Science and Technology (2007) 42, 65-69	A R P Kingsly, R K Goyal, M R Manikantan and S M Ilyas
25.	Mathematical modelling of thin layer drying kinetics of plum in a tunnel dryer.	Journal of Food Engineering (2007) 79 : 176 - 180.	R K Goyal, A R P Kingsly, M R Manikantan and S m Ilyas
26.	Thin -layer drying kinetics of organically produced tomato.	American Journal of Food Technology, (2007)2(2): 71-78	A R P Kingsly, Rajbir Singh, R K Goyal and D B Singh
27.	Interactive effects of planting time and mulching on 'Chandler' strawberry (*Fragaria* × *ananassa* Duch.)	Scientia Horticulturae, (2007) 111 : 344-351.	Rajbir Singh, R R Sharma and R K Goyal
28.	Optimization of process parameters for dehulling of pigeonpea.	Biosystems Engineering (2007)	R K Goyal, Vishwakarma, R K and O D Wanjari

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29.	Design, development and performance evaluation of two pass solar air heater with built-in-thermal energy storage	AMA (2007) (accepted).	R K Goyal and H Sakurai
30.	Design and development of castor depodder and decorticator	J. of Agricultural Engineering (2007) (accepted).	V K Garg, R K Goyal A R P Kingsly and Satyendra Kumar
31.	Some physical and mechanical properties of aonla fruits	Journal of Food Engineering (2007) (Press).	R K Goyal, A R P Kingsly, P Kumar and Himanshu Walia
32.	Status of Post harvest Technology of Aonla in India – A review	American Journal of food Technology (2007) (press).	R K Goyal, R T Patil, A R P Kingsly H Walia and P Kumar
33.	Properties of *idli* batter during its fermentation time	Journal of Food Processing and Preservation (2007) 31: 32-40	S Balasubramanian and R Viswanathan
34.	Effect of extrusion process variables and legumes on corn extrudates behaviour	Journal of Food Science and Technology (2007) 44(3): 330-333	S Balasubramanian and N Singh
35.	Effect of selected decorticated legumes protein on rheology of maize extrudate pastes	Journal of Food Science and Technology (2006) 43(5): 590 - 595	S Balasubramanian, N Singh, S M Ilyas and O D Wanjari
36.	Textural properties of fruit pulps and retexturized fruit bars	Beverage and Food World 2007 34(2): 67 - 69	S Balasubramanian
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40.	Modeling the performance of the reversed absorber with packed bed thermal storage natural convection solar dryer.	Journal of Food Engineering. (2007) 78:637-647	Dilip Jain
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47.	Effect of differential soil moisture and nutrient regimes on post harvest attributes of onion (Allium cepa Linn.)	Scientia Horticulturae (2007) 112(2):121-129.	Satyendra Kumar, M Imtiyaz, A Kumar

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48.	Modelling for simplifying hydraulic design procedure of drop inlet spillway.	Journal of Agril. Engg.(2006) 43 (2): 41 - 44	Satyendra Kumar, A Kumar and N N Sirothia
49.	Effect of irrigation scheduling and fertigation on storability of onion (**Allium cepa** L.) under microsprinkler irrigation regime.	Indian Journal of Agricultural Science. (2006) 76(7):401-404.	Satyendra Kumar, A Kumar and G Mandal
50.	Strawberry production under row cover with different mulching in semi-arid region of Punjab.	Annals of Agriculture Research. 26(4): 469-475. 2006.	Rajbir Singh, R Asrey and Satyendra Kumar
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54.	Growth pattern and yield potential of some exotic cultivars of kiwifruit in Sikkim.	*Haryana Journal of Horticulture Science* . (in press). 2006.	Ramesh Kumar and D S Yadav
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56.	Storage stability of guava leather in different packing materials.	*Acta Horticulturae (2007)* 735 : 621 -626.	Ramesh Kumar, R K Jain and G Mondal
57.	Effect of drip irrigation and plant spacing on yield quality and economic return of guava (*Psidium guajava* L.) grown in saline soils.	*Acta Horticulturae* (2007) 735: 427 -432.	G Mondal, Satyender Kumar, Ramesh Kumar and Rajbir Singh

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59.	Kohra hai phaldar vrikshon ka dusman.	Parsar Doot, (2006) 10: 46 - 47	R R Sharma, Ramesh Kumar and Rajbir Singh
60.	Drying kinetics of pomegranate arils.	*Journal of Food Engineering.* (2006) 79 741-744.	A R P Kingsly and D B Singh
61.	Influence of pruning intensity on light penetration and leaf physiology in high-density orchards of mango trees.	*Fruits, (2005) 61(2) 117-123.*	R R Sharma, Room Singh and Desh Beer Singh
62.	Induction of regular and early fruiting in Mango (*Mangifera indica*) by Paclobutazor under tropical humid climate.	*Indian J. Hort(2006) 63(3): 248 - 250*	D B Singh and H R Ranganath
63.	Thin – Layer Drying Behaviour of Orga nically Produced Tomato.	*American Journal of Food Technology(2007) 2(2): 71 - 78.*	A R P Kingsly, Rajbir Singh R K Goyal and D B Singh
64.	Aam Ke Pramukh Kiryatmik Vikar, Rog aivan Unka Parbhadhan.	*Krishi Darpan (2006) 1(6): 25 - 29.*	R R Sharma, Dinesh Singh and D B Singh
65.	In Andaman and Nicobar Islands……Genetic diversity in banana.	*Indian Horticulture.* 51(5): Cover page 1, II and III. 2006.	D B Singh
66.	Stationary versus fluidized-bed drying of high-moisture paddy with rest period.	Drying Technology 2006. 24: 1443-56.	Abhay Kumar Thakur and A K Gupta
67.	Two stage drying of high moisture paddy with intervening rest period.	Energy Conversion & Management 47 (18-19), 3069-83.	Abhay Kumar Thakur and A K Gupta
68.	Interactive effects of planting time and mulching on 'Chandler' strawberry (*Fragaria x ananassa* Duch.).	Scientia Horticulturae (2007) 111:344 - 351.	Rajbir Singh, R R Sharma and R K Goyal

