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भाकृअनुप
ICAR

केन्द्रीय कटाई-उपरांत इन्जीनियरिंग एवं प्रौद्योगिकी संस्थान

CENTRAL INSTITUTE OF POST HARVEST ENGINEERING & TECHNOLOGY
LUDHIANA

वार्षिक प्रतिवेदन
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CENTRAL INSTITUTE OF POST HARVEST ENGINEERING & TECHNOLOGY

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PREFACE

The institute continued with the good progress shown during previous years in research and extension activities, which got further momentum through in-house and externally funded projects. The research projects covered value addition to food grains, oilseeds, spices, meat, fruits and vegetables, storage of fruits and vegetables, ohmic heating of foods, development of tools and equipments, non-destructive techniques for quality determination, power factor correction system and micro-encapsulation. Dissemination of technologies were done through licensing, publications, presentations, training of entrepreneurs/farmers, exhibitions, video-conferencing, pilot plants, front line demonstration and National Farm innovators meet etc.

The research output included development of non-destructive systems, micro-organisms based ripening/ anti-ripening agent, use of moisture absorbers and anti-microbial agents in packaging, production of cellulases, ethanol, feed supplements, value added product from rice straw and bagasse, pelletization, dewatering process for onion, extraction of dietry fibre from peel, flaxseed as food and feed, flour from de-oiled sesame and peanut de-skinning machine etc.

Fish descaling equipment, ohmic heating, power factor correction equipment and litchi peeling machine are the new developments during the period. A dehuller for dehulling guar gum with 92% efficiency has been developed. Ber destoner, ber fruit grader, fruit harvester for jamun and aonla has also been developed. Mixed fruit aonla cheese was prepared using pulp/juice from aonla, papaya, pineapple and guava. Shelf life of guava was enhanced using coating made from cassava starch, chitosan, rice, turmeric and carnauba wax.

For effective communication of agricultural technologies to the end users, the media and scientists interacted on a common platform. News clippings, television, radio programs and documentaries of agricultural technologies were prepared, published and broadcasted. An exhibition on showcasing of technologies of CIPHET, other institutes and SHGs was held. A national seminar on "Post Harvest Packaging, Cold Chain Logistics and Instrumentation Techniques for Quality and Safety of Perishables" and a national training on "Smart Packaging Techniques for Shelf Life Enhancement and Retention of Bioactive Compounds in Food" were organized. Various training programs sponsored by ATMA and other government agencies were conducted for the farmers and officials from different states in the areas of post harvest technologies and establishment of APCs in rural catchments. The AICRP on Post Harvest Technology and AICRP on Application of Plastics in Agriculture have also developed many useful technologies.

We thankfully acknowledge constant encouragement from Dr. S. Ayyappan, Secretary DARE and DG, ICAR, Sh. Rajiv Mehrishi, Additional Secretary DARE and Secretary ICAR for the cause of post harvest technology and value addition. I acknowledge with thanks the support and cooperation extended by Dr. M. M. Pandey, DDG (Engg), Dr. K.K. Singh ADG (PE), Dr. N.P.S. Sirohi, ADG (Engg), Dr. S. Ganesan, Principal Scientist (Engg.) and Dr.D.Dhingra, Senior Scientist, ICAR, New Delhi . The help rendered by Dr. S.K.Nanda, PC(PHT), Dr.P.R. Bhatnagar, PC (APA), Dr. S.N. Jha, Dr.R.K.Gupta, Dr. D.R.Rai, Dr. Sangeeta Chopra and all scientific, administrative, technical and supporting staff of CIPHET Ludhiana and Abohar, in preparation of this report is highly appreciated.

U. S. Shivhare
Director, CIPHET

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कार्यकारी सारांश

संस्थान ने सत्र 2011.12 के दौरान अनुसंधान एंव विस्तार गतिविधियों में उल्लेखनीय प्रगति की है। इन गतिविधियों को आंतरिक और वाहय वित्त पोषित परियोजनाओं द्वारा सक्रिय किया गया। अनुसंधान परियोजनाओं के अन्तर्गत अनाज, तिलहन, मसाले, फल व सब्जियों का मूल्य वर्धन, मवेशियों व कुक्कुट घरों में पर्यावरण नियंत्रण, केला, आम व अन्य फसलों के लिए उपकरणों का विकास, नॉन डिस्ट्रिक्टिव तकनीक से गुणवत्ता निर्धारण एवं मास आधारित विविध मूल्य वार्धित उत्पादों का निर्माण किया गया।

आम की सतह से निकाले गये जीवाणु जैसे पेन्टोया डिस्पर्सा, बैसीलस थूरीजेनेसिस, बैसीलस सीबी, स्यूडोमोनास टूजरी के मिश्रित कल्चर से निषिकषित एटीपी को दो डिटेक्टर जैसे फलोरोंसेंस स्पेक्ट्रोफोटोमीटर एवं मल्टीलोड माइक्रोप्लेट रीडर द्वारा निर्धारित किया और इसे प्लेट कल्चरिंग द्वारा कुल सूक्ष्मजीवी लोड के साथ सह संबंध किया गया।

कम तापमान एवं एल डी पी ई बैग में रखे गये प्याज के पाउडर की शैल्फ आयु 6 महीने पायी गयी। चार कवक आइसोलेट्स द्वारा निर्मित सेलुलेज एंजाइम का थर्मोस्टेबल विशेषताओं के लिए 50-80 डिग्री सेल्सियस के बीच तापमान द्वारा मूलयांकन किया गया। इस एंजाइम ने 16 घंटों तक 60 डिग्री सेल्सियस पर स्थिर एंजाइम टाइटर प्रदर्शित किये और तत्पश्चात् इसकी गतिविधियों में गिरावट होने लगी। मैप के अन्तर्गत ताजी व ताजी कटी हुई मशरुम की श्वसन प्रक्रिया का मूल्यांकन किया गया। भडारण के तीन दिन बाद नियंत्रित नमूने अस्वीकार्य पाये गये। 15 डिग्री सेल्सियस तापमान पर अछिद्रित पॉलीप्रोपाइलीन फिल्म में ताजे मशरुम की शैल्फ आयु 9 दिन तक बढ़ गयी। न्यूमैटिक सॉसेज फिलर विकसित किया गया जिसमें भरा सिलेण्डर पिस्टन से कस कर लगाया जाता है एवं पिस्टन को ऊपर नीचे करने के लिए न्यूमैटिक परिपथ होता है। न्यूमैटिक परिपथ में हवा कंप्रेसर, फिल्टर नियामक, लुब्रीकेटर (एफ.आर.एल.) इकाई, हवा साइलेंसर के साथ डबल सोलेनॉयड वाल्व (5 पोर्ट-3 स्थान), गति नियंत्रक वॉल्व व न्यूमैटिक सिलेडर होते हैं। अपरिष्कृत एंजाइम का प्रयोग कर धान की उपचारित भूसी से प्राप्त ग्लूकोज को 50 डिग्री सेल्सियस तापमान पर 30-45 मिनट के लिए नैनोफिल्ट्रेशन एवं निर्वात सांद्रण द्वारा 60 ग्राम/लीटर से 220 ग्राम/लीटर तक सांद्र बनाया गया। प्राप्त सिरप का रंग अल्का भूरा था। झिल्लियों के माध्यम से सांद्रित ग्लूकोज सिरप गंधरहित था व इसका खाघ अनुप्रयोग किया जा सकता है। धनिये की पत्तियों का श्वसन दर 29 मिग्रा/किग्रा/घंटा पाया गया।

5-7.5 प्रतिशत तक एलोवेरा लुगदी का प्रयोग करने से भौतिक, रासायनिक व संवेदी गुणों में कोई नकारात्मक प्रभाव नहीं था। एस्परजिलस नाइगर स्ट्रेन से प्राप्त अपरिष्कृत इंजाइम से किन्नू के छिलके के निर्जलीकरण के बाद छिलके से निर्मित सांद्र सिरप में कुल फिनोलिक मात्रा 5 मिग्रा/मि.ली. थी एवं सिरप की स्केवेंजिंग गतिविधि 60-70% थी। सिरप का रंग गहरा भूरा व स्वाद अच्छा है। नियंत्रित तापमान में कांच के बायोरिएक्टर में शुष्क छिलकों का निर्जलीकरण किया गया और प्राप्त सिरप को रोटरी निर्वात सांद्रक का प्रयोग करके निर्वात में सांद्रित किया गया। पूर्व उपचारित एक्सट्यूडेड बायोमास जैसे गेहूं की भूसी व गेहूं का पुआल का मिश्रण का जल विघटन से लगभग 50% शर्कराकरण हुआ। मिश्रण से बने 16 प्रतिशत नमीयुक्त एक्सट्यूडेड उत्पाद में नियंत्रित नमूने की तुलना में महत्तवपूर्ण रुप से कम पीक श्यानयता थी व कुल स्वीकार्यता उच्च पायी गयी।

बाजरा (पीसीबी 164) को 24-72 घंटों के लिए अंकुरित करके आटा बनाया गया। तत्पश्चात् 50-80 डिग्री तापमान पर ट्रे ड्रायर में 6.2 से 9.8 प्रतिशत नमी तक सुखाया गया। पेटेंटेड प्रक्रिया के आधार पर ग्वार की डिहर्लींग के प्रोटोटाइप का मूल्यांकन किया गया। 92 प्रतिशत की डिहर्लींग क्षमता में 98 प्रतिशत की छिलका हटाने की क्षमता देखी गयी। मशीन की क्षमता 80 कि.ग्रा./घंटा है। हाइड्रोथर्मल विधि से उपचारित बाजरे के आटे के नमूनें 50 दिन की भंडारण अवधि तक स्वीकार्य थे। बरसीम चिकोरी बीज सैपरेटर पर अध्ययन किया गया। इसकी क्षमता 50-60 कि.ग्रा.। घंटा पायी गयी। क्रायोजेनिक विधि से पीसे गये मसाले का 'एल' अंक सामान्य

तरीके से पीसे गये मसाले की तुलना में ज्यादा पाया गया जो कि क्रायोजेनिक मसालों की प्रभावशीलता को दर्शाता है। 20 मिनट की पर्लिंग, 15 मिनट के लिए भिगोना, 15 मिनट के लिए भाप देना व तत्पश्चात् 240 मिनट के लिए 50 सेल्सियस पर सुखाने पर के बीज से प्रोटीन से भरपूर आटा प्राप्त हुआं इसमें तेल का निष्कर्षण पूरी तरह से हुआ एवं पोषण विरोधी तत्वों की माला भी कम पायी गयी। 44-72 वोल्ट/सेमी. के बीच मक्के के आटे की ओहमिक हीटिंग में विद्युत चालकता का मूल्यांकन किया गया। तापमान व नमी की मात्रा बढ़ने से विद्युत चालकता में मुख्य रुप से वृद्धिहुई। 44-72 वोल्ट/सेमी. के बीच वोल्टेज गेंडियंट लगाकार 20, 30 व 40 प्रतिशत नमी वाले राइस ब्रान की ओहमिक हीटिंग में चालकता निर्धारित की गयी। तापमान व नमी की मात्रा बढ़ने से विद्युत चालकता में मुख्य रुप से वृद्धि हुई। लेकिन वोल्टेज ग्रेडिएंट में बदलाव के साथ विद्युत चालकता में बदलाव महत्तवपूर्ण नहीं पाया गया। चार महीने के भंडारण के बाद उपचारित व कच्चे भूसे में मुक्त वसीय अम्ल की मात्रा क्रमशः 18.79 व 74.08 प्रतिशत थी। कैटल पायलट प्लांट व एग्रो प्रोसेसिंग सेंटर में मशीनों का पावर फैक्टर मापा गया। इसमें हैमर मिल, क्षैतिज पैलेटाइजर, वर्टिकल पैलेटाइजर व ब्लैंडर का पावर फैकटर बिना लोड व संपूर्ण लोड पर क्रमशः 0.61-0.75, 0.215-0.39, 0.27-0.45, 0.87-0.90 था। मछली डिस्केलिंग मशीन को सुधारा गया। प्रांदेशिक व राष्ट्रीय स्तर के मुख्य अखबारों में लगभग 194 खबरें छपी, सीफेट व एन.ए.आई.पी. की तकनीकियों पर 'दो दूनी चार' शीर्षक से 10 आकाशवाणी कार्यक्रम दूरदर्शन, जी-पंजाबी, पी.टी.सी. आदि पर प्रसारित किये गये। प्रादेशिक स्तर पर कटाई उपरान्त क्षेत्र में सभी स्टेकहोल्डरों को मंच प्रदान करने के लिए एक प्रदर्शनी आयोजित की गयी। राष्ट्रीय फार्म इन्नोवेटर्स मीट के साथ ही मीडिया मिलन का भी आयोजन किया गया। पोस्ट हार्वेस्ट पैकेजिंग, कोल्ड चेन, लॉजिस्टिक्स एंड इन्सट्यूमेंटेशन टेक्नीक्स फॉर कवालिटी एंड सेफटी ऑफ पेरिशेबल्स पर एक राष्ट्रीय सेमिनार आयोजित किया गया। सीफेट ने एन.ए.आई.पी. द्वारा प्रायोजित "स्मार्ट पैकेजिंग टैक्नीक्स फॉर शैल्फ लाईफ इनहेन्समेंट एंड रिटेंशन ऑफ बायोएक्टिव कम्पाउंड्स इन फूड" पर 14 दिवसीय राष्ट्रीय प्रशिक्षण दिया। हरी मिर्च प्यूरी व पाउडर, सोयाबीन प्रसंस्करण, हल्दी प्रसंस्करण, ग्रामीण लोगों के लिए कटाई उपरान्त तकनीक पर 10 प्रशिक्षण दिये गये।

लीची छीलने की मशीन को डिजाइन, विकसित व इसका मूल्यांकन किया गया। मशीन की क्षमता 60 किग्रा/घंटा है एवं 1 हार्स पावर मोटर से चलती है।

खुले खेत की तुलना में उपज व गुणवत्ता के संदर्भ में टमाटर, शिमला मिर्च, गेंदा की खेती के लिए नैट हाऊस में 35 प्रतिशत छाया बेहतर पायी गयी, 25-30 मैश के नैट हाऊस में टमाटर के पौधों में मिली बग का संक्रमण देखा गया, जबकि 60 मेश के नैट हाऊस में टमाटर में कोई कीट संक्रमण नहीं था। 35 प्रतिशत छाया वाले नैट व खुले खेत में गोभी व टमाटर में स्पोडाप्टेरा लिट्रा व सफेद फलाई का काफी संक्रमण देखा गया, जिसे फोलियर उपचार द्वारा नियंत्रित किया गया।

EXECUTIVE SUMMARY

The institute made significant progress in research and extension activities during the reported period of 2011-12. These activities were accelerated through in-house and externally funded projects. The research projects covered value addition of food grains, oilseeds, spices, fruits & vegetables, environment control of cattle and poultry houses, development of tools and equipment for banana, mango and other crops, non-destructive techniques for quality determination and diversified value added products from meat, dissemination of technologies, publications, presentations and training of entrepreneurs and farmers.

The ATP extracted from mixed culture of bacteria *Pantoea dispersa, Bacillus thuringiensis, Bacillus cibi, Pseudomonas stutzeri* (all isolated from mango surface) was determined using two detectors *viz.,* fluorescence spectrophotometer and multi-mode micro plate reader and correlated with total microbial load by plate culturing. Onion powder packed in LDPE bags and low temperature conditions had shelf life of 6 months. Cellulase enzyme produced by the four fungal isolates, isolated from different habitats were evaluated for thermostable characteristics by varying temperatures between 50-80 °C. Enzyme produced by above isolates showed stable enzyme titres at 60 °C until 16 h and a decline in the activity thereafter was seen. The respiratory behavior of fresh and fresh cut mushroom was evaluated under MAP. Control samples became unacceptable after 3rd day of storage. For fresh mushrooms, shelf life was extended up to 9 days in non perforated polypropylene film and with 1-2 macro-perforations at 15°C. Pneumatic sausage filler was developed which consists of filling cylinder tightly fitted with piston and pneumatic circuit to move piston up and down. The pneumatic circuit consists of air compressor, filter regulator and lubricator (FRL) unit, double solenoid valve (5 ports / 3 positions) with air silencer and speed control valve, pneumatic cylinder. Glucose obtained from pre treated rice straw using crude enzyme consortium was concentrated from 60 g/l to 220 g/l through nanofiltration and vacuum concentration at 50 °C in 30-45 min. Syrup obtained was light brown in color. Glucose syrup concentrated through membranes was odourless and could be used in food applications. Respiration rate of coriander intact leaves was found to be 29.0 mg/kg/h. There was no negative effect of using aloe pulp upto 5-7.5% on physicochemical and sensory characteristics. The concentrated syrup prepared from Kinnow peels after hydrolysis of the peels using crude enzyme consortium obtained from the *Aspergillus niger* strain had a total phenolic content of 5 mg/ml and the scavenging activity of the syrup ranged from 60-70%. The syrup was dark brown in colour with a pleasant taste. Hydrolysis of the dried peels was done in a glass bioreactor under controlled temperature conditions and the syrup obtained was concentrated under vacuum using rotary vacuum concentrator. Hydrolysis of the extruded pretreated biomass i.e wheat straw and combination of wheat straw and wheat bran resulted in about 50% saccharification. Extrudates developed from blend having 16% moisture were found to have significantly lower peak viscosity and higher overall acceptability as compared to control sample.

Sprouted pearl millet flour was prepared by sprouting the pearl millet (cv.PCB164) for 24 to 72h, followed by drying in a tray dryer at 50-80° C to 6.2 to 9.8% moisture content. Prototype for dehulling of guar was evaluated based on patented process. The dehulling efficiency of 92% was observed with hull separation efficiency of 98%. The capacity of the machine was 80kg/h. Storage studies on hydrothermally treated pearl millet revealed that flour samples were acceptable till 50 days of storage. Berseem chicory seed separator was tested and a capacity of 50-60 kg/h was observed. L-value for the cryogenically grounded spices was found to be higher than ambient ground spices which indicated the effectiveness of cryogenically grounded spices. A combination of 20 min of pearling, 15 min cooking and 15 min of steaming, followed by drying at 50°C for 240 mins yielded protein rich flour from sesame oilseeds with less residual oil and anti-nutritinal components.

Electrical conductivity values were determined for ohmic heating of maize flour having 20, 30 and 40 % moisture content (w.b.) by applying voltage gradients between 44-72 V/cm. The electrical conductivity increased significantly with temperature and moisture content. Electrical conductivity values were also determined for ohmic heating of rice bran having 20, 30 and 40 % moisture content (w.b.) by applying voltage gradients between 44-72 V/cm. The electrical conductivity increased significantly with temperature and moisture content but the variation in EC was not significant with the variation in voltage gradient. FFA in ohmically heated rice bran and control was measured. The FFA of treated and raw bran was observed to be 18.79% and 74.08% respectively after 4 months of storage. Power factor of the machines installed in cattle pilot plant and APC were measured. The power factor of hammer mill, horizontal pelletizer, vertical pelletizer & blender in cattle pilot plant at no load and on full load was in the range of 0.61-0.75: 0.215-0.39: 0.27-0.45: 0.87-0.90 respectively. Around 194 news-clippings were published in leading regional and national dailies. 10 Radio programmes titled "Do Dooni Chaar" on CIPHET and NAIP technologies were broadcasted on TV programmes on Doordarshan, Zee Punjabi, PTC etc. To provide platform to all stakeholders in post harvest sector at regional level an exhibition was organized. Media meet was organized on sidelines of National Farm Innovators meet. The national seminar on "Post-Harvest Packaging, Cold-Chain Logistics and Instrumentation Techniques for Quality and Safety of Perishables" was organized. CIPHET conducted the 14-day NAIP sponsored National training on "Smart Packaging Techniques for Shelf Life Enhancement and Retention of Bioactive Compounds in Food". 10 trainings on making green chilli powder/puree, *Soybean processing and value addition,* Turmeric processing, Post Harvest Technology for Rural Catchments, and processing and value addition were conducted.

A litchi peeling machine was designed, developed and evaluated. The machine has a capacity of 60 kg/h and operated by 1hp electric motor. 35% shading in net house was observed to be better for the cultivation of tomato, capsicum and marigold, in terms of yield and quality as compared to open field. Mealy bug infestation was recorded in tomato plants under 25-50 mesh net-houses. Whereas no pest infestation was found in tomato under 60 mesh net-houses. Severe infestations of *Spodoptera litura* and whitefly were observed in cauliflower and tomato under 35% shade net and open field, which can be controlled by foliar treatment.

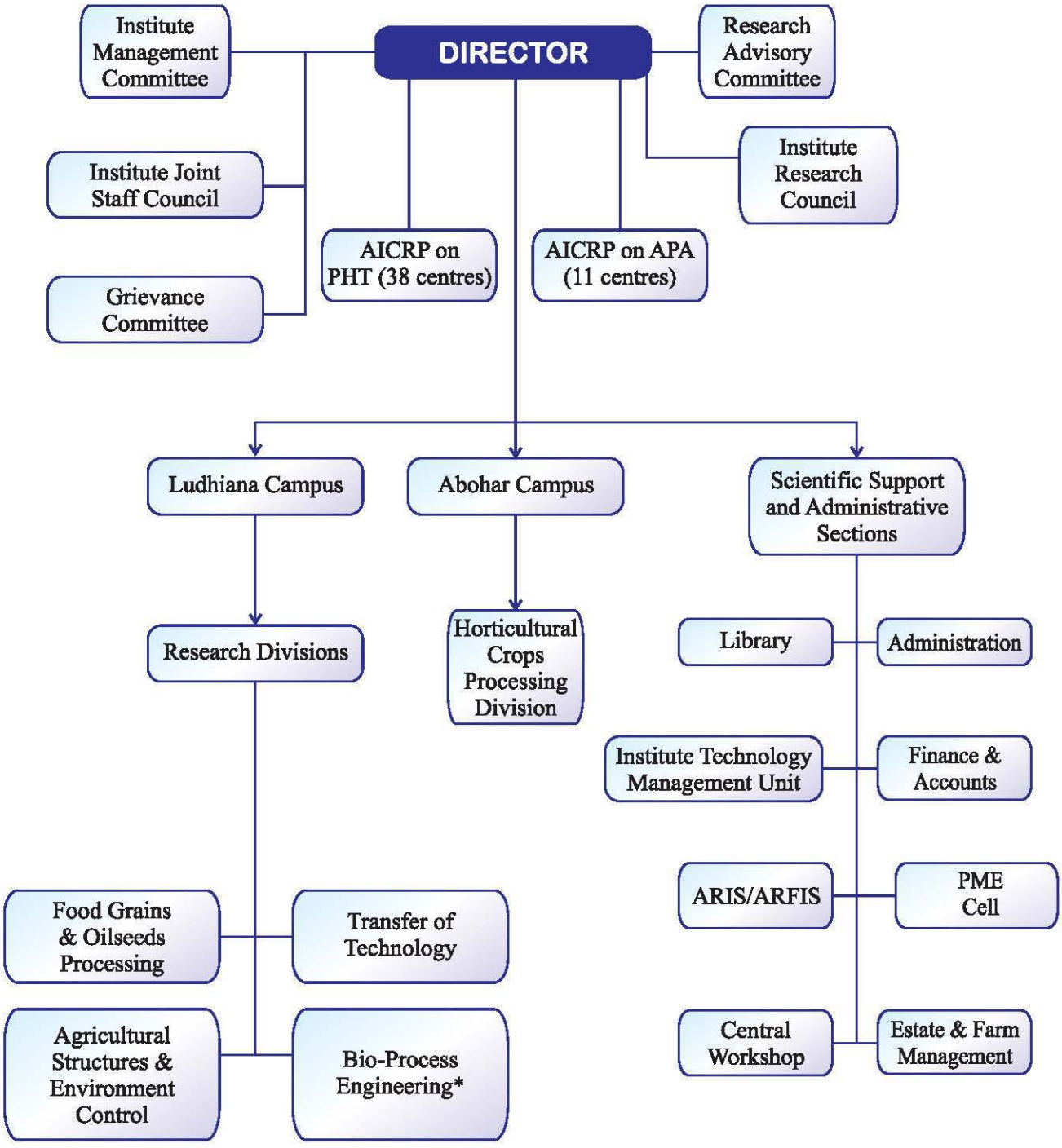
CIPHET - AN OVERVIEW

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

Mandate

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

ORGANIZATIONAL STRUCTURE



** Proposed to be established*

RESEARCH DIVISIONS

Ludhiana Campus

1. Agricultural Structures and Environment Control
2. Food Grains and Oilseeds Processing
3. Transfer of Technology
4. Bio-Process Engineering*

Abohar Campus

6. Horticultural Crops Processing

** Proposed to be established*

INFRASTRUCTURE

LIBRARY

The library of CIPHET has good collection of books and journals in the area of post-harvest engineering, biotechnology, food engineering and food microbiology that attracts many researchers / visitors from all over the nation to review the literature in post-harvest technology. It has a huge collection of various referred journals and books. Details are as follows :

Particular	Number
Books	4651
Annual Reports and Research Highlight etc.	970
Indian Journals	21
Foreign Journals	16
Bound volumes collections	967

The breakup of books and journals purchased in the year 2011-12 is as follows :

Books (Hindi)	11
Books (English)	31
Indian Journals	15
Foreign Journals	5

AKMU/ARIS Cell

The Institute has an Agricultural Knowledge Management Unit (AKMU) for the scientists for their data analysis and electronic communication. The unit has latest fifteen desktop computers including three servers. More than 100 desktop computers of the institute are well connected through local area network and internet. Internet connectivity is available through 100 mbps line provided by National Knowledge Network (NKN). All the computers are protected by the server based Symantec Anti Virus. Internet is provided to different nodes through proxy server Nebero. The Nebero facility provides the information of internet bandwidth; user details, security and stability on the network. Besides, the AKMU houses a number of analysis and design software such as Front Page 2003, Corel draw graphics Suite, Adobe Professional, SAS, Design Expert Software, Leap Office 2000 (Hindi Software). Institute Website www.ciphet.in is also maintained by AKMU.

At present following services are provided by AKMU.

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

Institute Technology Management Unit (ITMU)

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

1. Advisory & Consultancy: For general information regarding CIPHET developed

technologies, anyone can enroll as member of the institute by paying fees of Rs 1000/- only for one year. In return, institute provides all the general information for one year.

2. Training and Licensing: For practical training on a particular technology and hands on experience for 3-5 days, fees are charged. In this case, training certificate and license of technology is issued to the contracting party after successful completion of training.

3. Signing of MOU: Institute signs MOU with firms and NGO's interested in training (paid), general information, guidance, establishment of food processing industries and various activities related to postharvest technologies, value addition etc.

Prioritization, Monitoring & Evaluation (PME) Cell

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

STAFF POSITION (AS ON 22.03.2012)

Category	Sanctioned strength	Filled		Total Filled
		Ludhiana	Abohar	
Scientific	76*	31	08	39
Administrative	22#	16#	04	20
Technical	29	21	07	28
Supporting	04	03	01	04
Total	131	71	20	91

* Excluding Director
# Including SAO & F&AO

AICRP on Post Harvest Technology, CIPHET, Ludhiana

Category	Sanctioned Posts	Posts in Position
Scientific	3*	2
Administrative	2	0
Technical	4	0
Supporting	1	0
Total	10	2

* including PC (PHT)

AICRP on Application of Plastics in Agriculture, CIPHET, Ludhiana

Category	Sanctioned Posts	Posts in Position
Scientific	2	1
Administrative	3	1
Technical	2	2
Supporting	2	0
Total	9	4

STATEMENT OF BUDGET ESTIMATES AND EXPENDITURE (2011-2012)

NON - PLAN

(Rs. in lakhs)

S.No.	Account Head	Revised Estimate 2011-2012	Progressive Expenditure 2011-2012
1.	Establishment Charges	518.65	483.11
2.	Travelling Allowances	2.50	2.49
3.	Recurring Contingencies (incl. equipment)	51.65	29.57
4.	Works		
5.	Major Works	0.00	0.00
6.	Office Building	4.50	2.39
7.	Residential Building	2.00	1.26
8.	Minor Works	3.50	0.43
9.	HRD	0.00	0.00
	Total	**582.80**	**519.25**

PLAN

(Rs. in lakhs)

S.No.	Account Head	Revised Estimate 2011-2012	Progressive Expenditure 2011-2012
1.	Establishment Charges	0.00	0.00
2.	Travelling Allowances	11.74	11.72
3.	Recurring Contingencies (incl. equipment)	326.09	297.07
4.	Works		
5.	Major Works	155.97	155.97
6.	Office Building	0.00	0.00
7.	Residential Building	0.00	0.00
8.	Minor Works	0.00	0.00
9.	HRD	3.00	2.01
	Total	**496.80**	**466.77**

RESEARCH ACHIEVEMENTS

AGRICULTURAL STRUCTURES AND ENVIRONMENT CONTROL DIVISION

Development of non-destructive system for evaluation of microbial and physico-chemical quality parameters of mango (NAIP subproject)

S N Jha, K Narsaiah, Pranita Jaiswal and Ramesh Kumar

ATP luminescence biosensor for total microbial load

ATP bioluminescence based assay was evaluated for rapid estimation of microbial load as an alternative to conventional microbiological culturing techniques. The assay is based on the premise that all living things contain ATP and that intracellular ATP levels must be constant for cells to maintain normal physiological activities. The concentration of ATP determined in a sample is therefore proportional to the actual number of cells. ATP standard solution was prepared in de-ionized water from 10^{-4}- 10^{-13} M. Bioluminometer (Synergy H1 Hybrid Multi-Mode Micro plate Reader of Biotek USA, Fig 1a) and Fluorescence spectroscopy (Cary Eclipse of Varian USA, Fig 1b) were used for luminescence measurement.

Fig. 1a. Bioluminometer

Fig. 1b. Fluorescence spectrometer

In fluorescence spectroscopy the detectable range of ATP concentration was found from 10^{-4} to 10^{-8} M with R^2 of 0.96 (Fig. 2), and in bioluminometer the detectable range of ATP concentration was from 10^{-4} to 10^{-13} M with R^2 of 0.96. Effectiveness of different ATP extracting methods (0.03M TCA, 0.06M TCA, 0.2M Tris EDTA and sonication) was evaluated and extraction using 0.03M TCA showed the best result.

A correlation was observed between bacterial cell concentration with ATP luminescence and the range of detection was 10^2 to 10^6 cfu /ml (Fig. 3).

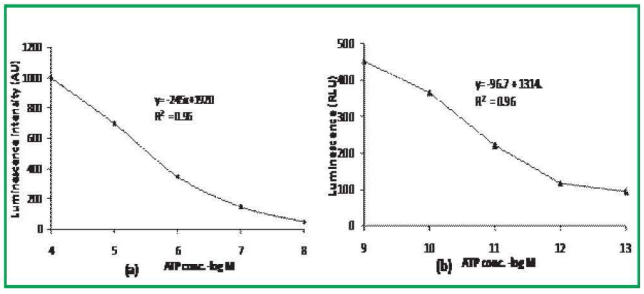


Fig. 2. Standard ATP assay by using (a) fluorescence spectroscopy (detectable range 10^{-4} - 10^{-08}M ATP) (b) Bioluminometer (detectable range 10^{-9} to 10^{-13} M ATP).

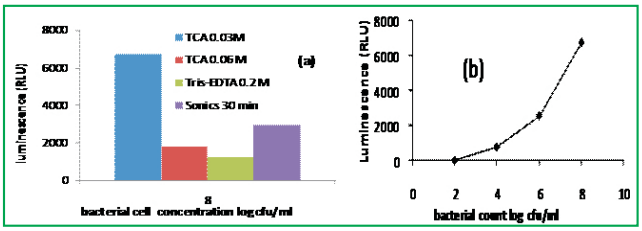


Fig. 3. Luminescence intensity of same concentration of bacterial cell ATP extracted by different treatments. (b) Relationship of plate count with ATP luminescence

In pursuance of alternative rapid methods, the potential of visible and near-infrared (NIR) spectroscopy in the wavelength range of 299-1100 nm and 900-1700 nm were evaluated to determine total microbial load on mango surfaces. NIR models were developed using multiple-linear regression (MLR) and partial least square (PLS) regression employing pre-processing techniques (baseline correction, smoothening, multiplicative scatter correction (MSC) and second order derivatives). Wavelength range of 299-1100 nm was found to be more suitable as compared to the wavelength range of 900-1700 nm for estimation of microbial load. The maximum multiple correlation coefficients for calibration and validation were found to be 0.66 and 0.56, respectively in the wavelength range of 504.806 - 533.176 nm.

Quartz crystal microbalance (QCM) biosensor for spoilage and /or toxigenic microorganism

Purified polyclonal anti-*Salmonella* antibodies (0.1mg/ml) were immobilized on quartz crystal for detection of *S. enteriditis* cells (procured from Microbial Type Culture Collection (MTCC), Chandigarh). Different steps in development of QCM immunobiosensor are shown in Fig. 4.

The frequency was measured, before and after addition of *S. enteriditis*. The frequency shift (ΔF) was the difference between these two readings. A linear relationship between the frequency shift (-3200 to -13000) and logarithmic value of *S. enteriditis* concentration was found in a range 1.5×10^{2} to1.5×10^{6} cfu/ml, and the coefficient of determination (R^2) was 0.98 with RSD < 3%. The increase in resonant frequency shift in liquid contact mode was from 35-161 Hz with increase in cell concentration of *S. enteriditis* (Fig. 5 & 6).

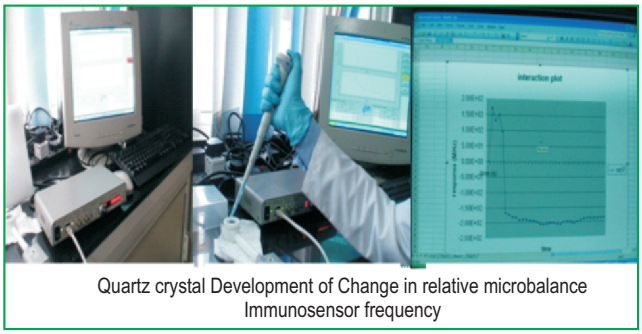


Fig. 4. Detection of pathogen by using QCM based biosensor

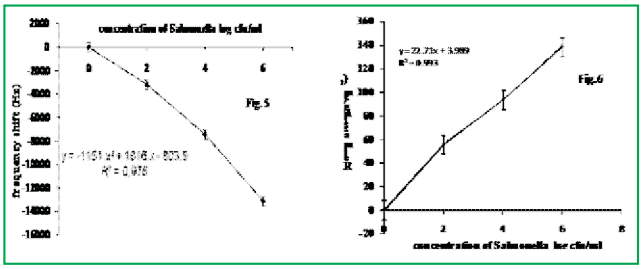


Fig. 5 & 6 Correlation between frequency shift (Hz) of the immunosensor and concentration (log cfu/ml) of *s. enteriditis* (n=5) in air contact mode and in liquid mode.

This non-Sauerbrey response of increase in frequency may be attributed to Brownian motion and the nature of velocity fluctuations in liquid near the surface. It might be causing antibodies to buoy up and therefore the apparent overall mass on crystal surface decreased causing the crystal to resonate at higher frequency compared to resonant frequency of crystal with antibodies only. Compared to air contact mode, the frequency shift was low with higher RSD (12-25%). It can thus be inferred that the air contact mode is more sensitive than that of liquid contact.