S.No.	Title	Journal	Author
69.	Thin -layer drying behaviou r of organically produced tomato.	American Journal of Food Technology (2007) 2(2): 71-78.	A R P Kingsly, Rajbir Singh, R K Goyal and D B Singh
70.	Use of soil solarization in weed management on soybean under Indian conditions.	Tropical Science. (2006) 46(2):70 - 73	Rajbir Singh
71.	High density strawberry cultivation with plasticulture is profitable in semi -arid regions.	ICAR News (2006) 11(4): 1-4	Rajbir Singh and R Asrey
72.	Influence of mulching on growth and yield of tomato (*Lycopersicon e sculentum*).	Vegetable Science (2006) 32(1): 55-58	Rajbir Singh
73.	Effect of plastic tunnel and mulching on growth and yield of strawberry.	Indian Journal of Horticulture (2006) 63(1): 18-21.	Rajbir Singh, R Asre and S Kumar
74.	Strawberry produc tion under row cover with different mulching in semi-arid region of Punjab.	Annals of Agriculture Research (2006) 26(4): 469-475.	Rajbir Singh, R Asrey and S Kumar
75.	Post harvest treatment and shelf life of 'Chandler' strawberry.	Indian Food Packer (2006) (1) 43 - 46	R Asrey, Rajbir Singh and S Kumar

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1.	Physico -chemical properties of apple.	41st Annual convention and symposium of ISAE during 29-31 January at Junagadh Agricultural University, Junagarh. (2007).	S N Jha and Ruchi Garg
2.	Nondestructive methods for quality evaluation of fruits and vegetables.	Invited paper in one day seminar organized in Hindi at Central Scientific Instruments Organizations (CSIO), Chandigarh on 26 September (2006).	S N Jha
3.	Non-destructive methods for quality evaluation of fresh produce.	Invited lead paper for a workshop on Technology and equipments for processing and quality assurance of foods funded by DST and organized during 23 - 24 August at NDRI, Karnal (2006).	S N Jha
4.	Design, Development and Evaluation of manually operated Banana-Hand Cutter	National Conference on Food and Nutrition Security : Food and Biotechnologies interentions, held at SLIET, Longowal on 22-23 March 2007	D M Kadam, R T Patil D Dhingra
5.	Analysis of particle size of milled food grains and spices	National Conference on Food and Nutrition Security : Food and Biotechnologies internentions, held at SLIET, Longowal on 22-23 March 2007	D Dhingra, J Singh R T Patil
6.	Sanchar Sadhno Ka Samajik Utthan Main Bhumika.	Krishi Vistar Samikasha, July - Dec., 13 - 14. (2007).	M S Meena & R K Goyal
7.	Effect of roasting on some physical properties and acceptability of sorghum for making sattu.	41st Annual Convention & Symposium of ISAE, January 29 - 31, 2007, CAET, JAU, Junagarh (Abstract No. APE 2007 ACP 21).	D Mridula, R K Goyal and M R Manikantan

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8.	Studies on osmotic delrydration of banana slices	18th Indian Convention of Food Technologists (ICFOST-06) 16-17 Nov 2006, ANGRAU, Hyderabad	D Dhingra, D S Uppal and R T Patil
9.	Role of agricultural marketing infrastructure in reducing post harvest losses.	Presented in 18th Indian Conventions of Food Technologists (ICFOST-06) 16-17 Nov 2006, ANGRAU, Hyderabad	Jasjeet Singh and D Dhingra
10.	Physical Properties and Acceptability of qorghum Based Soy Fortified Biscuits.	International Conference on Post Harvest Technology and Value Addition in Cereals, Pulses and Oilseeds, Kanpur, November 27-30, 2006 (Abstract N P.1.01)	Mridula D R K Gupta M R Manikantan and O D Wanjari
11.	Effect of Roasting on Quality of Soybean and Soybean Fortified Sattu.	International Conference on Post Harvest Technology and Value Addition in Cereals, Pulses and Oilseeds, Kanpur, November 27-30, 2006 (Abstract N P.3.27).	Mridula D O D Wanjari M R Manikantan and R K Goyal
12.	Profile of basmati rice processing in India.	IRC 2006 held at New Delhi during October 9 - 12, 2006	R K Goyal and R T Patil
13.	Effect of mustard oil as pre-milling agent on dehulling efficiency and dehulling loss of pigeonpea. In Souvenir of International Conference on Post -harvest Technology & Value Addition in Cereals, Pulses and Oilseeds,	International Conference on Post Harvest Technology and Value Addition in Cereals, Pulses and Oilseeds, Kanpur, November 27-30, 2006 (Abstract N P.1.01)	R K Goyal and R K Vishwakarma
14.	Performance evaluation of solar air heaters for drying of high moisture paddy	SOLARIS 2007 held at IIT, New Delhi during February 7 -9. (2007)	R K Goyal M R Manikantan and O D Wanjari
15.	Polymer nano-composites for food packaging - an appraisal	20th National Convention of Agricultural Engineers, 19-20 January 2006, PAU Ludhiana	D. Dhingra Jasjeet Singh, R T Patil and D S Uppal

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16.	Prospects and performance of food processing industry in Punjab	National Conference on Food & Nutrition Security : Food and Biotechnologies interventions, held at SLIET, Longowal during 22-23-March 2007	D K Bharti, R T Patil, D Dhingra and M S Meena
17.	Protein enriched ready-to-eat corn balls.	8th Agricultural Science Congress. TamilNadu Agricultural 15 - 17 University. Coimbatore, 15 February 2007. pp.123 - 124.	S Balasubramanian and N Singh
18.	Recent trends in cereal based food products.	National conference on prospectus and challenges in food processingh SRM University. Chennai, 24 - 25 January (2007)	S Balasubramanian
19.	Effects of pretreatments and drying methods of oyster mushroom (*pleurotus spp*.).	National Conference on Prospectus and Challenges in Food Processing. SRM University. Chennai, 24 - 25 January 2007. pp. 38.	S Anandakumar T Arumuganathan S Balasubramanian and Shanmugasundaram.
20.	Process consideration for starch noodles.	World Food Day Foodozeal'06. AEC&RI, Tamil Nadu Agricultural University. Coimbatore, 16 October 2006.	S Balasubramanian
21.	Solar energy based thermal model for prediction of wheat grain temperature under covered and plinth storage.	SOLARIS 2007, 3rd International Conference on Solar radiation and day lighting during 7 -9 February 2007, Indian Institute of Technology, New. Delhi.	Dilip Jain D S Uppal and R T Patil
22.	Study the kinetics of solar drying of mango pulp.	SOLARIS 2007, 3rd International Conference on Solar radiation and day lighting during 7 -9 February 2007, Indian Institute of Technology, New Delhi	Dilip Jain and P. Pathare