The specific target (*S. enteriditis*) showed decrease in frequency with time where as the non-specific target (*E. coli*) did not show any reactivity with antibodies on quartz crystal (Fig. 7). Three food samples namely milk, mango juice and guava juice, spiked with *S. enteriditis* were tested to evaluate the

immunosensor in food matrix. The detection limit in milk, mango and guava juices was found to be 10^2 cfu/ml with RSD < 5%. The frequency shift in all samples was <3000 Hz as compared to frequency shift in PBS (>3000 Hz) at the concentration of 10^2 cfu/ml. The frequency shifts and RSD were less for food samples as compared to that of pathogens in PBS (Fig.8) indicating interference of constituents of food samples.

Physico-chemical quality parameters

Variation in physico-chemical characteristics such as TSS, titratable acidity (TA), dry matter (DM) and eating quality viz. appearance (APR) and taste (TST) scores were studied as a function of harvesting

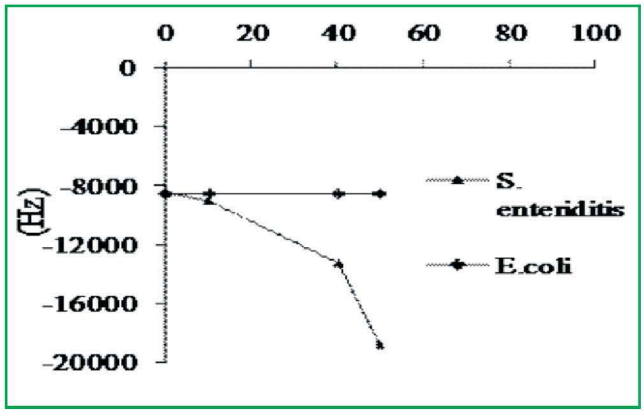


Fig. 7. The real-time frequency response for a antibody coated crystal exposed to *s. enteriditis* cells (Δ) (10^6 cfu/ml) and non-specific cell, *e. coli* (♦) (10^7 cells/ml) (n=3)

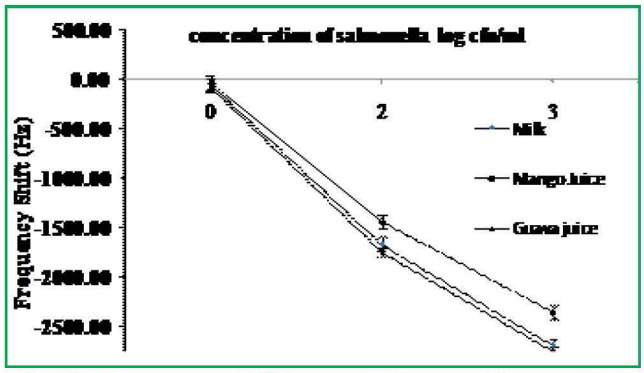


Fig. 8. Frequency shift caused by negative controls uninoculated samples) and inoculated with *S.enteriditis* in milk, mango juice and guava juice samples respectively, ranging from 2 and 3 log cuf/ml with RSD < 5% (n=5)

stage. TSS, TA and DM varied between 7.6 to 22.1°Brix, 6.31 to 0.24 % and 14.84 to 31.67 %, respectively. The surface of first and second harvest mangoes got shriveled and did not ripen well except cv. *Chausa* and *Langra* obtained from Uttar Pradesh, *Maldah* from Bihar and *Mallika* from Odisha during ripening. However, mangoes from third harvest ripened well and led to higher sensory scores except cv. *Alphonso* obtained from Karnataka and *Neelam* from Tamil Nadu. Among selected cultivars, the mango showing superior eating quality exhibited variations in TSS, TA and DM in the range of 11.7 to 14.6 °Brix, 0.51 to 6.28 % and 18.94 to 27.36 %, respectively at the time of harvesting. The correlation coefficient ranged between 0.98 to 0.68, 0.99 to 0.78 and 0.91 to 0.35 for TSS, TA and DM, respectively. The measured quality parameters therefore may be taken as maturity indicators to decide the optimum picking date of mango cultivars or could further be used to develop the maturity index.

Prediction of maturity and eating quality

Spectral data were analyzed using MLR and PLS. The best MLR models were in the wavelength range of 1600-1800 nm for maturity index and dry matter with multiple correlation coefficients for calibration of 0.89 and 0.81 respectively (Fig. 9). Acidity however could be better predicted in the spectral range of 475–925nm using PLS model having multiple correlation coefficients for calibration and validation of 0.77 and 0.67, respectively (Fig. 10). Maximum values of R for calibration and validation of TSS in PLS regression were found to be 0.73 and 0.72, respectively for the wavelength range of 1600-1799 nm, whereas in case of MLR these values were 0.83 and 0.45 respectively. This indicated that MLR model is more suited for the prediction of TSS although, the large difference in R values of calibration and validation may cause instability during prediction. The calibration model could slightly be improved using pre-processing techniques. The best calibration was found following treatment of spectra using second order derivatisation which yielded highest R values

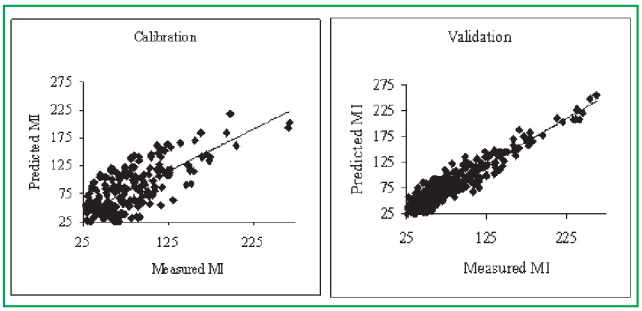


Fig.9 : Scatter plots of different varieties of mango for maturity index (MI) in wavelength range of 1600-1800 nm for calibration and for validation set of samples

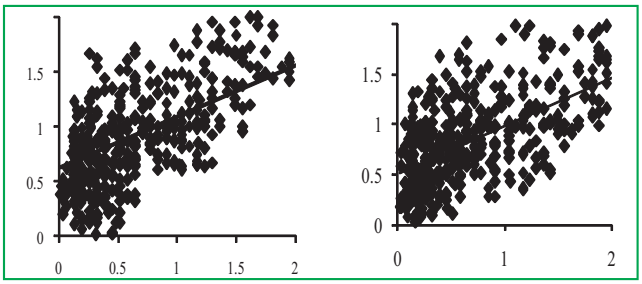


Fig.10: Scatter plots of different varieties of mango for acidity after second order derivatisation in wavelength range of 475-925 nm for calibration (a) and validation (b) set of samples

of calibration and validation (0.78 and 0.76, respectively). This indicated that TSS could be predicted with reasonable accuracy using PLS model (Fig. 11a). Scatter plots of models after second order derivatisation of the wavelength range of 1600 – 1799 nm indicated that the slope of the curve is near

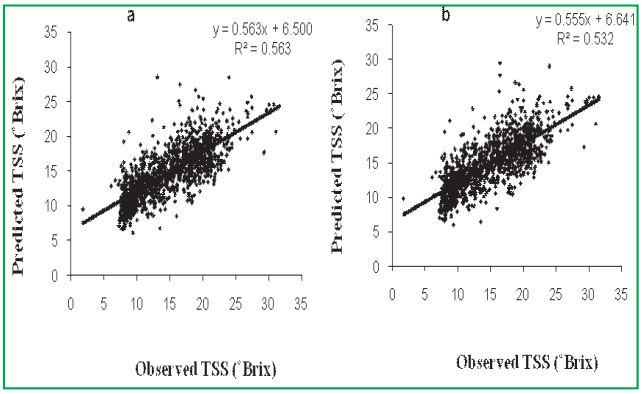


Fig.11a. Scatter plots of different varieties of mango for TSS after second order derivatisation in wavelength rage of 1600-1799 nm for calibration (a) and validation (b) sets of samples

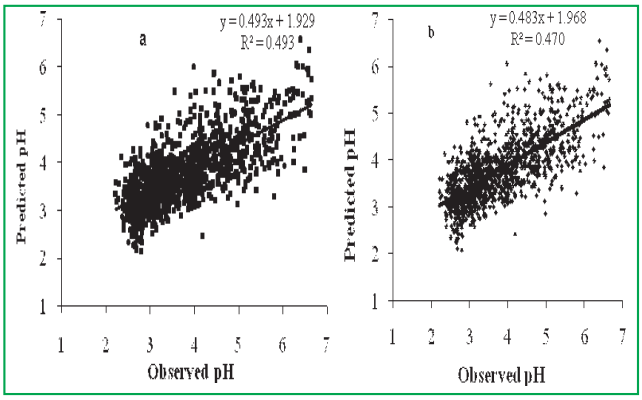


Fig.11b. Scatter plots of different varieties of mango for pH after second order derivatisation in wavelength rage of 1600-1799 nm for calibration (a) and validation (b) sets of samples

to 45° and thus predicted values were very close to measured ones. The wavelength range for the developed calibration model using PLS for prediction of pH was found to be 1600-1799 nm (Fig. 11b). The highest R values for calibration and validation were 0.72 and 0.70, respectively following second order derivatisation. Scatter plots developed model showed that the slope of the curve is near to 45° and thus predicted values were very close to measured ones.

Varietal identification of mangoes using NIR

Identification of mangoes presently is being carried out visually which might be misleading during marketing at least in cities. NIR spectral data were therefore analyzed to explore the possibility of identifying mangoes using instrumental methods.

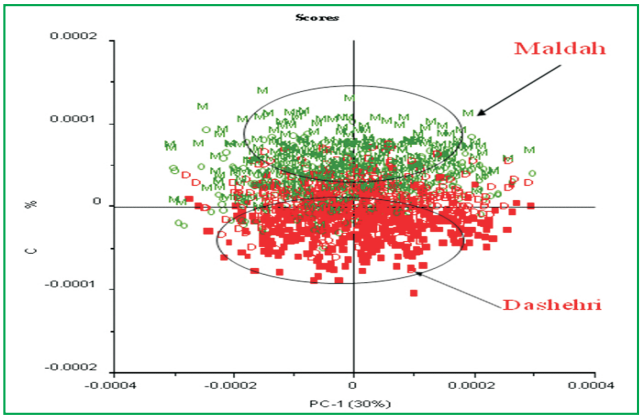


Fig. 12. Score plots of classifying the mangoes using spectral signature in NIR range.

Score plots indicated that there is possibility of classifying the mangoes using spectral signature in NIR range (Fig. 12).

Discriminate analysis using PLS characteristics variables taken as 0 and 1 were carried out and results showed that *Alphanso* could be discriminated if mixed with *Banganapalli* variety. Similarly *Maldah* could be identified when mixed with *Dasheheri* variety. The results indicated that these verities could be identified with at least 94% accuracy (Table 1) while other cultivars did not show appreciable results. Similarly a rapid method for qualitative and quantitative prediction of adulteration of mango juice by outside sugar has been established using ATR-FTIR in conjunction with chemometric analysis of spectral data (Jha and Gunasekaran, 2010).

Value Chain on Novelty Pork Products under Organized Pig Farming System (*NAIP subproject*)

K. Narsaiah, Suresh K. Devatkal

A refrigerated transport vehicle was developed to lower down the temperature of meat and meat products for safety storage and the distribution of centrally packaged retail ready meat and raw meat. Chilling of livestock carcasses is employed to ensure food safety, maximize shelf life, and reduce shrinkage with less emphasis on maintaining tenderness and colour factors of the finished product and raw meat. Temperature is the most important extrinsic factor influencing the storage life of fresh

Fig. 13. Refrigerated transport vehicle

Table 1: Varietal identification of mango using NIRS

Varieties	No. of samples	⩾ 0.5		⩾ 0.5		Correctly classified (%)
		Calibration	validation	calibration	Validation	
Alphonso	325	10	3	315	322	99.07
Banganpalli	239	238	238	1	1	99.58
Dasheheri	431	3	7	428	424	98.37
Maldah	317	315	298	2	19	94.0

Table 2: Effect of chilling on colour of meat

		0 hrs	4h	8 h	12 h	24 h
Chilled sample	L	31.20	37.16 [a]	28.26	28.52	37.50 [b]
	a	8.43	6.64	14.18 [b]	16.11 [a]	12.64 [b]
	b	9.56	8.50	11.75	15.34 [a]	15.59 [a]
Control sample	L	23.66	27.96	30.79	29.70	31.34
	a	15.14 [a]	11.36	10.01	11.50	8.63 [a]
	b	12.03 [a]	10.07	12.16	12.12	17.19 [a]

meat. This vehicle can also be used for other perishable items like fruits, vegetables, milk, fish etc.

The developed refrigerated transport vehicle has a refrigeration unit mounted on top for cooling the solution of ethylene glycol and salt stored in the jacket of insulated box (Fig. 13). This solution is cooled to subzero temperature by running the refrigeration unit by plugging to power source for 8-10 h before use. The refrigerated transport vehicle has capacity to transport 300 kg of meat and meat products to lower the temperature of meat up to 5 °C. The unit was tested with pork meat to check the effect of chilling on carcass. The effect of chilling on colour is shown in Table 2. The variance for colour values of L, a, b are 0.77%, 6.12 and 9.46% respectively (Fig. 14).

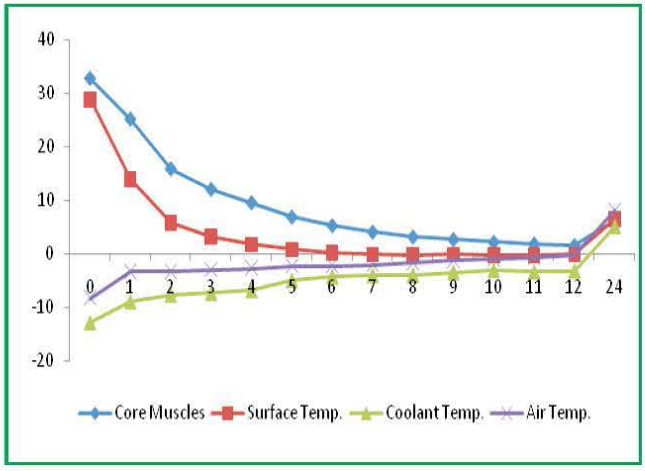


Fig. 14. Temperature profile for 24hrs cooling of meat careass in refrigerated transport vehicle

The experiment showed the reduction of core muscle temperature up to 7°C in just 6 h and maintains the temperature below 7°C up to 24 h.

Sausage Filler

For making of the sausage, minced meat with other ingredients is forced to fill in tubular casing by applying high pressure with the help of pneumatic cylinder. Tubular shape of meat is made with the help of round shape funnel attached with the horizontal cylinder. The casing cylinder is filled with minced meat by adding salt, herbs or spices according to taste or by different recipes.

The whole construction mounted on square steel frame, a pneumatic cylinder is fitted inside the frame, and the side wall of frame is covered with the steel plates. The FRL unit is attached with one side of steel plate and connected with the air compressor to supply compressed air to pneumatic cylinder for lifting and downing the piston mounted on cylinder (Fig. 15).

The sausage filler consists of the casing cylinder, pneumatic cylinder, solenoid valve, air silencer, foot switch, FRL unit, air compressor and a funnel. The machine has steel frame covered with SS sheet.

The cylinder has capacity to make 5 kg of sausages. It was tested with minced meat to make the sausages and had efficiency about 75-80% to make sausages from 5 kg minced meat at a time; time required for making sausage is 2-3 minutes.

Fig. 15. Sausage Filler

Indigenous Meat Cutter

The meat cutter/bowl chopper is the commonly used meat chopping equipment designed to produce small or very small ("finely comminuted") lean meat and fat particles. Bowl cutters consist of a horizontally revolving bowl and a set of curved knives rotating vertically on a horizontal axle at required speeds. Bowl cutters are equipped with a strong cover. This lid protects against accidents and its design plays a crucial role in the efficiency of the chopping process by routing the mixture flow. Number, shape, arrangement, and speed of knives are the main factors determining the performance of the cutter. Bowl cutters are used to chop and mix fresh or frozen lean meat, fat (and/or edible offal, if required) together with water (often used in form of ice), functional ingredients (salt, curing agents, additives) and extenders (fillers and/or binders). Indigenous meat cutter can be used for the manufacture of processed meat products like, kebabs, sausages, koftas, nuggets, patties, tikkas etc. (Fig. 16).

The Specifications of meat cutter are as under ;

Bowl Capacity (L)	Power requirement kW)	Number of blades/ knife	Shaft-knife speed (rpm)	Bowl rotation	Sound level (dB)	Chopping time (min)
5	0.74	2	320	Fixed	80	4-6

Fig. 16. Indigenous meat cutter

Experiment was done on meat emulsions prepared using food processor (FP), an indigenous meat cutter (MC) and bowl chopper (BC) were evaluated for physicochemical, texture and electron microscopic studies (SEM). Product yield, emulsion stability, hydration properties and gel strength (N) were significantly ($P < 0.05$) higher in BC. Total fluid release (TFR), water release (WR) and fat release (FR) was lowest in BC. Significantly ($P < 0.05$) higher lightness (L) in BC and redness (a) in FP emulsion were observed. Higher firmness, gumminess, chewiness and cohesiveness were observed in BC emulsion. SEM studies revealed a

Table 3: Effect of treatments on meat emulsions

Parameter	Treatments			Mean standard error
	FP	MC	BC	
Yield (%)	85.1[a]	90.8[b]	92.3[b]	0.54
Total fluid released (%)	19.2	18.3	17.8	1.85
Water released (%)	17.2	16.6	16.6	1.84
Fat released (%)	2.0	1.6	1.2	0.35
Gel strength (N)	3.7[a]	4.1[a]	5.2[b]	0.17
Moisture (%)	71.8[b]	71.3[a]	71. 9[b]	0.15
	Hunter colour values of raw emulsions			
L	60.1[a]	68.0[b]	72.3	0.49
a	9.8[b]	7.6[a]	6.9[a]	0.23
b	18.7	19.1	19.0	0.30

dense and compact protein matrix characteristic of heat induced protein gels. All micrographs showed structures that are compatible with fat globules, muscle fiber, meat protein matrix and heat induced gel/protein matrix. Thus, food processor and indigenously developed meat cutter found suitable for producing a stable meat emulsion required for indigenous meat products.

Micro-encapsulation methods for Bacteriocins for their Controlled Release

K Narsaiah , SN Jha, MR Manikantan

Optimizing microencapsulation of nisin with sodium alginate and guar gum

Incorporation of nisin into food systems is another challenge as directly added nisin is prone to inactivation by food constituents. Encapsulation of nisin has been done so far in liposome which is rather an expensive technology involving multiple processes. Other cost effective alternatives with good encapsulation efficiency and better control release properties are sought. Alginate is useful as a matrix for entrapment of bioactive compounds. Present study was aimed at optimizing conditions for microencapsulation of nisin using calcium alginate as primary wall material and guar gum as filler at different air pressures using response surface methodology. A 17 run Box-Benhken design with three factor and three levels, including five replicated at the centre point, was used for the fitting a second order response surface. The actual encapsulation efficiency obtained in experiments and predicted encapsulation efficiency produced by the model are given in Table 4.

In order to determine whether the quadratic model was significant, it was necessary to run ANOVA analysis. The ANOVA of quadratic regression model demonstrated the model to be

Table 4: Actual and predicted values of encapsulation efficiency for experimental runs of Box-Behnken design.

Run	Guar Gum %	Sodium Alginate %	Pressure bar gauge	Encapsulation Efficiency (Actual)%	Encapsulation Efficiency (Predicted) %
1	0.4	2.5	0.25	37.415	36.270
2	0.6	2.0	0.25	37.989	37.842
3	0.4	2.0	0.50	36.942	36.653
4	0.4	2.0	0.50	36.535	36.653
5	0.4	2.5	0.75	37.107	36.528
6	0.2	2.0	0.75	30.259	30.406
7	0.2	2.0	0.25	28.157	28.870
8	0.4	1.5	0.25	24.929	25.508
9	0.2	1.5	0.50	22.081	20.789
10	0.4	2.0	0.50	36.733	36.653
11	0.2	2.5	0.50	30.415	30.847
12	0.6	2.0	0.75	36.432	35.719
13	0.4	1.5	0.75	23.521	24.666
14	0.4	2.0	0.50	36.891	36.653
15	0.6	1.5	0.50	27.110	26.678
16	0.6	2.5	0.50	37.951	39.243
17	0.4	2.0	0.50	36.162	36.653

mathematical equation expressing relationship of encapsulation efficiency with variables $X_{guar\ gum}$, $X_{alginate}$ and $X_{pressure}$ is given below in terms of coded factors. $Y= 36.65 + 3.57X_{guargum} + 5.66X_{alginate} -0.15X_{pressure} – 2.40X_{guargum}^2 – 4.86X_{alginate}^2 -1.04X_{pressure}^2 +0.63X_{guargum}X_{alginate} – 0.91X_{guargum}X_{pressure} + 0.27X_{alginate}X_{pressure}$

significant, as is evident from Fisher's F-test value being 46.08. The *P*-value was used as a tool for checking the significance of each coefficient. It also indicated the interaction strength of each parameter. The smaller the *P*-value, the larger is the significance of corresponding coefficient. Here the *P*-value was smaller than 0.0001which indicated that the model was suitable for use. The fitness of the model was further confirmed by a satisfactory value of coefficient of determination (R^2) which was calculated to be 0.983. The value of adjusted coefficient of determination ($R^2_{adjusted}$) was calculated to be 0.962 which established high significance of the model. At the same time relatively low value of the coefficient of variation (3.36%) indicated greater accuracy and reliability of the experiment. The linear terms $X_{gum\ gum}$ and $X_{alginate}$ as well as $X_{alginate}^2$ were significant model terms with *p*-value less than 0.0001. $X_{gum\ gum}^2$ was also significant model term with *p*-value less than 0.01. $X_{gum\ gum}$, $X_{alginate}$ and $X_{pressure}$ had largest effect on encapsulation efficiency. $X_{pressure}$ was non-significant as revealed by high *P*-value.

The 3D plots are the graphical representations of the regression equation and are presented in Fig.17 from which the value of encapsulation efficiency for different variables can be predicted. These graphs are plotted as a function of two of factors while keeping the third as constant at its mean level. There was increase in encapsulation efficiency with increase in both alginate and guar gum concentration. The maximum encapsulation efficiency was achieved

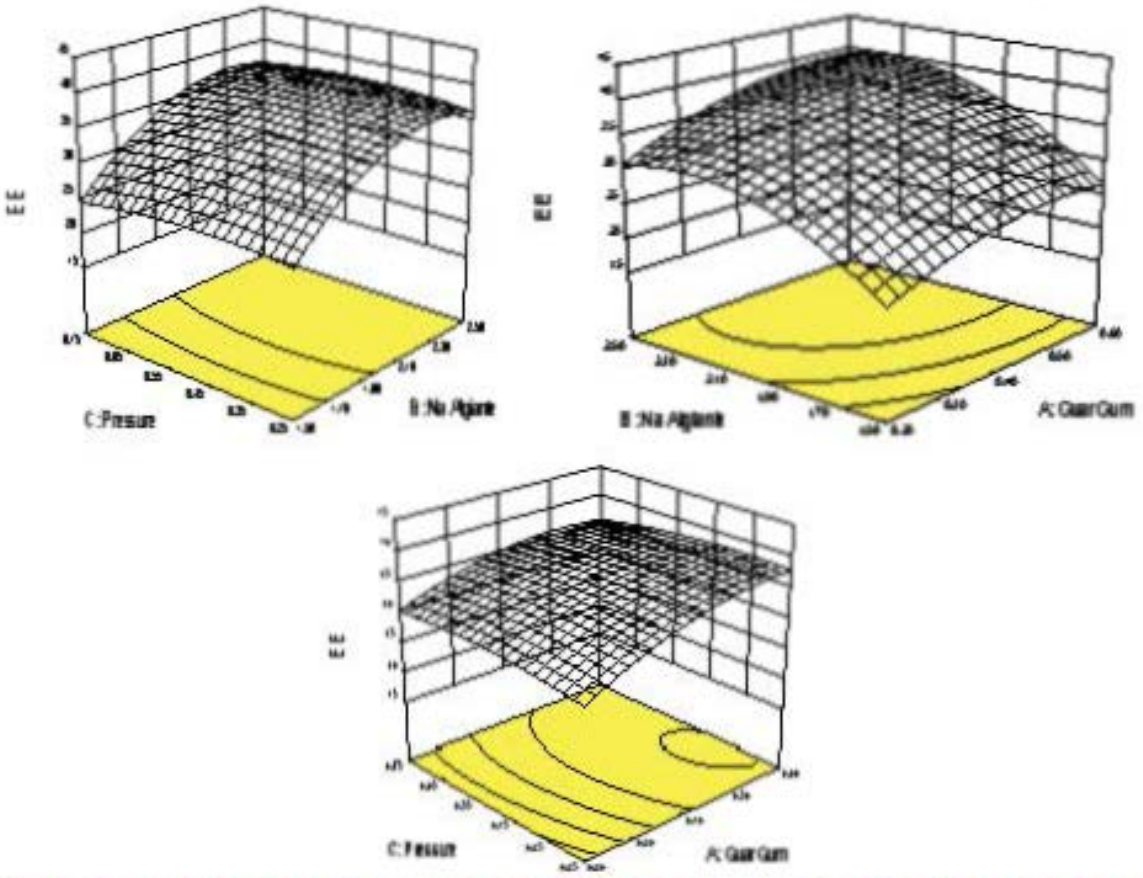


Fig. 17. Response surface plots for encapsulation efficiency (EE) with respect to (a) sodium alginate and guar gum, (b) sodium alginate and air pressure and (c) Guar gum and air pressure

with highest concentrations of alginate and guar gum. Pressure had no significant effect on encapsulation efficiency as can be observed from the surface plots.

A numerical procedure was carried out for predicting the optimum level of alginate concentration, guar gum concentration and air pressure leading to the desirable encapsulation efficiency. The optimization procedure showed that the optimum values were: Sodium alginate concentration (2%w/v), guar gum concentration (0.4% w/v), and air pressure (0.5bar gauge). Under these optimum conditions, the predicted response value for encapsulation efficiency was 36.65% which was close to experimental encapsulation efficiency (36.65%) obtained by testing the microcapsules prepared according to the optimized conditions. The prediction error for encapsulation efficiency for three variables was found to be 1.2%. These results represents that the regression equation was a suitable model to describe the response of experimental parameters to the encapsulation efficiency of microcapsules. The mean particle size of the microcapsules was 233 µm. Morphologically capsules were spherical in shape, were shiny and whitish in colour. Surface of the capsules was not very smooth with small pits on its walls (Fig 18).

An autoclavable microencapsulation system with multistage break up two fluid nozzle was developed for microencapsulation of sensitive food components which are prone to contamination (microorganisms and their products) including bacteriocins. This system consists mainly of autoclavable vessel, multistage breakup two fluid nozzle and programmable pump (Fig. 19). Microencapsulation of yeast, *Lactobacillus casei*, crude bacteriocins, nisin, xylanase and amylase was done. Optimization of particle size was achieved by controlling different process variables. Particle size ranges from 100- 500µm. Patent was filed and technology was transferred.

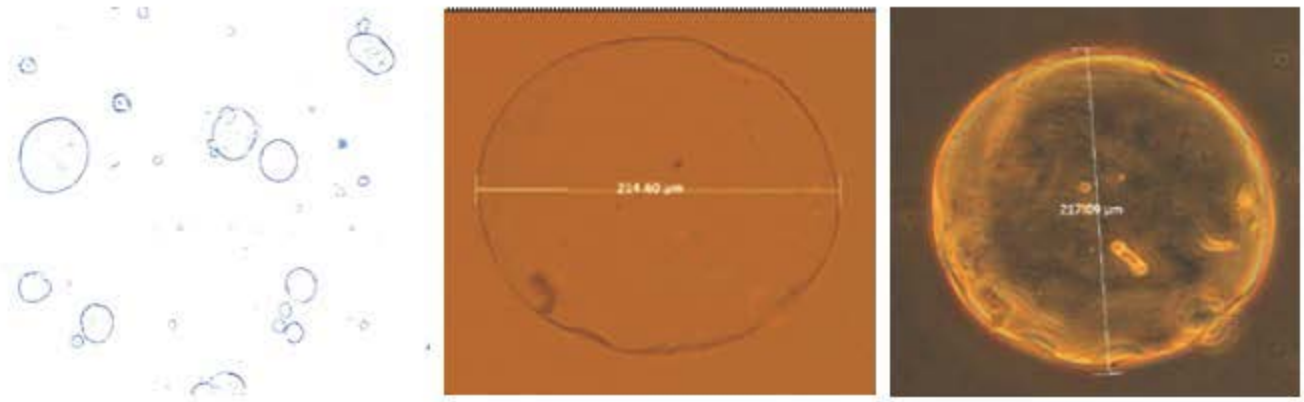


Fig. 18. Morphology of microcapsules (produced at optimized conditions) (a) 10 X magnification, (b) 40X-bright field, and (c) 40X-dark field

Optimization of parameters for utilization of paddy straw, kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements, sub-project under AMAAS

Harinder Singh Oberoi

Pea pod waste is a good substrate for cellulase production. Statistical process optimization using pea pods was done to enhance the cellulase activity.

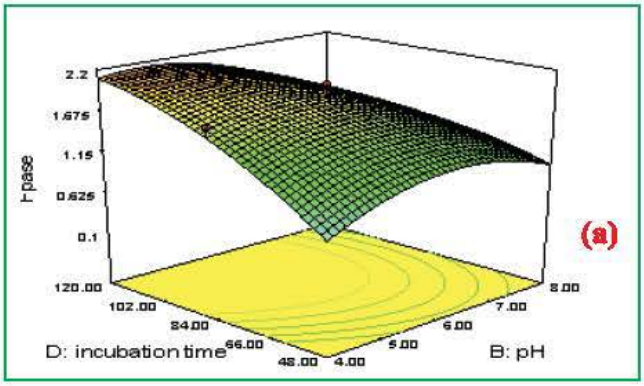
Fig. 19 Autoclavable microencapsulator system

Filter paper cellulase and β-glucosidase activity of 30 FPU/gds and 280 IU/gds, respectively were obtained during the validation studies with *Aspergillus niger* using the optimized parameters, viz., 55% moisture, pH-4.2, temperature- 30 °C and incubation time of 112 h.

The products such as candies, beverage, leather and pickle prepared from Kinnow peel were evaluated for nutritional, sensory and shelf life studies. It was observed that the products possessed the similar characteristics during three months of storage under ambient conditions (Fig. 20).

Effect of significant interactions on filter paper cellulage activity and β-glucosidase activity is depicted in Figs. 21-22. Crude enzyme successfully hydrolyzed the alkali treated rice straw with about 77% hydrolytic efficiency.Two yeast strains and a bacterial strain isolated using selective adaptation on xylose medium have shown the capability to assimilate and ferment pentose sugars such as, xylose and arabinose. Xylitol was produced from hydrolyzate obtained using mild acid pretreatment of rice straw. Hydrolyzate thus obtained was fermented using the newly isolated strain of *Pichia carribica*. The yeast showed xylose to xylitol conversion of 55%

Fig. 20. Products prepared from Kinnow residues



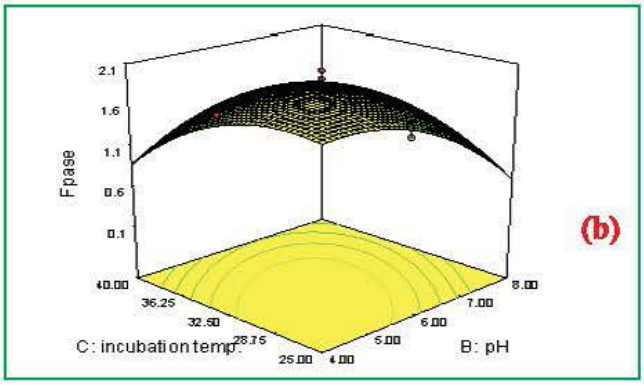
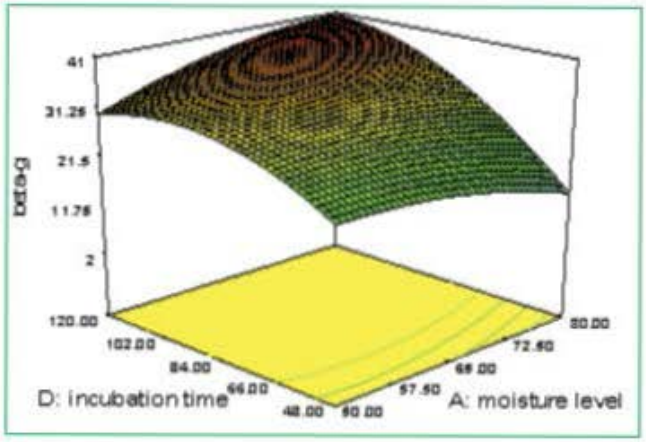
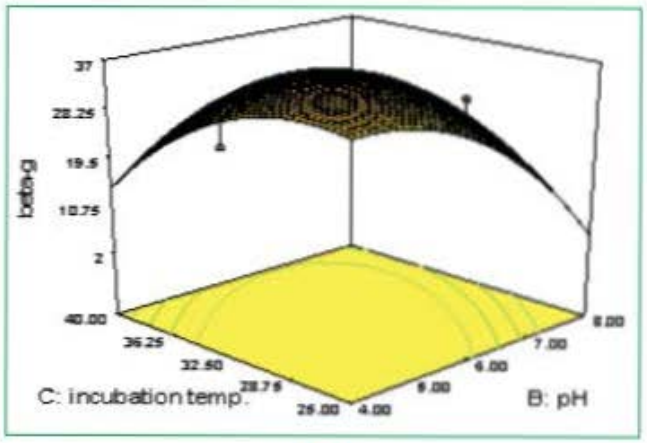


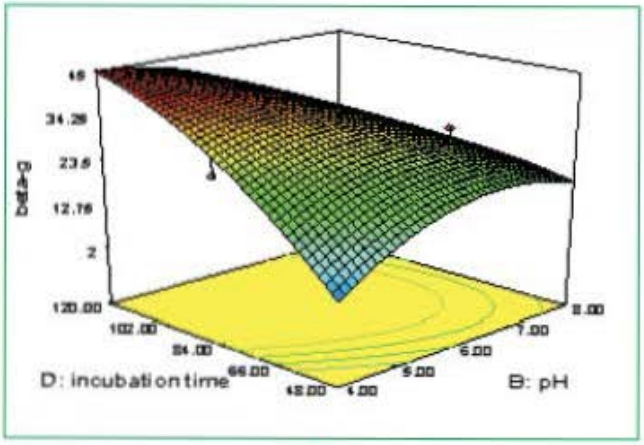
Fig. 21: Effect of (a) incubation temperature and pH and (b) incubation time and pH on filter paper cellulase activity by *Aspergillus niger* using pea pods as substrate



(a)



(b)



(c)

Fig. 22: Effect of (a) incubation time and moisture content (b) incubation temperature and pH and (c) incubation time and pH on β-glucosidase activity by *Aspergillus niger* using pea pods as substrate

Novel biotechnological processes for production of high value products from rice straw and bagasse, NAIP sub-project

Harinder Singh Oberoi, M. Manjunatha

Five fungal isolates belonging to the genus *Aspergillus* have shown a good cellulolytic ability, out of which four isolates have been identified as strains of *A. oryzae* (2), *A. niger* and *A. fumigatus* through molecular characterization. Statistical process optimization employing Plackett-Burman design in combination with central composite design (CCD) as and when appropriate or CCD alone was used to optimize different process and operational parameters. Validation studies conducted using two *Aspergillus* isolates in a SSF tray bioreactor showed three and two fold increase in filter paper and β-glucosidase activity, respectively. The enzyme used for hydrolysis was recovered from hydrolysate using suitable UF membranes. Analysis of the residual paddy straw after enzyme extraction showed nearly a 50% increase in protein content, 10-15% increase in Ca and Mg content and reduction in K, P and S content by about 8-15% compared to the native paddy straw. The phylogentic dehdrogram for *Aspergillus niger HN-2* and related strain is given in Fig. 23.