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23.	Modeling the iced fish cooling behaviors and ice requirement for safe storage.	National Conference on "Food and Nutrition security : Food and biotechnological interventions" during 22-23 March 2007 at SLIET Longowal 148106, Punjab.	Dilip Jain and R T Patil
24.	Yield and yield attributes of onion (Allium cepa) under drip irrigation and fertigation.	National Symposium on Conservation Agriculture and Environment w.e.f 26 -28 October 2006 held at BHU, Varanshi.	S Kumar, G Mandal, Rajbir Singh and D D Nangare
25.	A comparison of microsprinkler, drip and furrow irrigation in canal command area.	41st ISAE Annual convention & symposium (Abs No.SWCE -2007 -PI -10)w.e.f 29-31st January, 2007 held at College of agricultural Engineering and Technology, JAU, Junagarh.	S Kumar, G Mandal Rajbir Singh and D D Nangare
26.	Response of different levels of nitrogen and potassium in relation to fruit weight and yield of strawberry (*Fragaria ananassa*).	National Symposium on Conservation Agriculture and Environment w.e.f 26 -28 October, 2006 held at BHU, Varanshi.	Rajbir Singh S Kumar, and D D Nangare
27.	Testing of the low cost screen filter under drip irrigation system	41st ISAE Annual convention & Symposium (Abs No.SWCE -2007 -PI-24) w.e.f. 29-31st January 2007 held at College of Agricultural Engineering and Technology, JAU, Junagarh.	D D Nangare, S Kumar and Rajbir Singh
28.	Development of value added products from guava.	Paper presented in *National Guava Symposium* held at Shirdi, Maharasthra during February 17-20, 2007.	Ramesh Kumar, Goutam Mondal, Satvir Singh and R T Patil

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29.	Tray wrap packaging for extending shelf life of kinnow mandarin.	2nd Indian Horticulture Congress held at ICAR Research complex for NEH Region, Barapani (Meghalaya) during March, 17-21, 2007.	Ramesh Kumar M R Manikantan D D Nangrare and Rajbir Singh
30.	Efficiency of boron application on control of fruit cracking and improvement in yield and quality of pomegranate fruits.	National symposium on "Improving Input Use Efficiency in Horticulture" from 9 -11 Aug. 2006 held at The Hotel Atria. Bangalore.	D B Singh and A R P Kingsley
31.	Agricult ural Engineering for Enhanced Productivity and Employment: Role of Post Harvest Management and Value addition. Souvenir.	41st ISAE Annual Convention and Symposium, Indian society of Agricultural Engineers, January 29-31, 2007. Pp19 -30.	R T Patil and D B Singh
32.	Development of a lotus seed decorticator.	"National Conference on Food and Nutrition Security: Food and Biotechnologies Interventions (FNS -2007)" from 22 -23 March, 2007, organized by Department of Food Engineering and Technology, Sant Longowal Inst. of Engineering and Technology, Longowal.	V K Garg A R P Kingsly D B Singh and S Kumar
33.	Integrating Food Value Chain	During International Food and Agriculture Conference, held at Chandigarh.On 2nd December, 2006	D B Singh
34.	Two-stage drying characteristics of paddy under stationary and fluidized bed condition.	2nd International Rice Congress, New Delhi, 9 -13 October 2006.	A K Thakur and A K Gupta

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35.	Moisture transport characteristics and change in physical properties of green peas during convective drying.	41 st ISAE Annual convention and symposium, Junagardh Agricultural University, Junag adh, 29 -31 January, 2007	A KThakur and G Mandal
36.	Post-harvest quality of Kinnow fruits by pre-harvest spraying of protective fungicide and calcium nitrate.	National Symposium on Improving Input Use Efficiency in Horticulture, IIHR, Bangalore, August 9 -11, 2006. p. 193 -194.	Dinesh Singh and A K Thakur
37.	Performance of a flat plate collector solar dryer for fruits and vegetables.	3rd International Conference on "Solar Radiation and Day Lighting: SOLARIS 2007", Center for Energy Studies, Indian Institute of Technology Delhi, February 07– 09, 2007.p. 38.	A K Thakur G Mandal and D B Singh

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2.	Dairy and Food Processing Plant Maintenance: Theory and Practice.	Publisher: International Book Distributing Company (Publication division), Lucknow (2006).	S N Jha
3.	Sprouts for health of all.	Agriculture Update Vol. 1 No. 15 -17. (2006).	D Mridula and O D Wanjari
4.	Energy Efficient pulse milling technology	CIPHET (ICAR), Ludhiana. (2006).	R K Goyal O D Wanjari S M Ilyas R K Vishwakarma M R Manikantan and D Mridula
5.	Processing and utilization of defatted meal from traditional and non-traditional oilseeds.	CIPHET (ICAR), Ludhiana. 2006	R K Gupta, M R Manikantan D Mridula and O D Wanjari
6.	Food Quality and Safety of Raw and Processed Food.	Director, CIPHET, Ludhiana. (2006)	S M Ilyas D S Uppal and R K Goyal
7.	Adopt greenhouse technology to earn more profit in tomato cultivation.	Extension Bulletin -1, published by Project Coordinating Unit, AICRP on APA, CIPHET, Ludhiana. (2006)	Gulshan Mahajan K G Singh R K Goyal and O D Wanjari
8.	Castor Depodder cum Decorticator.	CIPHET/Pub/14/2006.	Garg, V.K. Kingsly, ARP Goyal, R.K. and Kumar, Satyendra

S.NO.	TITLE	NAME OF PUBLICATION	AUTHORS NAME
9.	Post harvest technology and value addition in mung bean and black gram.	In book on Mung bean and Black gram (Ed. Masood Ali and Shiv Kumar), IIPR, Kanpur, pp 422 -449. (2006)	S M Ilyas and R K Goyal
10.	Post harvest agro processing and value addition.	In book on Resource Conserving Technologies for Social Upliftment" (Eds Sharda, V.N., et al.), Allied Printers, Dehradun. Pp 185190. (2006)	S M Ilyas and R K Goyal
11.	Effect of Post Harvest Operations on Quality of Farm Fresh Tomatoes.	In Book on Food Quality and Safety of Raw and Processed Food (Eds. Ilyas, S.M., Uppal, D.S. and Goyal, R.K.) Yugangar Prakashan (P), Ltd, New Delhi. (2006)	R K Goyal and S M Ilyas
12.	Quality assurance of raw produce for processed quality product in post WTO era.	In Book on Food Quality and Safety of Raw and Processed Food (Eds. Ilyas, S.M., Uppal, D.S. and Goyal, R.K.) Yugangar Prakashan (P), Ltd, New Delhi (Press). (2006)	Ilyas, S.M. and Goyal, R.K.
13.	Status and scope of organic food production and its post-harvest management in India.	In Book on Food Quality and Safety of Raw and Processed Food (Eds. Ilyas, S.M., Uppal, D.S. and Goyal, R.K.) Yugangar Prakashan (P) Ltd, New Delhi (Press) (2006)	Rajbir Singh R K Goyal and S M Ilyas
14.	Prospects of post harvest technology and value addition in pulses.	In Post Harvest Management and Value Addition (Eds. Goel et al.), Daya Publishing House, New Delhi. (2007)	R K Goyal and S M Ilyas