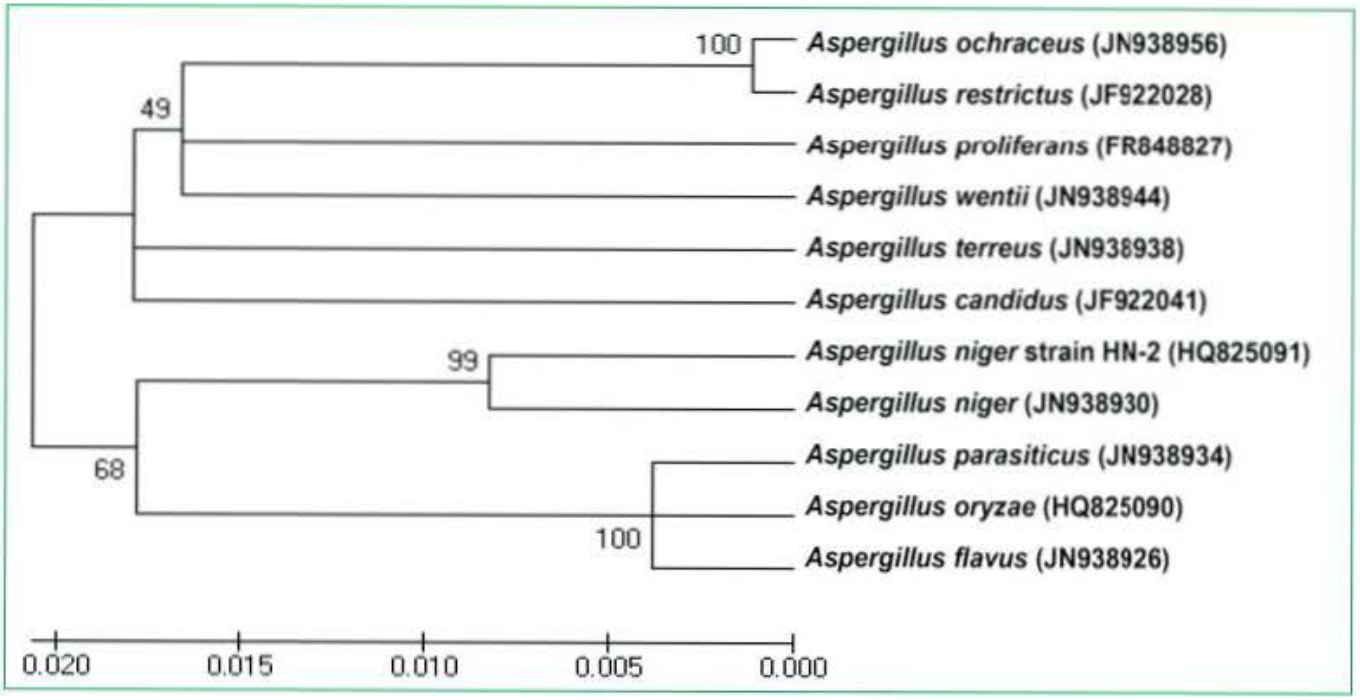


Fig. 23: Phylogenetic dendrogram for *Aspergillus niger* HN-2 and related strains with their accession numbers based on the 26s rRNA gene sequence

Development of technologies for pelletization, delignification and saccharification of cellulosic biomass such as rice straw, cotton stalk, sweet sorghum, switchgrass, *Prosopis julifera* and *Lantana camara*, DBT project

Harinder Singh Oberoi, Rahul K. Anurag

An integrated pilot plant for pretreatment, hydrolysis and fermentation for production of value-added products from crop residues has been designed and installed. The integrated pilot plant was tested with about 3 kg rice straw and the sugar yield to the extent of 60% of the theoretical efficiency could be achieved. Some minor additions have been made to the design to improve the efficiency of the pilot plant before the same could be tried with bagasse.Rice straw and bagasse pellets made with 40% and 35% moisture, respectively using custom-designed pelletizer, without the use of binders showed comparable textural attributes after seven months of storage. No bacterial, yeast or mold growth was observed in the pellets after three months storage. Dilute acid treatment of rice straw with 0.8% (w/v) sulphuric acid, 140 °C for 15 min was found to be optimal for obtaining glucose in significant quantities. Hydrolysis of the pretreated rice straw biomass at 15% (w/v) with concentrated crude enzyme resulted in about 75% glucan to glucose conversion. Custom-designed biomass extruder has been procured and installed (Fig. 24). The testing of the machine was done with wheat straw and combination of wheat straw and wheat bran. The extruder was run twice with each material at moisture content varying from 20-25% and the results were found to be satisfactory in terms of expulsion of biomass from the extruder. Hydrolysis of the extruded pretreated biomass resulted in about 50% saccharification (Fig. 25).

Fig 24 : Extruder for biomass processing

Fig 25: Integrated pilot plant for pretreatment, hydrolysis and fermentation for production of value-added products from crop residues

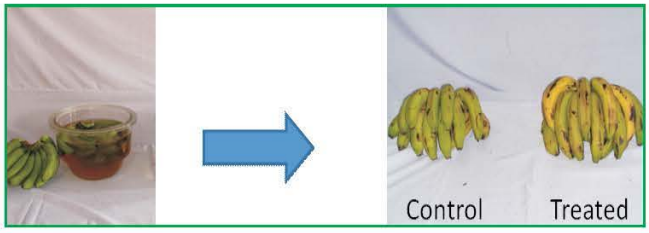


Fig 26 : Changes observed between control and treated banana samples

Development of microorganisms based ripening/anti-ripening agent for mango and banana

Pranita Jaiswal

Protocol for evaluation of role of microbes in ripening was finalized; Role of 10 microbial cultures in ripening of mangoes was tested. Results showed that 1 mold and 2 bacterial cultures were having potential to enhance the ripening process, as evident from 6-15% increase in TSS content and the increment was statistically significant. Further treatment of banana bunches with microbial extract/culture for 2 hours at room temperature (19-20^{0}C), resulted into hastening the ripening of banana 2 days before untreated one without any additional chemical treatment as evident from 10-12% lower fruit firmness and 13-18% higher TSS content compared to control. The bacterial isolate purified from surface of spoiled fruits and vegetables were evaluated from ethylene production (Fig. 26). However, no detectable ethylene production was observed.

Role of 3 bacterial cultures in anti-ripening mangoes have been tested. Results showed that one bacterial isolate significantly delayed the ripening process (based on ANOVA results). In order to further enhance the shelf life of mango the cumulative effect of microbial treatment and packaging were studied. Results showed that among three bacterial isolates, one bacterial treatment along with packaging at 14^{0}C could enhance the shelf life of mango to 25 days.

NIR spectral data was also correlated with microbial load on mango surface (obtained during year 2010-11) was analysed, Wavelength range of 299-1100 nm was found to be more suitable for prediction of microbial load on the mango surface as compared to the wavelength range of 900-1700 nm.

The maximum multiple correlation coefficients for calibration and validation were found to be 0.66 and 0.56, respectively in the wavelength range of 504.80-533.17 nm. Color ('L', 'a' and 'b' value) and textural attributes of bananas (peel, fruit and pulp firmness; pulp toughness; stickiness) were studied simultaneously. In order to correlate textural and color attributes of banana, five types of equations were evaluated. Among them, polynomial equation was found to be the best fit for prediction of texture using color properties for bananas. The 'a' value showed R^2 above 0.84 with pulp firmness, peel toughness and pulp toughness indicating its potentiality in predicting textural profile of bananas non-destructively.

Development of partial dewatering process for onion for value addition and safe storage

Manpreet Kaur Grewal, SN Jha

Onion powder obtained using the optimized process condition i.e Agrifound dark Red, 59.43% dewatering and 68.29°C temperature sieved through 30 mesh sieve (ADOGA) was stored in three types of packaging material i.e. LDPE (51.3 µm thickness), HDPE (49.5 µm thickness)and aluminium foil (65.7 µm thickness). The packages were sealed using heat sealing machine. The samples were stored in three conditions in month of February i.e. ambient, ambient but dark and refrigerated for a period of six months and evaluated for quality attributes at regular interval of 2 months. Quality parameters evaluated during storage were Pyruvic acid content (measure of pungency), non enzymatic browning, colour (L*, a* and b* values), ascorbic acid content, aerobic plate count and coliforms count. After six months it has been observed that LDPE/aluminum foil can be used as package material for storage of onion powder. HDPE is not a suitable package for storage of onion powder prepared by partial dewatering process. To maintain original colour, flowability and other quality attributes of powder,it should be stored under refrigerated conditions. A falling film evaporator with capacity10 kg/h was designed and outsourced to local firm for fabrication. Proximate composition of onion juice concentrate was found to be: 22.68% moisture, 15.04% protein, 1.51% ash, 3.22% fat and 57.54% carbohydrate. Onion juice concentratrate with 75% total soluble solids has phenol content 13.74 mg/ml and ascorbic acid 643.3 mg/100g. Density of fresh juice and concentrate (70°brix) at 30°C was 1025 kg/m^3 and 1283-1299kg/m^3 respectively. Thermal conductivity of fresh juice and concentrate (70°brix) at 30°C was 2.79±0.5 W/mK and 0.52±0.15 W/mK respectively.

Rapid identification and detection of microbes in poultry meat using IR spectroscopy and chemometrics

Manpreet Kaur Grewal, Pranita Jaiswal

One of the poulty specific microbial strain (*Pseudomanas)* procured from IMTECH, Chandigarh was revived of to achieve active growth phase, routine sub-culturing of all the bacterial strains (*E. coli, Salmonella enteritidis*, *Pseudomonas ludensis* and *Listeria monocytogenes*) was done in every 48 h to keep them in active phase of growth. In order to acquire spectra of samples with varying concentrations of bacterial population eight different dilutions were prepared with 10 replications for all the four bacterial cultures viz. *Pseudomonas ludensis, E. coli, Salmonella enteritidis* and *Listeria monocytogenes*. Spectral signature of different dilution with 10 replication each for *E. coli, Salmonella enteritidis, Pseudomonas ludensis* and *Listeria* were acquired using FTIR spectrometer in the range of 4000-375cm^{-1} with ZnSe ATR crystal cell and in the range of 299-1110 nm using NIR spectrometer. The

microbial population in the samples was simultaneously validated by traditional colony count method. The unmodified spectra of four bacterial species in the range of 4000-375cm^{-1} showed different patterns in range of 2955-2965 cm^{-1}, while those in range of 299-1110 nm showed vary high noise level due to uneven surface of sample holder hence found unsuitable for analyses.

Packaging and allied applications for bioactive components, antioxidants and microbiological safety of fresh and fresh-cut fruits and vegetables.

Manjunatha M, Rahul K. Anurag

MAP technology to delay and minimize chilling injury to cucumber under low temperature: Cucumber (*Cucumis sativus* L.) is not suitable for long term storage even at low temperature as it susceptible to chilling injury at 10°C or low temperature and yellowing at 15 °C or higher (Fig. 27a).

Fig. 27a : Effect of treatments on the quality of cucumber

Film packaging of fruits and vegetables reduces physical, physiological and pathological deterioration throughout marketing, reduction of moisture loss and modification of in-package atmosphere. Low density polyethylene (LDPE) bags were used for MAP study to minimize chilling injury under cold room (4±1°C and 90±2% RH). Cucumbers stored in perforated MAP under cold room (4±1°C and 90±2% RH) and ambient condition (23-26°C and 63-66% RH) were evaluated for physiological loss in weight (PLW), firmness, colour, chilling injury and sensory characteristics. After 12 days of storage the PLW was in the range of 1.62-12.89% whereas the cucumber stored under MAP having 2 perforations at 4±1°C and 90±2% RH recorded least PLW of 1.62%. The firmness of cucumbers was decreased to 0.33 and 0.32 N on 6th and 12th day of storage, respectively from initial value of 0.37 N. The minimum change in colour (Hunter L, a and b values) was observed in the cucumber samples stored at cold room condition. The increase in 'b' values (yellowness) was more in the sample stored at ambient condition with unsealed sample registered highest 'b' values (35.82). On 12th day of storage, sensory quality evaluation revealed that samples stored under perforated MAP at 4±1 °C and 90±2% RH were acceptable in condition with sensory score of 7.1 and 7.5. Chilling injury was severe in sample unsealed (4.4 chilling injury score). The study revealed that cucumber can be stored under MAP with 2 perforations at 4±1°C and 90±2% RH and ambient condition (23-26 °C and 63-66% RH) for 12 and 6 days, respectively.

Active MAP technology of green beans: Green beans (*Phaseolus vulgaris* L.), also called as snap beans, is one of the important vegetable grown and consumed in most of the countries in world. In India, green beans mostly consumed afresh. Green beans are highly perishable vegetable as they quickly deteriorate if not given proper temperature management. Green beans can be preserved by high pressure processing, freezing and canning. These methods are costly and pose some disadvantages like discoloration, chilling injury. Green beans stored under modified atmosphere packaging (LDPE, 10±1 °C and 90% relative humidity) were evaluated for physico-chemical, sensory and

instrumental texture and color properties. Further, the effect of macro-perforation (2, 4, 6 and 0.3 mm dia each) and five gram mustard seeds flour on these qualities were also evaluated. Physiological loss in weight (PLW) of beans and weight gain (WG) by mustard seeds flour was in the range of 1.20-9.56% and 23.08-32.30%, respectively. Maximum amount of total phenol content (99.95 mg/100 g) was observed in non-perforated MAP. The retention of ascorbic acid content was least (5.12 mg/100 g) in control samples while it was maximum (13.20 mg/100 g) in samples stored in MAP (2 perforations) with mustard seeds flour. Generally, decrease in firmness and increase in slicing force was observed with storage period. After 15 days of storage, the total plate counts were maximum in control (9×10^5 cfu/g) than all other perforated samples. Changes in instrumental color were maximum in control sample. It was concluded that 2 perforations with MAP and 5 g mustard seed flour was beneficial in improving the physico-chemical and sensory quality of green beans.

Non-chemical based moisture absorbents under MAP to increase shelf-life and maintain quality of minimally processed cauliflower: Minimally processed cauliflower generates high humidity under MAP due to high transpiration rate of exposed cellular structure. The in-pack high humidity get condensed at refrigeration temperature due to lower water vapor transmission rates (WVTR) of polymeric films relative to the transpiration rates of the cauliflower, causing microbial growth and quality deterioration. The study was undertaken to investigate the effect of moisture absorbents (PHP:paddy husk powder; SG:silica gel; MSF:mustard seeds flour, 5 g each) on postharvest quality of minimally processed cauliflower stored under polypropylene MAP (2 perforations, 0.3 mm dia each) at 3±1 °C and 90% relative humidity (Fig. 27b).

The sample packed with SG had maximum physiological loss in weight (2.54%). The SG absorbed highest in-pack water vapor (71.45 % of its weight) followed by PHP (32.18 %) and MSF (31.50 %). Total phenol content (mg/100 g) increased to 183.6 from 162.7. Ascorbic acid retention was maximum in the samples packed with SG (88.27%) followed by MSF (87.46%), PHP (87.16%) and control (85.65%). Total microbial load (4×10^6 cfu/g) was lowest in sample packed with MSF while it was highest in control (16×10^6 cfu/g). The samples packed with MSF, PHP and SG had good overall

Control Mustard seed flour Silica gel Paddy husk powder

Fig. 27b: MAP samples of cauliflower

sensory quality score and less water vapor accumulation than control while slight wilting was observed in samples packed with SG. Results indicate that PHP, SG and MSF have potential to control high humidity under MAP of minimally processed cauliflower for maintaining its postharvest quality.

Shelf-life extension of meat and meat products using natural extract and vacuum packaging as hurdles.

Suresh K. Devatkal, K. Narsaiah

The major research work was focused on evaluation of antibacterial activity of pomegranate peel extract (PPE). Experiments were conducted to know the the antibacterial activity of pomegranate peel extract against *Bacillus cereus*, *Staphylococcus aureus*, and *E.coli* of poultry origin. The average diameter of inhibition zones for *Bacillus cereus* were 21mm, 18mm, 11mm in water extract, autoclaved water extract and methanolic extract respectively and 35 mm and 35 mm in chloramphenicol and clindamycin respectively. A clear zone of inhibition was (22) mm observed against staphylococcus aureus. Effect of dipping of chicken legs in pomegranate peel extract for 10 minutes was evaluated. Results showed the total plate counts of log 4.1, log 3.4, log 2.4 cfu/g in chicken legs dipped in sterile distilled water, pomegranate peel extract and 0.01% sodium hypochlorite respectively. Experiments were also conducted to know the effect of vacuum packaging on shelf-life of meat products. Overall TBARS values were 0.25, 0.16 and 0.13 mg malonaldhyde/kg meat in control, vacuum packaged and natural extract and vacuum packaged goat meat samples. In aerobic packaged meat, total plate counts reached more than log 7 cfu/g in 6 days and in vacuum packaged meat APC were below log 7 cfu/g even after 9 days of storage. The results of vacuum packaging studies showed that use of vacuum packaging and 1 % pomegranate peel extract extended the shelf-life of raw goat meat by 3 days and cooked goat meat nuggets by 7 days.

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

Suresh K. Devatkal, Rahul K. Anurag & P.S. Rao

The optimization of pressure, time and temperature combination for shelf-life extension of fresh meat using high pressure was carried out. Independent variables of pressure (varied from 100 to 600 MPa),) and temperature (varied from 5 to 45 C) were studied to know the optimum combination (Fig 28).