S.NO.	TITLE	NAME OF PUBLICATION	AUTHORS NAME
15.	Post harvest management and value addition: prospects and opportunities.	In Post Harvest Management and Value Addition (Eds. Goel et al.) Daya Publishing House, New Delhi. (2007)	S M Ilyas and R K Goyal
16.	CIPHET Rotary maize Cob Sheller.	Technical Bulletin no : CIPHET/Pub./ 06/2006. 2007.	V K Garg Satyendra Kumar Satya Vir Singh
17.	Post Harvest Management of Fruits and Vegetables -An Overview.	Paper presented during "ICAR Training on "Post Harvest Management of fresh fruits and vegetables and its Export" held at College of Agricultural Engineering and Technology, Marathwara Agricultural University, Parbhani during 12 -21 Sept. 2006.	R T Patil and D B Singh
18.	Quality standards for export and processing of pomegranate.	In: Food Quality and Safety standards for Agricultural Raw and Processed Produce ". Pub by CIPHET, Ludhiana (*In press)*	D B Singh and A R P Kingsley
19.	Pomegranate (*Punica granatum*)	In: "Prospects and dimensions for Utilization of Arid Foods". Pub by Yash Publications. Bikaner Pp 94 - 100. 2006.	D B Singh and A R P Kingsley
20.	Post Harvest Diseases of Kinnow and their Management.	Technical Bulletin No.: CIPHET/Pub./1 -2006.	Singh, Dinesh and A K Thakur
21.	Tudai Uprant Kinnow ke Phalon ka Upchar evam Rakh Rakhav.	Krishi Darpan, 2(6): 30 -31. (2007).	Singh, Dinesh and A K Thakur
22.	Project Profile on Milling of Cattle Feed	CIPHET / Pub./07/2006	D Dhingra Ashwani Kumar D K Bharti and D M Kadam

S.NO.	TITLE	NAME OF PUBLICATION	AUTHORS NAME
23.	Project Profile on Milling of Mustard Oil	CIPHET / Pub./08/2006	D Dhingra Ashwani Kumar D K Bharti and D M Kadam
24.	Project Profile on Milling of Pulses	CIPHET / Pub./09/2006	D Dhingra Ashwani Kumar D K Bharti and D M Kadam
25.	Project Profile on Soymilk	CIPHET / Pub./10/2006	D Dhingra, Ashwani Kumar D K Bharti and D M Kadam
26.	Project Profile on Milling of Spices	CIPHET / Pub./11/2006	D Dhingra, Ashwani Kumar D K Bharti and D M Kadam
27.	Project Profile on Milling of Wheat	CIPHET / Pub./12/2006	D Dhingra, Ashwani Kumar D K Bharti and D M Kadam

PARTICIPATION IN TRAINING COURSES

Participated in the National Conference on Food and Nutrition Security: Food and Biotechnologies Interventions' Presented paper on **Prospects and Performance of Food Processing Industry in Punjab**' held at SLIET, Longowal, March 22 -23, 2007.	D K Bharti
Participated in the Institute -Industrie s Interface Meeting and Sensitization Workshop on Food Processing, CIPHET, Ludhiana, November 14 -15, 2006	D K Bharti
Participated in the Xth Annual Conference of North West Indian Sociological Association of State, Market and agrarian Social Structure i n North West India, PAU, Ludhiana, November 16 -17, 2006.	D K Bharti
Participated in the International Trade Fair at Pragati Maidan, New Delhi, November 24 -26, 2006.	D K Bharti
Attended NIAS -DST Workshop/Training on **"Dimensions of Nanotechnology: Scie nce, Technology and Society"** at National Institute of Advanced Studies (NIAS), Bangalore from June 26 to July 1, 2006.	Dattatreya M. Kadam
Attended Winter School training on "**Extrusion Cooking Technology and Its Application for Processing Soybean**" at SPU Centre, Central Institute of Agricultural engineering (CIAE), Nabi Bagh, Berasia Raod, Bhopal from November 1 to November 21, 2006.	Dattatreya M. Kadam
Importance of self - help groups in processing sector for the trainees of Maharastra state under EDP on guava processing at CIPHET, Abohar on dated 28th March 2007.	M S Meena
Participated in International Conference on Agri-Infrasructure at Chandigarh, organised by CII during 1-4 Dec 2006	D Dhingra
Development of skill for ent repreneurship" for Horticultural officers of Haryana at CIPHET, Abohar on dated 20.02.07.	Dr. M.S. Meena
Skill development for entrepreneurship for scientist / teachers of different universities under EDP on Protect Cultivation.	M S Meena
Seminar deliv ered on *Planning and Delivering of an Extension Talk* on 8th Jan.2007 at CIPHET, Ludhiana.	

Participated in the exhibition organized by Global Forum on Agricultural Research at NASC Complex, New Delhi.	D Dhingra & M S Meena
Attended a course on **"Purchase Management in Government"** conducted by ISTM, New Delhi on 17.04.2006 to 19.04.2006	Kunwar Singh, UDC
Participated in a workshop/Training Programme on **"Nano - Techonology and Nano - Matrial"** held at NIAS, Banglore on 26.06.2006 to 01.07.2006	D.M Kadam
Attended a Training Course on **"Handling of CAT Cases"** held at ISTM, New Delhi on 03.07.2006 to 05.07.2006	Sh. J. S. Paul, Asstt. Admn. Officer
Attended a workshop on **"PERMISnet and launching of Intelligent Reporting System (IRS)"** held at NASC, New Delhi on 21.07.2006 to 22.07.2006	Sh. J. S. Paul, Asstt. Admn. Officer
Attended a workshop on **"PERMISnet and launching of Intelligent Reporting System"** (IRS) held at NASC, New Delhi on 21.07.2006 to 22.07.2006	Sh. Ajay Kumar Tandon, LDC
Attended ICAR Summer School on **"GIS based decision support systems for sustainable agriculture"** organized by NAARM, Hyderabad. 05.07.2006 to 25.07.2006	Satyendra Kumar
Attended a summer School on **"Extension and Communication Management"** organized by CCS, HAU, Hisar on 18.08.2006 to 07.09.2006	M S Meena, Scientist (SS)
Participated in Training Programme on **"Medicinal and Aromatic Plants"** at ISAP , Bhopal on 13.08.2006 to16.08.2006	Rajbir Singh, Sr. Scientist
Participate in a Training Programme on **"Medicinal and Aromatic Plants"** at ISAP, Bhopal on 13.08.2006 to16.08.2006	M S Meena, Scientist (SS)
राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल द्वारा आयोजित राष्ट्रीय हिन्दी कार्यशाला राजभाषा के प्रचार–प्रसार में हिन्दी अनुभागों की प्रासंगिकता में भाग लिया। 05.09.2006 to 06.09.2006	Sh. Vijay Kumar, AF&AO
राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल द्वारा आयोजित राष्ट्रीय हिन्दी कार्यशाला राजभाषा के प्रचार–प्रसार में हिन्दी अनुभागों की प्रासंगिकता में भाग लिया। 05.09.2006 to 06.09.2006	Sh. Vishal Kumar, T-2