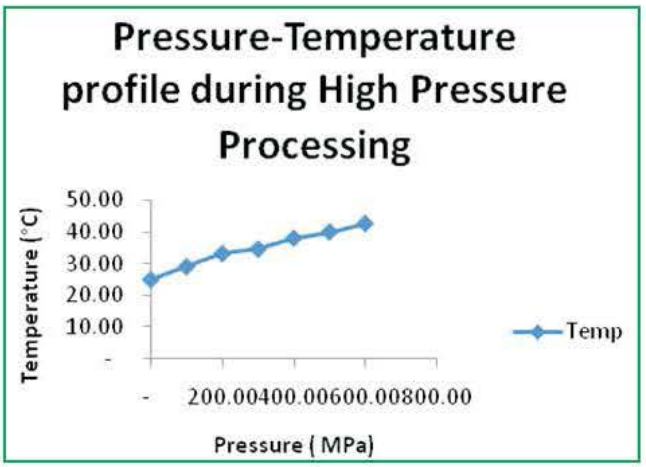


Fig 28: Pressure Temperature Profiling during High Pressure processing

The reduction in total microbial load, lipid oxidation (Thiobarbituric acid reacting substances), sensory attributes, texture and spoilage characteristics (slime, odour, colour) were studied to know the effect of high pressure on the shelf life extenstion and microbial safety. The results showed that high pressure had a significant effect on the peak cutting force (N) values when compared to control (Table 5 and 6).

Table 5: Effect of High Pressure processing on Texture Profile Analysis, Peak cutting force and Puncture strength of poultry leg meat.

Samples	Peak Cutting Force (N)	Puncture Strength (N)	Hardness (N)	Gumminess (N)	Cohesiveness	Springiness (mm)	Chewiness (N-mm)
Control	110.4	7.10	311.97	125.56	0.409	0.443	54.36
High Pressure Processed	242.99	6.96	300.44	144.56	0.471	0.76	121.96

Table 6: Effect of High Pressure processing on Color value of poultry breast and Leg meat

Samples	L value	a value	b value
Control Breast	56.65	0.88	8.32
High Pressure Processed Breast	72.08	0.055	13.60
Control Leg	55.57	0.88	8.32
High Pressure Processed Leg	72.75	2.544	12.54

Development of novel value added meat products (pastries and spreads) with or without use of non-meat ingredients.

Yogesh Kumar, Tanbir Ahmad, Manpreet Grewal

Two new meat products with good acceptability scores were developed. Response surface methodology (RSM) was employed for simultaneous analysis of the effects of added meat and other non meat ingredients on the overall acceptability, spreadability and cooking yield of chicken meat spread and overall acceptability and springiness for chicken meat pastries (Fig. 29).

For chicken spread the optimized level of meat, fat, spice mix and binders is 51.45-54.03%, 29.23-29.43%, 4.39-4.44% and 4.19-4.36% respectively. There was no significant result between these optimized levels for overall acceptability, spreadability and cooking yield

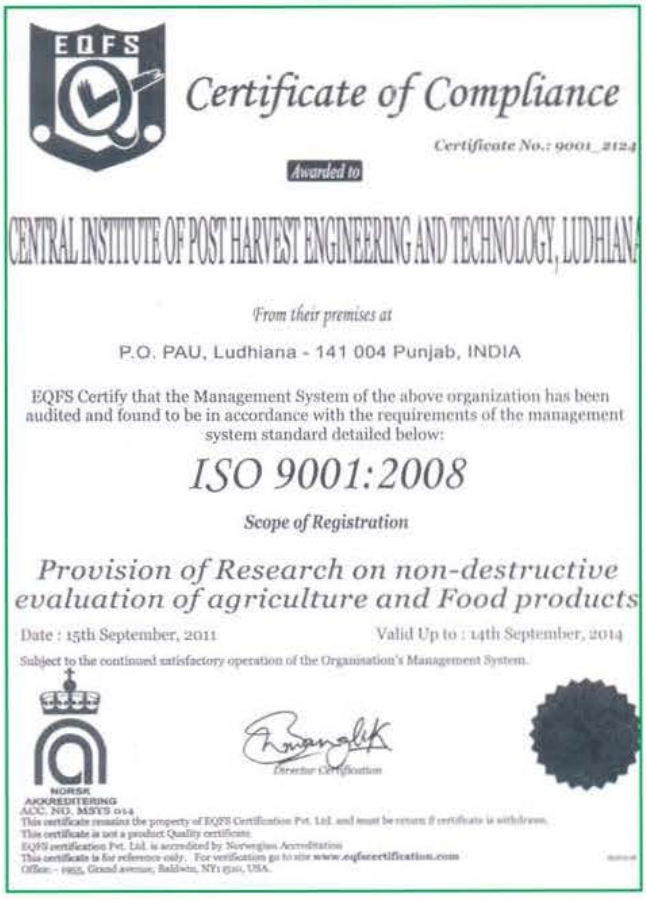
Fig 29. Chicken spread and pastries

scores. The color and TBARs values were quite stable upto 22 days, while the microbiological shelf life of the developed product was between 24 days when stored aerobically at 4±1°C. Developed chicken pastries also showed better overall acceptability and springiness scores. The meat, Na_2CO_3 and sugar contents were 45 %, 0.83-0.88% and 14.23-15.06 respectively in developed pastries. The shelf life of pastries was also appreciable when compared to market available similar products; as stored aerobically at 4 ±1°C.

Significant features of this technology are; 1) Utilization of non meat ingredients to reduce cost of production, 2) technology was developed using low cost meat processing equipments 3) Improved products quality, sensory attributes and stability, 4) use of natural plant extract to improve product sensory attributes and to reduce extent of lipid oxidation in developed products.

ISO Certification for Non-destructive quality evaluation laboratory

CIPHET has acquired IS0 9001:2008 certification for research on non-destructive quality evaluation of agriculture and food products. The lab is fully equipped with UV Vis and NIR spectrometers as well and SPR and QCM biosensor, Flow injection analysis system and effective management systems are in place for handling materials, human resource and data (Fig. 30).


EQFS

Certificate of Compliance

Certificate No.: 9001_2124

Awarded to

CENTRAL INSTITUTE OF POST HARVEST ENGINEERING AND TECHNOLOGY, LUDHIANA

From their premises at

P.O. PAU, Ludhiana - 141 004 Punjab, INDIA

EQFS Certify that the Management System of the above organization has been audited and found to be in accordance with the requirements of the management system standard detailed below:

ISO 9001:2008

Scope of Registration

Provision of Research on non-destructive evaluation of agriculture and Food products

Date : 15th September, 2011 Valid Up to : 14th September, 2014

Subject to the continued satisfactory operation of the Organization's Management System.

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Fig 30. Certificate of Compliance for CIPHET, Ludhiana

FOOD GRAINS & OIL SEEDS PROCESSING

Development of technology for oil expelling of dehulled flaxseed (linseed) kernel and utilization of de-oiled cake

Mridula D and P Barnwal

a. Dehulling characteristics of selected flaxseed varieties

The dehulling characteristics of six different varieties namely *Shikha, Rashmi, Shekhar, Sweta, Padmini* and *Neelam* were studied at different residence times (40, 50 and 60 s) and moisture content 2-2.2% (w.b.). The dehulling parameters namely embryo recovery, extraction rate, yield, hull and hullability were found affected with the residence time and varietal characteristics (Table 7). The embryo recovery, extraction rate, yield, hull and hullability of all six varieties was in the range of 23.71±0.77-61.35±0.94%, 58.26±2.20-79.11±0.43%, 22.96±0.44-43.85±1.38%, 16.83±1.75-61.54±5.11% and 45.92±0.51-90.62±2.85% (d.b.), respectively for studied varieties of flaxseed and residence time. The embryo recovery of studied six varieties of flaxseed was ranged from 23.71±0.77-54.77±2.22%, 32.43±0.79-59.70±1.26% and 34.34±0.65-61.35±0.94% (d.b.) at 40, 50 and 60 S residence time, respectively. Residence time for 60 s showed the significantly higher embryo recovery with minimum in case of *Shikha* variety and maximum for *Rashmi* and *Neelam* variety of flaxseed ($p \leq 0.05$), which may be due to difference in the geometrical dimensions, of studied flaxseed varieties. *Padmini* and *Neelam* varieties of flaxseed were found suitable for dehulling purposes of flaxseed amongst the studied flaxseed varieties at 60 s residence time.

(b) Development of Power Operated Flaxseed Dehuller

The power operated flaxseed dehuller principally consists of a feed hopper, outer cylinder (casing), inner perforated cylindrical screen, emery coated abrasive cylindrical roller inside the perforated cylindrical screen, frame, main shaft and a prime mover or electric motor. The flaxseed dehuller was run on load for evaluation of its performance. During on load testing of the flaxseed dehuller, it was found that the capacity of the developed flaxseed dehuller was 50 kg/h and embryo recovery ranged from 60 to 64 % for 2.0-2.5% w.b. moisture content of flaxseed (Fig. 31).

Table 7 ANOVA table for different dehulling parameters of studied flaxseed varieties

Dehulling parameters		Df	SS	MS	*F* value	*P* value
Extraction rate	V	5	910.87	182.17	86.51 **	0.000
	T	2	576.58	288.29	136.90 **	0.000
	VT	10	92.73	9.27	4.40 **	0.014
Hullability	V	5	3899.23	779.85	89.53 **	0.000
	T	2	2303.14	1151.57	132.20 **	0.000
	VT	10	332.34	33.23	3.82 **	0.023
Yield	V	5	845.71	169.14	80.34 **	0.000
	T	2	576.52	288.26	136.92 **	0.000
	VT	10	92.71	9.27	4.40 **	0.014
Embryo recovery	V	5	4109.37	821.87	157.33 **	0.000
	T	2	539.06	269.53	51.60 **	0.000
	VT	10	123.89	12.39	2.37 ns	0.095
Hull	V	5	3489.62	697.92	210.13 **	0.000
	T	2	1126.65	563.32	169.60 **	0.000
	VT	10	156.24	15.62	4.70 **	0.011

V- variety; T-residence time

Fig. 31 Flaxseed dehuller

(c) Screw pressing performance of dehulled flaxseed

Screw pressing performance of dehulled flaxseed was studied at different seed moisture (6.4 to 11.1% d.b.) and press head temperature (80-120 °C). Oil recovery, residual oil content, press rate and sediment content were determined as a function of seed moisture and press head temperature at different levels of dehulled flaxseed (50, 60, 70, 80, 90 and 100%). Oil recovery decreased (Fig. 32) while residual oil content in cake increased with increasing moisture content. There was a reducing trend in oil recovery with increasing level of press head temperature (Fig 33). Press rate was found maximum for 100% dehulled flaxseed while minimum for 50% dehulled flaxseed. Press rate at 6.4% moisture content and 80 °C press head temperature was found minimum. The sediment content in oil was reduced while FFA content increased with increasing press head temperature. The sediment content was minimum (3.49%) in the oil obtained from the 100% dehulled flaxseed at 6.4% moisture content (Table 8 & 9). In view of the maximum oil recovery (82.9% d.b.) and lower FFA content from the sample with 70% dehulled flaxseed along with 30% whole flaxseed at 6.4% d.b. moisture content and 80 °C press head temperature, these conditions may be considered for screw pressing of dehulled flaxseed (Fig 33).

Table 8 Anova table for different oil expelling parameters of whole and dehulled flaxseed at different moisture content

Oil expelling parameters		DF	SS	MS	F value	P value
Oil recovery	F	6	282.45	47.07	44.03**	0.000
	M	2	1326.05	663.02	620.09**	0.000
	FM	12	26.15	2.18	2.04**	0.116
Residual oil	F	6	466.39	77.73	114.10**	0.000
	M	2	767.64	383.82	563.40**	0.000
	FM	12	30.41	2.53	3.72**	0.016
Press rate	F	6	3.102	0.517	38.71**	0.000
	M	2	0.687	0.344	25.73**	0.000
	FM	12	0.530	0.044	3.31*	0.024
Sediment content	F	6	14.94	2.49	7.23**	0.002
	M	2	44.46	22.23	64.49**	0.000
	FM	12	30.24	2.52	7.31**	0.001

F- Level of dehulled Flaxseed; M-moisture content; FM- FXM

Table 9 Anova table for different oil expelling parameters of whole and dehulled flaxseed at different press head temperatures

Oil expelling parameters		DF	SS	MS	F value	P value
Oil recovery	F	6	281.65	46.94	37.72 **	0.000
	T	2	50.67	25.33	20.36 **	0.000
	FT	12	32.17	2.68	2.15 ns	0.099
Residual oil	F	6	423.85	70.64	193.51 **	0.000
	T	2	22.53	11.25	30.87 **	0.000
	FT	12	4.44	0.37	1.01 ns	0.491
Press rate	F	6	2.262	0.377	43.63 **	0.000
	T	2	7.240	3.620	418.99 **	0.000
	FT	12	0.718	0.060	6.93 **	0.001
Sediment content	F	6	92.59	15.43	65.33 **	0.000
	T	2	2.74	1.37	5.79 **	0.017
	FT	12	5.79	0.48	2.04 ns	0.115

F- Level of dehulled Flaxseed; T-press head temperature; FT- FXT

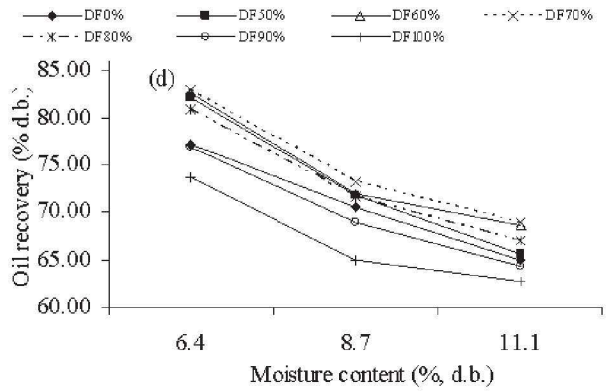


Fig. 32 Effect of moisture content and different level of dehulled flaxseed on oil recovery

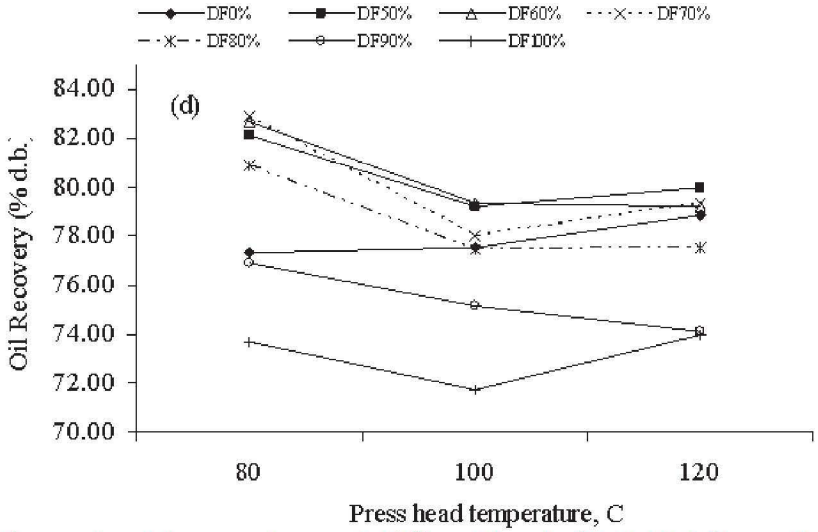


Fig. 33 Effect of press head temperature and different level of dehulled flaxseed on oil recovery

(d) Growth performance, carcass characteristics and α-linolenic acid in flaxseed fed broiler chicks

A forty two days feeding trial on broiler chicks was conducted to evaluate the effect of full-fat flaxseed (0, 2.5, 5, 7.5 and 10% in corn soy based diet) on growth performance, carcass characteristics, alpha-linolenic acid (ALA), linoleic acid (LA) contents, and organoleptic characteristics of chicken meat. A total of 200 one-day old broiler chicks were randomly attributed to 5 experimental groups and fed iso-energetic and iso-nitrogenous diets containing flaxseed at 0, 2.5, 5.0, 7.5 and 10%. Flaxseed supplementation did not affect the weekly body weight of broiler chicks during the first three weeks but thereafter it reduced with increasing level of flaxseed in the diets. Birds fed with 10% flaxseed in their diet showed a reduction of 10.08% in body weight as compared to control group. Diets containing 5.0 to 7.5% flaxseed resulted in lower weight gain, higher feed conversion ratio, energy efficiency ratio and lower protein efficiency ratio as compared to control and 2.5% flaxseed diets. The carcass characteristics data indicated not much difference in the evisceration rate and giblet among treatment groups but the breast yield was significantly higher in control than flaxseed groups. The protein, fat and ash content of broiler meat were not affected with the level of flaxseed in the diets. However, inclusion of flaxseed in the diets significantly increased the ALA in the breast and thigh tissues. Organoleptic properties of breast meat from all the treatment groups indicated no significant difference in the mean scores for colour and flavour. Although statistically similar but mean sensory scores for tenderness and juiciness for the 10% flaxseed group were slightly better than the control group. The overall acceptability scores for breast meat from all the treatments ranged from 7.12 in control to 7.70 in 10% flaxseed fed groups but the difference were statistically non-significant. Statistically similar mean overall acceptability scores for all the treatment groups showed that flaxseed supplementation did not affect the organoleptic quality of meat. It was concluded that supplementation of flaxseed in the diet had adverse effects on growth performance of broiler chicks. However, the higher level of flaxseed increased the alpha-linolenic acid content in the meat and also not affected the sensory acceptability.

(e) Effect of flaxseed meal supplementation on broiler performance, carcass cut-up and alpha-linolenic acid on chicken meat

The effect of flaxseed meal on broiler performance, carcass characteristics, alpha-linolenic acid contents, and organoleptic characteristics of chicken meat was studied during a 42 days feeding trial. Broiler chicks were fed iso-energetic and iso-nitrogenous diets containing flaxseed meal at 0, 5, 10 and 15%. In order to lower down the mucilage content in meal, the flaxseed meal was prepared using 30% dehulled flaxseed and 70% whole flaxseed. Flaxseed meal did not affect the weekly body weight of broiler chicks during the first two weeks but thereafter it reduced among flaxseed meal group. At the end of 6th week, birds fed on 15% flaxseed meal showed a reduction of 8% in body weight than control group. Control group gained highest weight gain with slightly higher feed consumption and better feed conversion ratio (FCR), protein efficiency ratio (PER), and energy efficiency ratio (EER) than the flaxseed meal group. Birds of 5 and 10% flaxseed meal group had significantly better FCR, PER and EER compared to those of 15% flaxseed meal group. The carcass characteristics data indicated a significant reduction in the eviscerated weight and breast yield at 15% flaxseed meal in diet as compared to other dietary groups. However, the alpha-linolenic acid content in both breast and thigh meat was higher with increasing level of flaxseed meal in the diets without affecting the sensory acceptability of meat. Therefore, taking into account the higher growth retardation at 15% flaxseed meal in the diet, 10% of flaxseed meal may be considered in the broiler diet to enable designing of fatty acid profiles especially omega-3 fatty acid in terms of alpha-linolenic acid content in the lipid of muscular tissue, without losing much in terms of weight gain.

(f) Effect of flaxseed supplementation on layer's performance and egg quality

A nine weeks study was conducted to evaluate the effects of flaxseed supplementation (0, 2.5, 5, 7.5 and 10% in corn soy based diet) on layer's performance and egg quality parameters, α-linolenic acid content and organoleptic characteristics of egg. White leghorn commercial hens, with 38 weeks of age, were randomly divided into 5 experimental groups and fed iso-energetic and iso-nitrogenous diets containing ground form of full-fat flaxseed at 0, 2.5, 5.0, 7.5 and 10%. Average body weight of birds was unaffected through dietary treatments with flaxseed ($p>0.05$). Dietary inclusion of flaxseed showed statistically similar effect on egg production, egg weight and to those of corn-soybean meal based diet though the feed consumption was significantly higher among flaxseed fed groups. Feed conversion ratio and protein conversion ratio values of control and flaxseed fed groups were statistically similar. Specific gravity, egg shell thickness, haugh unit, yolk index and yolk colour score of eggs were also found unaffected due to inclusion of flaxseed in layers diet. Dietary treatment did not affect the total fat content in eggs but α-linolenic acid content increased significantly. This increase was 5 times higher in eggs from 10% flaxseed fed birds at 47 weeks of age than control birds fed on corn soybean diet. Although feed consumption was higher in flaxseed fed groups but the production performance of birds and egg quality was maintained and showed increased level of α-linolenic acid content in eggs without affecting the sensory acceptability. The incorporation of flaxseed at 10% level in the layer's ration showed a good option for production of α-linolenic acid enriched eggs.

(g) Production performance and egg quality of laying hens fed with flaxseed meal

The feeding trials were conducted for a period of nine weeks to determine the effects of flaxseed meal (0, 5, 10 and 15% in corn soy based diet) on layer's performance, egg quality parameters, α-linolenic acid content and organoleptic characteristics of egg. A total of 96 white leghorn commercial hens, with 38 weeks of age, were randomly attributed to 5 experimental groups and fed the diet containing ground flaxseed meal at 0, 5.0, 10 and 15%. Average body weight of birds was unaffected through the dietary treatments with flaxseed ($p>0.05$). Birds fed with flaxseed meal performed equally with respect to egg production and egg weight though the feed consumption was significantly higher in case of 10% and 15% flaxseed meal group than control and 5% flaxseed meal fed groups. The overall feed conversion ratio and protein conversion ratio were also statistically similar in all the studied groups. Egg shell thickness, specific gravity, haugh unit, yolk index and yolk colour score of eggs were also found unaffected due to flaxseed meal supplementation. Dietary treatment did not affect the total fat content but α-linolenic acid content increased significantly with five times at 15% flaxseed meal level than control. Flaxseed meal supplementation also did not show any deleterious impact on sensory acceptability of eggs in boiled form. In flaxseed meal group, the layers performance and egg quality was maintained with increased level of α-linolenic acid content in eggs, though with higher feed consumption. Thus 15% flaxseed meal, prepared from 30% dehulled and 70% whole flaxseed may be considered for enhancement of α-linolenic acid in eggs.

Development of Nutritive Functional Flour and Food Products

Mridula D., M.R. Manikantan, Anita Kochhar and Monika Sharma

(a) Preparation of value added flour from pearl millet and green gram

Value added pearl millet (cv.PCB164) and green gram (cv. SML668) flour was prepared by sprouting the grains for 24 to 48h, followed by drying in a tray dryer at 50-80 °C. The final moisture content of sprouted green gram and bajra after drying was ranged from 6.26 to 9.92% (w.b.) and 6.14 to 9.82%

(w.b.), respectively. It is evident that drying air temperature has an important effect on drying. The higher drying temperature of 80°C took 240 min to dry the sprouted green gram and 210 min to dry the sprouted bajra, where as it took 330 min to dry the sprouted green gram and 300 min to dry sprouted bajra when the drying air temperature was 50°C. When the temperature was increased, due to the quick removal of moisture, the drying time reduced. The drying rates were computed and the typical drying rate curves are shown in Fig 34 a & b. The drying curves showed that moisture ratio decreases continuously with drying time, which indicated that diffusion has governed the internal mass transfer. The drying rate decreased continuously throughout the drying period. An increase of drying rate was observed with the increase in drying temperature. It is obvious from the drying curves that the constant rate period was absent, and drying of sprouted green gram took place in the falling rate period for the entire duration. The drying in falling rate period showed that internal mass transfer has occurred by diffusion.

The sprouted dried grains were analyzed for colour, viscosity, water absorption index, nutritional quality and sensory acceptability. In general, protein, total sugars and reducing sugars of the dried sprouted grain flour increased with increasing sprouting time while the starch content decreased which resulted in the lower viscosity of the sprouted grain flour. Tannin content in pearl millet and green gram was also found reduced with increasing sprouting time. Drying time did not bring much effect on the proximate composition except for starch content, total and reducing sugars and viscosity. Sensory evaluation of pearl millet and green gram flour, sprouted up to 48 and 36h, respectively showed the good sensory acceptability. Hence, for preparation of value added flour from pearl millet and green gram upto 48h and 36h sprouting time, respectively and 50-60°C drying temperature may be considered.

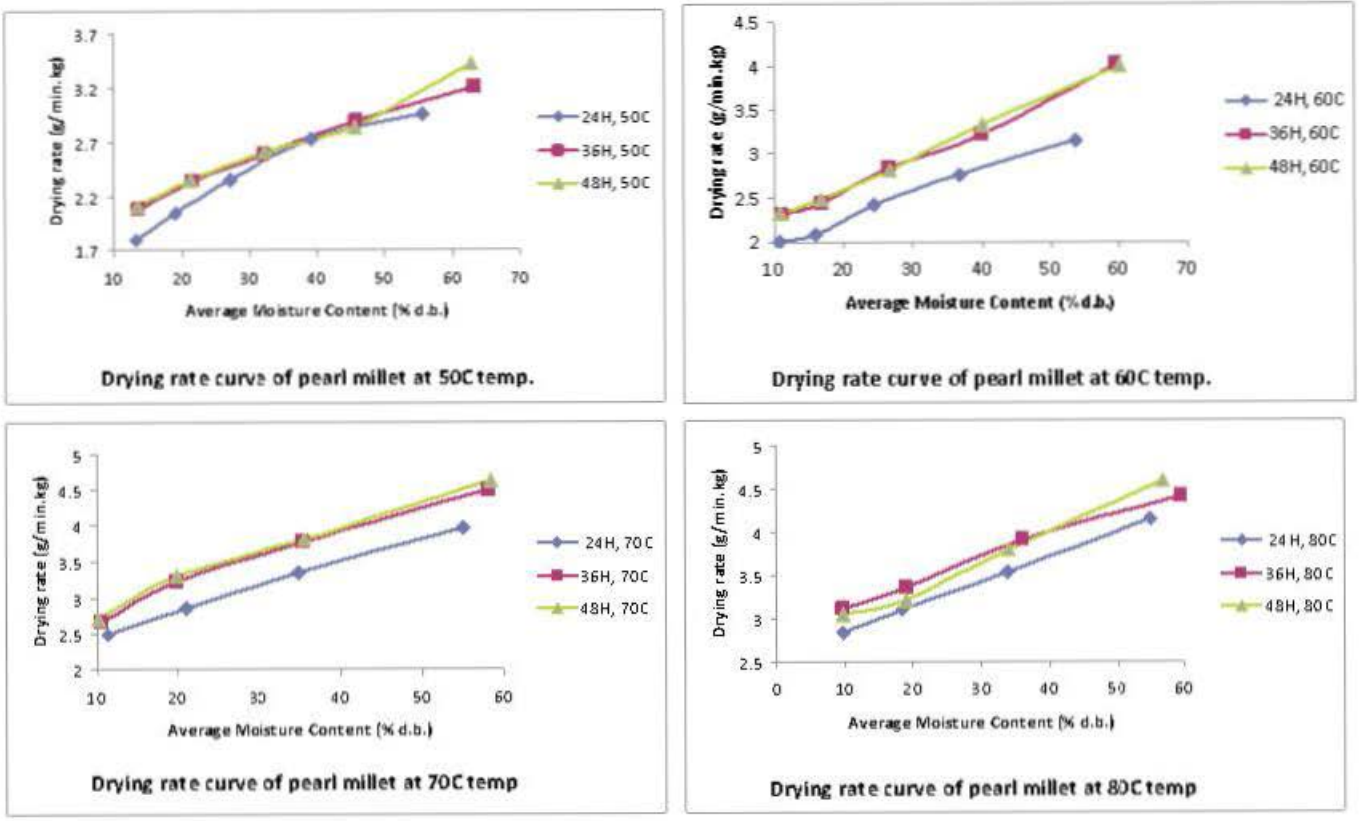


Fig 34a: Drying rate curve of pearl millet at different drying temperature

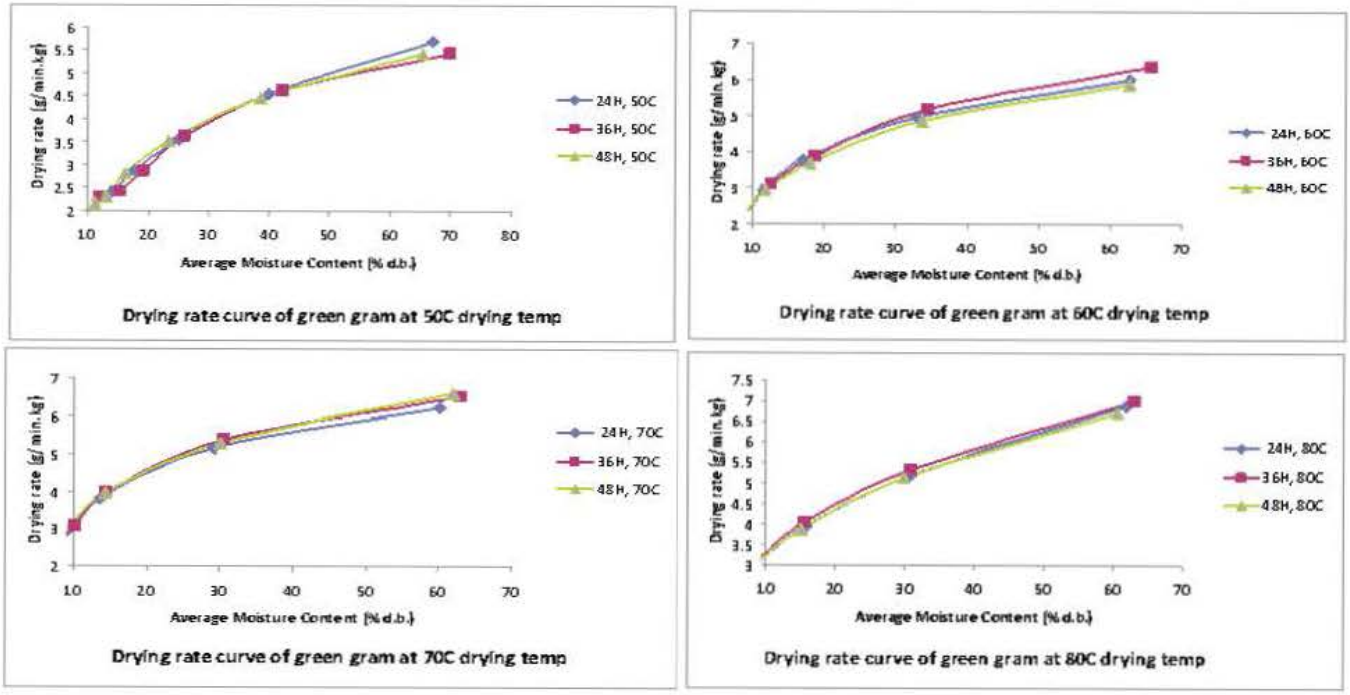


Fig 34b Drying rate curves of green grams at different drying temperatures

(b) Probiotic beverage using sprouted wheat

Experiment was designed following 'Box-Behnken Design' of RSM using Design expert-soft ware. Levels of different ingredients (independent variables) used for experimental design is presented in Table 10. Pre-heating of formulation mixture was done at 90 °C for 10 minutes followed by cooling to 37°C. Formulation mixture consisted of cereals (sprouted wheat flour, wheat bran, and oat meal) and food additive-guar gum as per the experiment plan. 29 probiotic beverage samples were prepared in duplicate using the probiotic culture (*L. acidophilus*-NCDC14, purchased from NDRI, Karnal) @ 1% to a water solution containing pre-heated cereal based formulation followed by incubation at 37°C for 8h. Control (without formulation mixture) was also prepared from the same probiotic culture. Samples, thus prepared (in duplicate) were analyzed for pH, acidity and probiotic counts. Acidity (in terms of lactic acid), pH and probiotic counts of the prepared 29 samples were ranged from 0.14 to 0.45%, 4.1 to 4.9 and $3x10^8$ to $9x10^{10}$ cfu/ml. Based on the desirability, three optimized formulations were selected for the validation to get the maximum acidity and probiotic counts. Results of this validation experiment are presented in Table 10. Finally, the optimized levels for different ingredients viz. sprouted wheat flour, oat meal, wheat bran and guar gum were 5.42, 6.0, 1.87 and 0.6 g per 100 ml of distilled water for preparation of sprouted wheat based probiotic beverage.

Table 10: Observed response values with different optimized combinations of independent variables

Sr. No.	Sprouted wheat flour, g	Oat meal, g	Sprouted wheat bran, g	Guar gum,g	pH		Acidity, %		Probiotic Count (cfu/ml)	
					Predicted	Experimental	Predicted	Experimental	Predicted	Experimental
1	5.42	6	1.87	0.6	4.47823	4.48	0.39	0.38	$7.49x10^{10}$	$6.33x10^{10}$
2	5.05	6	1.87	0.6	4.48764	4.49	0.38	0.36	$7.61x10^{10}$	$6.17x10^{10}$
3	5.51	6	1.87	0.6	4.46863	4.49	0.38	0.34	$7.39x10^{10}$	$5.83x10^{10}$

Characterization, fortification, cooking and quality evaluation of soft rice

Mridula D, Deepika Goswami, N. Shobha Rani and Suneetha Kota

Preparation and evaluation of quick cooking rice

The study was carried out to prepare quick cooking rice following different pre-treatments viz. additives and hydrothermal pre-treatments. For preparation of quick cooking rice, raw rice (cv. PR 118) samples were pre-treated with calcium chloride, sodium chloride, acetic acid and sodium citrate solutions followed by hydrothermal treatment and drying. The rice samples thus prepared were evaluated for different quality parameters such as pasting characteristics, color, amylose content, grain elongation ratio, rehydration ratio, cooking quality and sensory acceptability. Whiteness index of QCR samples was ranged from 87.9-91.8 as compared to 89.56 for raw rice. The minimum (1.57) rehydration ratio was observed for QCR pretreated with acetic acid while other salts pretreatments showed only a little change in the rehydration ratio. Solid loss in QCR samples was less than untreated rice. Different salts pre-treatment did not affected the grain elongation ratio but the cooking characteristics, amylose content (Fig 35), pasting characteristics and colour were found affected due to the various pre-treatments. Optimum cooking time of different QCR samples was ranged from 4.8 - 7.41 min as compared to 19.22 min for untreated rice. Though the means sensory acceptability for control and calcium chloride pre-treated QCR samples was comparable but the higher whiteness index, lower cooking time and lower solid loss in calcium chloride pre-treated QCR samples than control showed the scope for preparation of QCR following the calcium chloride pre-treatment (Table 11).