Participate in a Training Programme on **"TAXT plus and TAHD plus"** on 19.09.2006 to 20.09.2006	Ramesh Kumar Jangra, Scientist (Hort.)
On the **"spot assessment of areas of cooperation in the field of Agriculture between India and Serbia & Montenegro"** at USA on 25.09.2006 to 30.09.2006	R T Patil, Director
Deputation of ICAR Scientist as consultant in the field of Dairy Product Development & **"Food Processing Engineering to CARP, Sri Lanka"** under the Work Plan between ICAR -CARP for years 2006-2007 on 22.11.2006 to 06.12.2006	R K Goyal Pr. Scientist
Attending winter School on **"Water Saving Technology for Sustainable Agricultural Production"** held at WTC, IARI, New Delhi 15.11.2006 to 05.12.2006	Satyendra Kumar Scientist (SS)
Participated in a raining programme **"USA for Norman Borlaugh Fellowship under Indo - US Agricultural Knowledge Initiative"** held at USA on October to December, 2006	A R P Kingsly, Scientist (AS&PE)
Participated **in Institute -industry interface meeting & Sensitization Workshop on Food Processing under Indo -US K nowledge Initiative in Agriculture at CIPHET, Ludhiana on November 16, 2006.**	R K Goyal, Pr. Scientist
Delivered **lecture on appropriate technologies and Agro processing for value addition to Agricultural produce to post graduate students of Agriculture at Peradeniya University Kandy, Sri Lanka on December 1, 2006.**	R K Goyal Pr. Scientist

INSTITUTE ACTIVITIES

Institute Research Council Meeting

The Institute organized IRC meeting during 21-22 December, 2006 to discuss completed projects (RPF-III), ongoing projects (RPF-II) and new research project proposals (RPF-I) under the Chairmanship of the Director.

The IRC meeting began with welcome address of Dr. R.K. Goyal, Principal Scientist and Member Secretary, IRC. While welcoming the Chairman, IRC he mentioned that the vast experience of Chairman in the Post Harvest Sector would benefit the scientists of the Institute in sharpening their research projects.

Dr. R.T. Patil, Director and Chairman, IRC welcome all scientists and technical officers before making his remarks. He informed the house that such meetings refine the research Programme, hence the technical programme should be very clear. He said that scientist should identify clients for adoption of results in their area of work. At present the market intelligence is an important tool to assess the scope of particular technology in the market hence, it should become part of each research project. The duplication of research work should be avoided. The responsibility of research should be shared and the associates should work in a team spirit. He added that the authorship in any publication should be maintained as per the work. There are large numbers of scientists working in the field of applied research in PHT and publishing their work in various journals. He advised that scientist should discuss their work at divisional level atleast once in a month. He informed that a Patent Discloser Form has been developed and circulated. All patentable technology should be disclosed in this form for further evaluating the technology for filling the patents. He also informed that an electronic version of newsletter has been published giving valuable information on PHT. He stressed that Research Environment should be built up for brain hungry and for doing things in new way, with a new flavour.

1. Institute Industry Interface Meeting

Central Institute of Post-Harvest Engineering & Technology (CIPHET), Ludhiana has organized an Institute-Industry Interface workshop on Food Processing during 14 -15 November 2006 in collaboration with Indo-US knowledge initiative in Agriculture programme. The aim of the workshop was to understand the activities of various industries engaged in Indian Food processing sector and to know their need for carrying out Research & Development works to accelerate the processing technology generation and for the instant adoption of the post-harvest technologies. The technologies developed by the CIPHET (ICAR) were also discussed with detailed presentation. Two days' deliberations arrived at the following recommendation.

Recommendations

1. CIPHET, Ludhiana should hold Institute-Industries interface meeting at least once in a year.
2. Technologies for drying of high value crop developed by M/s Techno Consultant Mumbai is Recommended for use by farmers/entrepreneurs to meet the quality and food safety requirement of export.
3. For production of high quality food, good quality

of raw materials is essential Companies engaged in food processing must help the farmers for producing quality raw materials.

CIPHET may hold Crop specific Institute-Industries interface meeting involving concerned Commodity agencies such as Aonla growers associations, Guava growers associations etc.

5. Institute and Industry should work together to develop a long-standing relationship for this. CIPHET, Ludhiana proposed collaboration with private industries/ entrepreneurs for solving their problems related to Post-Harvest and food processing through a scheme of annual as well as 5 year membership (Rs.1000 for 1 year, Rs.5000 for 5 years).

6. Institute should take most of their research work based on need of the company engaged in food processing.

7. CIPHET should conduct an interface meeting between CIPHET and progressive farmers in the country so that they can be motivated to adopt processing of their problems. Two letter of intents for collaborative developmental work with M/s Osaw agro, Ambala & Choudhary Agro Bio Tech, Jaipur were signed during the meeting.

8. CIPHET should help entrepreneurs in testing quality of their produce at nominal charges.

9. Industry participants should come forward to participate in KIA between USA and India project to upgrade their knowledge and existing production.

2. CIPHET Press Meet

An Institute-Press meet was organized at CIPHET, Ludhiana on 16.01.2007 to inform how CIPHET can help the common people, students, industry and other stakeholders especially in the post-harvest utilization aspects.

In the meeting the development of technology for reduction in drudgery in food processing operations and reduction in post harvest losses of food grains was discussed. Director, CIPHET emphasized the objective of meeting in modernization of food processing industry. Dr. Patil appealed to all that CIPHET would be opened up for private industries to use the library facilities and for other consultancy services. Director enlisted and explained all the technologies developed at CIPHET, Ludhiana that were ready for commercialization.

3. Registration of potential Entrepreneur

ITMU has started a unique programme of registration of potential entrepreneur for on the spot advisory help for faster growth of food processing in the country. Five entrepreneurs, details given below, were registered during the period.

S. No.	Name/Address	Firm/company	Reg.No .
1	Narinder Kumar Gupta, Maharaj Nagar, St. no 5, Backside Circuit House, Civil Lines, Ludhiana.	Max Star International	CIPHET/ITMU/07 -01.
2	Golden Corns (India) Pvt. Ltd , 13B & 14 Jeetpur Industrial Area. Tehsil Amb Distt: UNA (H.P.)	Golden Corns (India) Pvt. Ltd	CIPHET/ITMU/07 -02
3	Dr. Karam Singh Nandpuri, H. No. 103 G, BRS Nagar, Ludhiana.		CIPHET/ITMU/ -07-03.
4	RACSUN FOODS, B - II/1607, Tractor Street, G. T Road, Ludhiana 141008		CIPHET/ITMU/07 -04.
5	Shriram Gadhave, President Vegetable Growers Asso. of India Crop. Add : Shivaneri Jrushi Pratisthan Narayangaon Junner, Distt Pune, (MH) Pin -410504		CIPHET/ITMU/07 -05.

4. Patent Filed

Following 11 patents were filed in the year 2006 -07:

Date of filing of complete specification	Application No.	Title	Name of Inventors
3.4.2006	937/DEL/2006	Rotary Maize Cob Sheller	Sh. V. K. Garg
3.4.2006	937/DEL/2006	CIPHET Castor Depodder/ Decorticator	Sh. V. K. Garg
10.5.2006	1159/DEL/2006	A new process of oil extraction from Karanj seed (*Pongmia Glabra*) through mechanical expression	Dr. R. K. Gupta
07.06.06	73/DEL/2004	CIPHET fruit collector cum grader	Dr. Satyavir Singh
16.6.2006	1436/DEL/2 006	A process for production of Kernels from NSFH -36 Variety of Sunflower seeds (Helianthus annusl) for confectionery purpose in Food Industry	Dr. R. K. Gupta
19.6.2006	1448/DEL/2006	Energy efficient Bengal gram S*attu* making technology.	Dr. Mridula D.
4.7.2006	1574/DEL/2006	Process Technology for making "Anardana Ready to mix Chutney	Dr. Desh Bir Singh
4.7.2006	1575/DEL/2006	Process Technology for making Digestive Product from Anardana (Anardana Hazmahazam	Dr. Desh Bir Singh
6.11.2006	2405/DEL/2006	Development of Sunflower Kernel based confectionery products.	Dr. R. K. Gupta
21.11.2006	2503/DEL/2006	Process for Debittering of Kinnow / Citrus Juices by Using Pretreated Indigenous Adsorbent Resin.	Dr. Satyavir Singh
6.3.2007	494/DEL/2007	Process Technology for Making Anonla Beverage	Dr. R K Goyal Er. A.R.P Kingsly Dr. R. T. Patil
7.6.2007		Process for dehulling guar seed for refined guar spilt production."	Er. R. K. Vishwakarma Dr. S. K. Nanda U. S. Shivhare

5. **Memorandum of Understanding (MoU) Signed**: During the period under report three MoU for collaborative research were signed.

   Stakeholders in MoU are.

i) Research center for Makhana, Darbhanga (ICAR Research Complex for Eastern Region, Patna) for Research On Makhana.

ii) Tamil Nadu Agricultural University, Coimbatore for Transiting the knowhow of ECS.

6. **Consultancy Provided**

i) Consultancy was provided to Neotel System. Chandigarh for commercialization of technology to know maturity of mango.

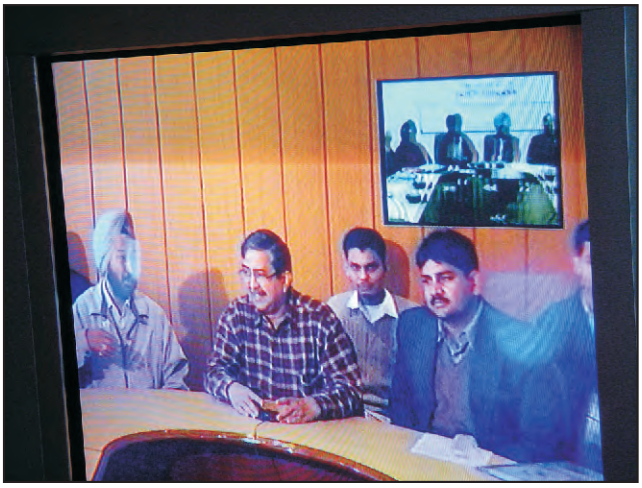
ii) Consultancies to small farmers' Agribusiness Consortium, New Delhi were provided to develop three Detailed Project Report as below:

   DPR for setting up of processing plant for orange integrated with cold storage and packaging Arunachal Pradesh.

a) DPR for setting up of an orange processing unit integrated with cold storage for production of orange juice & squash in Rajsthan.

b) DPR for setting up of a Banana Processing Unit by Banana Growers Society in Assam.

Establishment of linkage and documentation of the post-harvest technologies.



Discussion of CIPHET scientists with PAMETI Ludhiana

Central Institute of Post-Harvest Engineering & Technology (CIPHET) had face-to-face technical discussion with Punjab Agricultural Management & Extension Training Institute (PAMETI) through Video Conferencing (VC) on January 25, 2007. Director CIPHET gave informative lecture about technologies of CIPHET and Entrepreneurship Development Programmes (EDPs) in Post-Harvest Engineering and Technology. Director CIPHET also answered the queries of trainees and staff of the PAMETI. A demonstration and discussion through video conferencing was also conducted to the delegates of Coordination Committee Meeting held on Post-Harvest Technology at CIPHET, Ludhiana. The facility is used to popularize the post-harvest technologies among the farming community, rural youth, agricultural graduates etc. CIPHET is planning to connect all the training institutions and Krishi Vigyan Kendra (KVK) through VC for speedy transfer of post-harvest technologies.

Awareness-Cum-Demonstration programme organized

One-day wareness-Cum-Demonstration programme was organized on **"Spray Dried Soy Milk Powder"** on 16th March 2007 for entrepreneurs of Northern India. The awareness programme comprised of lectures and practical demonstrations

on the production of spray-dried soymilk along with packaging and product testing aspects. The production of Soymilk was based on Central Institute of Agricultural Engineering (ICAR) technology. CIPHET, Ludhiana has developed a spray drying protocol of making soymilk powder using pilot scale spray dryers.

A paid training programme on "Establishment of small & large-scale Mentha Distillation units and Turmeric curing; and Establishment of post harvest infrastructure, integrated pack-house, refer van & cold storage and training on its application" was conducted by Dr. A. K. Thakur, Senior Scientist and Course Coordinator in the Division of Horticultural Crop Processing, CIPHET Abohar during 24-28 February, 2007. This training was conducted for the Horticultural Officials of the Directorate of Horticulture and Food Processing, Government of Uttar Pradesh under State Horticultural Mission. A total of 18 officials from the different districts of UP were participated in this training. The training mainly focused on overall post harvest processing and management of fruits and vegetables with special reference to infrastructure development like cool chain, cold storage, pilot plants for processing, packaging units, distillation units etc. During the training, course covered on sorting, grading and waxing of fruits and vegetables, value added products from various fruits, polymeric/shrink packaging of fruits and vegetables, improved agro technique for quality produce, irrigation management to improve PH quality, processing of aromatic and medicinal plants including separation techniques of oils and aroma, organic cultivation for better quality, standard process for turmeric curing and overall requirement of infrastructure for post harvest processing and value addition. A visit to the commercial fruit grading and packaging plant; steam distillation unit and high-tech nursery were also arranged for the participants to make them aware of the latest technologies. In the concluding session, the participants showed their satisfaction over the knowledge gained during the programme and they responded that they will share with the horticulturist, food processor and other beneficiaries in their state to improve the post harvest infrastructure.

Training Programme on post harvest technology for participants from Assam

A training program on post harvest technology was organized for 18 participants from Assam during 22nd January - 30th January by Technology Transfer Division. It was co-ordinated by Dr D Dhingra. The participants belonged to NGOs and SHGs. State Institute of Rural Development, Guwahati, Assam, sponsored the training program. The training covered theory and practicals on milling of cereals, pulses, oilseeds, processing of tapioca, handling, packaging and value addition of fruits and vegetables, food safety and quality, food microbiology etc. Field visits to Markfed Canneries, Nijjer Horticulture Ltd. and rice mills in Jalandhar and Amritsar were also conducted.

Awareness program on "Scheme for Development / Strengthening of Agricultural Marketing Infrastructure, Grading & Standardization" for entrepreneurs

An entrepreneurship awareness program on "Scheme for Development / Strengthening of Agricultural Marketing Infrastructure, Grading & Standardization" was organized at CIPHET, Ludhiana on October 5, 2006. The program was co-ordinated by Dr D S Uppal and Dr D Dhingra. Thirty participants attended the training program. Sh. R.C. Chopra, Director SISI was the Chief Guest on this occasion. Lectures on salient features of the scheme, importance of agricultural marketing infrastructure, identification of projects, post harvest handling of horticultural crops and financial analysis of the projects were delivered by the faculty from CIPHET and ICAR, Sh. Mohinder Singh and Sh. Inder Mohan Singh narrated their experiences as successful entrepreneurs. National Institute of Agricultural Marketing, Jaipur, sponsored the programme.

RESEARCH ADVISORY COMMITTEE

1. Prof. B.P.N. Singh — Chairman
   Former Professor
   A 1555, Indira Nagar
   Lucknow - 226016

2. Dr. B. Ranganna — Member
   Professor & Research Engineer
   J-Block, GKVK Campus
   UAS, Bagalore 560 065
   Karnataka

3. Dr. U.S. Shivhare — Member
   Dept. of Chemical Engg.
   & Technology
   Punjab University
   Chandigarh 160 014

4. Dr. P.K. Srivastava — Member
   Faculty of Agril. Science
   Aligarh Muslim University
   Aligarh 202 002 (U.P)

5. Dr. P.K. Chattopadhyay — Member
   Emeritus Professor
   Deptt of Food and Agril Engg
   Indian Institute of Technology
   Kharagpur 721 302

6. Dr. R.P. Kachru — Member
   303, D.K. Rainbow
   Chuna Bhatti
   Kular Road
   Bhopal

7. Dr. S.K. Nanda — Member Secretary
   PC, PHTS, CIPHET
   Ludhiana

INSTITUTE MANAGEMENT COMMITTEE

1. Dr. R.T. Patil — Chairman
   Director
   CIPHET, Ludhiana

2. Dr. D.V.K. Samuel — Member
   Head
   Division of Post Harvest Technology
   IARI, PUSA, New Delhi 110 012

3. Dr. D. Nag — Member
   Head, TOT Division
   National Institute of Research
   on Jute & Allied Fibre Technology
   12 Regent Park
   Kolkata 700 040 (W.B)

4. Dr. S.P. Aggarwala — Member
   Head, Division of Dairy Engg.
   National Dairy Research Institute
   Karnal 132 001 (Haryana)

5. Dr. Pitam Chandra — Member
   ADG (PE)
   Indian Council of Agricultural Research
   Krishi Anusandhan Bhavan-II
   PUSA, New Delhi - 110 012

6. Dr. B.S. Modi — Member
   Principal Scientist (AS&PE)
   IARI, Regional Research Station
   Karnal 132 001 (Haryana)

7. Sh. Tej Ram — Member
   Administrative Officer — Secretary
   CIPHET, Ludhiana

PERSONALIA

JOINING

Dr. R T. Patil, Principal Scientist, CIAE, Bhopal has joined as Director, CIPHET, Ludhiana in the forenoon of 9th June 2006.

Sh. Tej Ram joined CIPHET, Ludhiana as Administrative Officer in the forenoon of 28th September, 2006.

Sh. Hardev Singh, T-2 (Driver) has been promoted to the post of T-3 (Driver) w.e.f. 21.08.2006.

Sh. Sanjay Kumar Gaur has joined the Institute as LDC on 06.11.2006 (F.N.).

PROMOTION

Dr. Devinder Dhingra has been promoted to the post of Sr. Scientist under CAS w.e.f. 07.11.2004

Dr. D. K. Bharti has been promoted form Scientist (SS) to Sr. Scientist under Carrier Advancement Scheme w.e.f. 12.07.2006.

Sh. Yashpal Singh, SSG-II has been promoted to the post of T-1 (Field Assistant)

Sh. Satwinder Singh, SSG-II has been promoted to the post of T-1 (Lab. Asstt.) w.e.f. 09.11.2006.

AWARD/ HONOUR

Dr. S.N. Jha Sr. Scientist received Dr. J. C. Anand Gold Medal of Horticulture Society of India for outstanding contribution and displaying leadership in Post-harvest Management of Fruits. A gold medal and a citation was presented by his Excellency Governer of Assam, Mr. Ajay Singh during 2nd Horticulture Congress held in Barapani, Meghalaya

Dr R. K. Goyal, Principal Scientist awarded Dr. S. R. Bhargava Medal of Broked Research Society, Allahabad for inhibition in the field of Agricultural Structure & process Engineering.

Dr. D.K. Bharti was awarded Post Graduate Diploma in Human Resource Management (PGDHRM) by Indira Gandhi National Open University (IGNOU) in 2006.

RELIEVING

Dr. Dinesh Singh, Scientist (SS) has been relieved from this Institute in the evening of 22nd July, 2006 to join IARI, New Delhi as Sr. Scientist

Sh. Binod Kumar, T-4 (Sr. Lib. Asstt.) has been relieved from this Institute in the evening of 29th July, 2006 to join as T-4 (Sr. Lib. Asstt.) at ILRI, Ranchi on transfer.

Dr. R. R. Sharma, Scientist (SS) has been relieved from this Institute in the evening of 31st July, 2006 to join as Sr. Scientist at IARI, New Delhi.

RETIREMENT / SUPERANNUATIONS

Sh. Shanti Lal Administrative Officer superannuated in the forenoon of 1st September 2006.

Dr. D. S. Uppal, Head, AS&EC superannuated in the afternoon of 31.03.2007.

PERSONNEL

Name	Designation
Dr. R.T. Patil	Director
Dr. S.K. Nanda	Project Coordinator (Post Harvest Technology Scheme)
Dr. O.D. Wanjari	Head, Division of Agril. Structures & Environmental Control
Dr. K.K. Singh	Head, Division of Food Grains & Oilseeds Processing
Dr. Matthew Prasad	Head, Division of Transfer of Technology
Dr. R.K. Gupta	Head, Division of Horticultural Crops Processing
Dr. P. R. Bhatnagar	Project Coordinator (Application of Plastics in Agriculture)
Dr. R.K. Goyal	Principal Scientist (Agril. Structures and Process Engineering)
Dr. S.N. Jha	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Dilip Jain	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Devinder Dhingra	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Deepak Raj Rai	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. K. Narsaiah	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Desh Beer Singh	Sr. Scientist (Horticulture)
Dr. Rajbir Singh	Sr. Scientist (Agronomy)
Dr. Abhay Kumar Thakur	Sr. Scientist (Agril. Structures and Process Engineering)
Dr. Dinesh Kumar Bharti	Sr. Scientist (Agril. Economics)
Dr. Sanjeev Kumar Tyagi	Sr. Scientist (Chem. Engg.)
Er. (Mrs.) Sangeeta Chopra	Scientist (SS) (Electrical Engineering)
Dr. (Mrs.) Mridula Devi	Scientist (SS) (Food & Nutrition)
Dr. Harinder Singh Oberoi	Scientist (SS) (Microbiology)
Dr. S. Balasubramanian	Scientist (SS) (Agril. Structures and Process Engineering)
Er. Rajesh Kumar Vishwakarma	Scientist (SS) (Agril. Structures and Process Engineering)
Er. M.R. Manikantan	Scientist (SS) (Agril. Structures and Process Engineering)
Dr. Satyendra Kumar	Scientist (SS) (Soil and Water Conservation Engineering)
Sh. Goutam Mandal	Scientist (SS) (Horticulture)

Er. Prady uman Barnwal	Scientist (Mech. Engineering)
Er. (Mrs.) S.K. Aleksha Kudos	Scientist (Agril. Structures and Process Engineering)
Dr. Vinod Kumar Bhargav	Scientist (Farm Machinery and Power)
Dr. Dattatrya M. Kadam	Scientist (Agril. Structures and Process Engineering)
Dr. Ramesh Kumar	Scientist (Horticulture)
Er. D.D. Nangare	Scientist (Soil and Water Conservation Engineering)

Technical

Sh. V.K. Garg	T-9 (Training Assoc.)
Sh. Mahipal Singh	T-6 (Technical Officer)
Smt. Satnam Kaur	T-6 (Home Science)
Sh. V.K. Saharan	T-6 (Technical Officer)
Sh. Rajinder Singh	T-5 (Technical Officer)
Sh. O. P. Moondan	T-5 (Technical Officer)
Smt. Promila Rani	T-4 (Library Assistant)
Sh. Mukund Narayan	T-4 (Technical Asstt.)
Sh. Prithvi Raj	T-4 (Technical Asstt.)
Sh. Rajesh Kumar	T-4 (Technical Asstt.)
Smt. Davinder Bhan Chadda	T-I-3 (Data Entry Operator)
Sh. Chaman Lal	T-2 (Lab. Asstt.)
Sh. Hardev Singh	T-3 (Driver)
Sh. Gurdip Singh	T-I-3 (Lab. Asstt.)
Sh. Lakhwinder Singh	T-2 (Fitter)
Sh. Bhajan Singh	T-2 (Fitter)
Sh. Jaswant Singh	T-2 (Welder)
Smt. Sonia Rani	T-2 (Data Entry Operator)
Sh. Hardeep Singh	T-2 (Turner)
Sh. Beant Singh	T-2 (Driver)
Sh. Jaswinder Singh	T-2 (Machinist)
Sh. Jagtar Singh	T-2 (Electrician)
Sh. Pawan Kumar	T-2 (Electrician)
Sh. Vishal Kumar	T-2 (Data Entry Operator)
Sh. Ganpat Ram	T-2 (Driver)
Sh. Devinder Kumar	T-2 (Fitter)
Sh. Dalu Ram	T-2 (Fitter)
Sh. Pradip Kumar	T-1 (Field Asstt.)
Sh. Yashpal Singh	T-1 (Field Asstt.)
Sh. Satwinder Singh	T-1 (Lab. Technician)

Administrative

Sh. Tej Ram	AO
Sh. Vijay Kumar	AF&AO
Sh. J.S. Paul	AAO
Sh. Manni Lal	JAO
Smt. Jasvindar Kaur	Stenographer
Sh. B.C. Katoch	Assistant
Sh. Pawan Kumar	Assistant
Sh. Kunwar Singh	UDC
Sh. Avtar Singh	UDC
Sh. Tarsem Singh	UDC
Sh. Gurdial Singh	UDC
Sh. Harbhupinder Singh	UDC
Sh. Mohan Lal	UDC
Smt. Jasvir Kaur	LDC
Sh. Ashwani Kumar	LDC
Smt. Sunita Rana	LDC
Sh. Ajay Kumar Tandon	LDC
Sh. Ram Khelawan Yadav	LDC
Sh. Sohan Lal	LDC
Sh. Sanjay Kumar Gaur	LDC
Sh. Rajinder Kumar	LDC
Sh. Iqbal Singh	LDC

Supporting

Sh. Sukhbir	SSG-II
Smt. Viran Vali	SSG-II
Sh. Surinder Kumar	SSG-II
Sh. Sarup Singh	SSG-I
Sh. Shalikgarm Dwivedi	SSG-I