Table 11 ANOVA table for colour quality of QCR samples

Colour values of QCR	Pretreatment with salts	df	SS	MS	F value	P value
L values	C	3	7.70	2.57	4.76*	0.030
	L	3	22.48	7.49	13.91*	0.001
	CL	9	15.07	1.67	3.10*	0.053
a values	C	3	1.10	0.37	168.23**	0.000
	L	3	0.15	0.05	22.65**	0.000
	CL	9	0.38	0.04	19.48**	0.000
b values	C	3	2.43	0.81	6.27*	0.014
	L	3	0.91	0.30	2.35ns	0.140
	CL	9	2.97	0.33	2.59ns	0.089
Whiteness Index	C	3	2.78	0.93	2.14ns	0.164
	L	3	14.81	4.94	11.46**	0.002
	CL	9	14.72	1.64	3.79*	0.300

C-Chemical salts; L-Level of chemical in the soaking solution; CL-CL

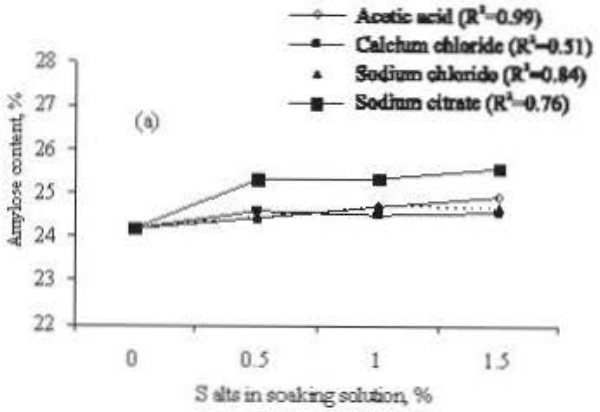


Fig 35. Effect of soaking pretreatment with salts on amylose content in QCR

Development of process and technology for dry degerming of maize at small scale

P Barnwal and D M Kadam

A power operated scale up maize degermer has been fabricated in Institute Workshop at CIPHET, Ludhiana. A pearling system has also been fabricated using abrasive roller , sieving system etc. and the overall dimension (L×W×H) of pearling system is 1230 mm × 440 mm × 1010 mm. The pearling system has been integrated with the fabricated scale up maize degermer in Institute Workshop. The power operated scale up maize degermer integrated with pearling system is shown in Fig.36. Its overall dimensions (L×W×H) and capacity are 1660 mm × 1120 mm × 1820 mm and 65-70 kg/h, respectively. An electric motor (2.0 HP, three phase, 1370 rpm) was fitted to drive the driven shaft (rotor) using v-pulley fitted on drive and driven shafts, cam shafts of sieving systems of the machine. Safety measures/ gadgets such as belt guards etc. were also provided on the machine for safety of the operator during its operation.

Fig 36. Power operated Scale up maize degermer integrated with pearling system

Development and testing of berseem-chicory seed separator (*Inter-institutional Collaborative Research Project*)

IGFRI, Jhansi: **PK Pathak and CS Sahay;** ***CIPHET, Ludhiana:*** **P Barnwal**

An aspirator grader (berseem-chicory seed separator), fabricated for separation of berseem and chicory seed from berseem-chicory seed mixture at

CIPHET, Ludhiana (Fig.37a), was run for its preliminary testing. Modifications were incorporated, as observed during preliminary testing, e.g. arrangement to control the air flow rate, fabrication and attachment of blower outlet and re-orientation of suction blower and blower outlet in Institute Workshop (Fig.37b). It has overall dimensions (L × B× H) of 2000 mm × 1540 mm × 2020 mm. It is operated by 2.0 hp, 3 phase electric motor. Berseem-Chicory Seed Separator was tested for separation of berseem from field sample of berseem-chicory mixture and pure berseem-pure chicory mixture at CIPHET Ludhiana. A capacity of 50-60 kg/h was observed during its testing.

Fig.37a: Aspirator grader (*berseem-chicory seed separator*), prior to modifications

Fig.37b: Berseem-chicory seed separator after modifications

Studies on Cryogenic Grinding for Retention of flavour and Medicinal Properties of Some Important Indian Spices

P. Barnwal and S. Balasubramanian

Spice Tablet Formation from Cryogenically Ground Spices

Cryogenic ground spices (powders) are rich in aroma and flavour due to their low temperature exposure (cryogenic conditions) during its grinding; therefore preservation of their quality is essential. Spice tablet may be used as one of the method to preserve the quality of the ground spices along with its aroma, flavour and colour etc. The spice tablets may not be favourable for ambient ground spices due to their lower quality as compared to cryogenic ground spices. For formation of spice tablet from cryogenically ground spices (powders), a suitable binding agent (material) is required. Cryogenically ground spices (powders) of turmeric, fenugreek, black pepper and coriander with different binding material combination e.g. salt, starch and gum acacia were used for making spice tablets and the feasibility of formation of spice tablets were carried out. The tablet formed were subjected to blister packing for safe handling and to increase their storage life (Fig.38)

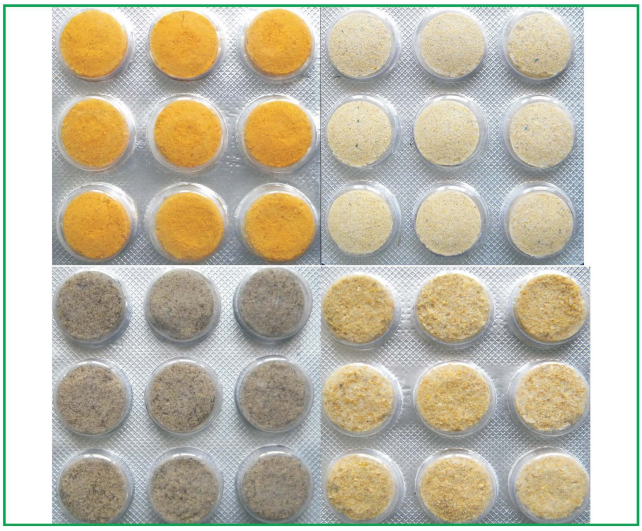


Fig.38: Turmeric, fenugreek, black pepper and coriander tablets prepared from cryo-ground spices

Physico-mechanical properties of turmeric and black pepper powders

The physico-mechanical properties of ambient and cryogenic ground spices will be helpful for packaging, handling and storage etc. The physico-mechanical properties of turmeric powder (cv. *Prabha)* and black pepper *(cv. Panniyar-1)* were studied for ambient and cryogenic grinding. The ambient and cryogenic grinding was carried out using a micro pulverizer (hammer mill) and an imported cryogenic grinder, respectively at four moisture levels (4, 6, 8 and 10% w.b.). The ground outputs were graded in three grades in sieve shaker using BSS Nos. 40, 85 and pan. The various physico-mechanical properties namely bulk density, true density, porosity, angle of repose and static coefficient of friction etc. were determined for the ground spices. The tap densities for ambient and cryogenic ground turmeric decreased from 642.3 to 568.3 kg/m^3 and 678.6 to 546.9 kg/m^3, respectively with increase in moisture content. The angle of repose for ambient and cryogenic ground turmeric increased linearly from 23.10 to 28.06° and 26.86 to 34.01°, respectively with increase in moisture content. Tap densities for ambient and cryogenic ground black pepper decreased from 711.0 to 631.6 kg/m^3 and 674.5 to 584.0 kg/m^3, respectively with increase in moisture content (4 to 10% w.b.). The angle of repose for ambient and cryogenic ground black pepper linearly increased from 23.86 to 30.52° and 25.41 to 32.57^0, respectively with increase in moisture content. The static coefficient of friction increased non-linearly for three structural surfaces namely mild steel sheet, galvanized iron sheet and plywood surfaces. There was significant difference in the colour (L, a and b values) for ambient and cryogenically ground turmeric and black pepper. The value of L was higher for cryogenic ground samples than ambient ground samples which shows that it is lighter in colour than ambient ground sample.

Design and drawing of indigenous cryogenic grinding system for spices

Under this activity, for the cryogenic pre-cooling unit of the spice grinding system, cooling load of spices was calculated and retention or freezing time of spice in the pre-cooling unit was calculated using modified plank's equation. The pre-cooling parameters were used to design the cooling screw of pre-cooling unit. The various parameters of cooling screw are total length 1000 mm, length of cooling screw 800mm, diameter of cooling screw 120 mm, diameter of shaft of cooling screw 35mm etc. Considering various important aspects, the design and drawing of indigenous cryogenic spice grinding system was finalized for its fabrication.

Grinding Characteristics of Selected Spices

The effect of ambient and cryogenic grinding of selected spices using a laboratory spice grinder (m/s Hosakowa Alpine, Germany, pin mill) on the various grinding characteristics such as Rittinger's constant, Kicks constant, average particle size, volume surface mean diameter, mass mean diameter, volume mean diameter, specific surface of mixture and specific energy consumption were studied. Cinnamon (cv. *Nityashree*), black pepper (cv. *Panniyar–1*) and turmeric (cv.*Pratibha*) was procured from Indian Institute of Spices Research (IISR), Calicut, Kerala, India whereas coriander (cv. *RCR-41*) and fenugreek (cv. *AM-1*) were procured from National Research Centre of Seed Spices (NRCSS), Ajmer, Rajasthan, India. It was observed that the specific energy consumption is higher for ambient grinding as compared to cryogenic grinding of spices as expected. The highest specific energy consumption was for ambient grinding of black pepper (202.17 (kWh/tonne) and that of lowest for cryogenic grinding of fenugreek (14.43 kWh/tonne). The average particle size of cryo-ground samples was found finer than ambient ground samples.

Development of dairy analogues from peanut kernel and utilization of deoiled cake for food purposes

D N Yadav and S N Bhowmik

Process parameters to obtain edible grade partially de-oiled peanut cake flour (PDPCF) Peanut kernels were moistened up to 15% moisture and conditioned for 20 min, dried at 70 ^{0}C for 3 h (7-8 % moisture), de-skinned in peanut de-skinner. De-

skinned peanut kernels were again moistened up to 12-13% moisture level and expelled through oil expeller (single pass) to recover 70% oil. The pressed cake obtained after oil extraction is dried at 60°C for 2 hours to moisture content of 9-10% and ground in mill to obtain fine powder (100 mesh). The flour is called as Partially De-oiled Peanut Cake Flour (PDPCF) and it had moisture 9.7%, crude fat 10.1%, protein 30.3%, ash 3.3% and carbohydrate 43.7%.

Optimizations of level of PDPCF in bread and biscuits making

Bread: Decrease in physical parameters such as loaf weight, volume, specific volume, etc. with an increase in level of PDPCF was observed. The bread became harder and required higher cutting strength as the level of PDPCF increased from 0-20%. The color of bread was darker than the control. Our results further supported that 15g PDPCF can be added in 100g of refined wheat flour for acceptable quality bread.

Biscuits: Biscuits incorporated with 20% level of PDPCF were nutritionally rich but received lower score for different sensory attributes. The textural properties i.e. hardness and breaking strength decreased while stickiness of dough increased. Incorporation of PDPCF had significant effect on color values as lightness decreased while a and b values increased producing a darker color with higher levels of PDPCF. Thus, biscuits were acceptable for all the attributes evaluated up to 15% while higher levels had a negative effect. The study demonstrated that PDPCF, byproduct obtained from peanut oil industry offers a great potential for supplementing protein.

To optimize process parameters for production of peanut protein isolate/concentrate and to improve its functional properties

Defatted peanut flour is rich source of protein (47-55 %) and is byproduct of peanut oil processing industry. An attempt was made to produce the peanut protein concentrate/isolate for beneficial utilization of peanut protein and to study their functional properties. Protein concentrate/isolate was obtained by fermentation and enzymatic hydrolysis. Defatted peanut flour (fermented/unfermented) was dissolved in water and centrifuged at 8000 rpm for 20 minutes. Supernatant collected was centrifuged to collect protein concentrate. Hydrolyzed peanut protein concentrate/isolate was obtained by enzymatic (*Trichoderma ressei, Aspergillus oryze*) hydrolysis. Fermented protein isolate/ concentrate showed better water holding and oil binding capacity whereas hydrolyzed protein concentrate/ isolate has better emulsifying capacity making it more suitable for use in meats and sausages. The dispersibility of hydrolysed protein was higher than non-hydrolysed. Wettability of hydrolysed isolate decreased due to higher solubility of protein and solubility rapidly increases upto 65% at neutral pH making hydrolysed protein more suitable for commercial application.

A value chain on composite dairy foods with enhanced health attributes

D N Yadav

Pearl millet-Whey protein concentrate extrudates

Extrusion was carried out at different moisture levels (14, 16, and 18%) with 5% whey protein concentrate (WPC). Extrudates obtained at 16% feed moisture level exhibited significantly ($p \leq 0.05$) high expansion ratio, water absorption index, overall acceptability and significantly ($p \leq 0.05$) lower bulk density, breaking strength, water solubility and peak viscosity as compared to control and were found to be most acceptable. Control sample had expansion ratio of 3.16, however sample with 5% WPC had expansion ratio of 3.64. Water absorption index also increased from 5.55 to 6.94 as compared to the control sample. Water solubility index decreased due to incorporation of WPC from 17.41 to 16.04. L value of 5% added WPC extrudates was 74.06 as compared to 74.98 for the control sample. Peak viscosity also decreased from 217 to 190 RVU as compared to control sample. Bulk density also decreased from 196 to 151 kgm^{-3}.

Hydrothermal treatment to stabilize pearl millet flour

Pearl millet flour has limited shelf-life (5-6 days) at ambient conditions mainly due to deterioration of its fat by action of lipase enzyme. Hydrothermal treatment (at 30±2% moisture and steaming at 1.05 kgm^{-2} for 0, 10, 15, 20 and 25 min) was given to whole and pearled pearl millet grains in order to inactivate lipase. The flour samples obtained after each treatment were evaluated for physical, functional and pasting properties followed by storage stability. Flour samples obtained from whole steamed (WS, 20 min) grains and pearled steamed (PS, 15 min) grains exhibited no lipase activity and acceptable physical, functional and pasting properties. Total phenols decreased from 228.3±1.55 (control flour) to 185.6±2.34 and 220.4±1.52 and tannin from 120.3±2.15 (control flour) to 90±1.32 and 100.5±1.55 mg 100 g^{-1}, in WS and PS flour samples after 20 and 15 min of steaming, respectively. Significant ($p \leq 0.05$) increase in bulk density (0.41 to 0.46 and 0.47 g cm^{-3}), water absorption index (1.83 to 3.91 and 2.25 gg^{-1}) and water solubility index (8.58 to 9.85 and 9.52%) was also observed in these samples with respect to control. There was significant ($p \leq 0.05$) decrease in peak, final, breakdown and setback viscosities of WS and PS flour samples with increase in duration of steaming. Storage stability study revealed that the hydro thermally treated flour samples were acceptable up to 50 days when stored in polyethylene pouches (75μ) at ambient conditions (15-35°C).

Pearl millet and whey protein concentrate based Porridge

The porridge is continuous mass matrix of starch molecules. Visco-elasticity of the product is very important in predicting the porridge quality. The grits (14, 20, 30, 40 ASTM mesh size) used for porridge preparation have different composition, which variably affect the porridge quality. The grits of different mesh size absorbs water at different rates, so the degree of starch swelling is also varied and thus producing porridge with different firmness. At lower particle size grits swell and uniformly disperse in continuous phase. The porridge consistency was also poor. Larger particle size porridge has compact structure, leading to harder texture and more viscous. The variation in visco-elastic behavior of porridge was influenced by particle size of grits as observed by rheometer. The presence of swelled granule in the dispersed phase and the gelatinous characteristics of the dispersing phase in the three-dimensional network combine to influence the finished product quality. The porridge made from 30 mesh size grits was more acceptable in terms of textural and sensory quality. An attempt was made to enhance the nutritional quality of pearl millet porridge (30 mesh size grits) by incorporating whey protein concentrate (2.5, 5, 7.5 % level). The results revealed that porridge made with 5% WPC was of better quality as assessed on basis of textural, rheological and sensory parameters.

Development of pilot level process and technology for the production of protein rich flour from de-oiled sesame and sunflower seeds

M.R.Manikantan, D.N.Yadav and R.K.Gupta

Effect of pretreatments on the production of protein rich flour from sesame oilseeds

In this study, the deoiled cake and flour were produced from sesame seeds using different pretreatments and the quality was analyzed at each stage. Pearling, soaking, steaming and drying treatments were employed during the production of protein rich flour. The effect of different pearling duration on thousand grains mass, crude fibre content, anti-nutrient oxalic acid content of sesame seeds was studied and 20 minutes of pearling was found to get the good quality pearled seed with less crude fibre and oxalic acid. The influence of soaking duration on hull removal from pearled sesame seeds was investigated and 15 minutes of soaking in water removed 53.90% hull from pearled seeds. The experiment on effect of steaming time at 1 ksc steam pressure on quality of partially dehulled seeds was conducted and 15 minutes of steaming yielded seed with 24.86% protein and 0.72% oxalic acid.

Steaming of partially dehulled sesame seeds for 15 minutes also resulted in the deoiled cake with 47.35% protein, 9.85% residual oil and 0.51% oxalic acid. The effect of drying temperature on quality of deoiled sesame cake was also studied and the deoiled cake dried at 50°C for 240 min yielded cake with 50.48% protein, 9.28% residual oil and 0.33% oxalic acid. The combination of 20 minute of pearling, 15 minute of soaking, 15 minute of steaming at 1 ksc steam pressure and 50°C drying temperature for 240 minutes yielded protein rich flour with less residual oil and anti-nutrient components.

Extraction of dietary fibre from by-products of selected coarse cereals, pulses and oilseeds processing and development of functional foods

SK Sharma, Sangita Bansal, P Barnwal, Anil K Dixit

Optimization of ingredients for preparation of fibre enriched bread using peanut hull flour

The ingredients for the preparation of fibre enriched wheat bread using peanut hull flour was optimized using response surface methodology. The optimized ingredients for preparation of fibre enriched functional bread by using refined wheat white flour and ground nut hull flour were: (i) refined wheat flour (267 g), (ii) groundnut hull flour (33 g), (iii) dry yeast 1.2 per cent and (iv) salt 1.5 per cent. The optimized product had 4.35 per cent crude fibre, 6.8 per cent protein, 0.63 per cent minerals as ash and only 2.10 per cent fat. The product had very good colour and had high sensory acceptability (Fig 39).

Fig. 39 Fibre enriched wheat flour breads prepared by using different levels of peanut hull flour

Development of non dairy based probiotic foods

Sangita Bansal and Satish Sharma

Ten *Lactobacillus* strains were procured from IMTECH, Chandigarh and one strain was purified from Bifilac sachet. These strains were revived on MRS broth and maintained as pure cultures on MRS agar. Preliminary trials on yoghurt preparation from milk and soy milk utilizing these *Lactobacillus* strains were conducted. The overnight grown cultures of *Lactobacillus fermentum, Lactobacillus casei* and *Lactobacillus sporogenes* were inoculated in dairy/ soy milk at an initial concentration of 1%. The samples were incubated overnight at a temperature of 37°C. Out of the strains tested, *Streptococcus faecalis* was able to ferment dairy/ soy milk efficiently (Fig. 40).

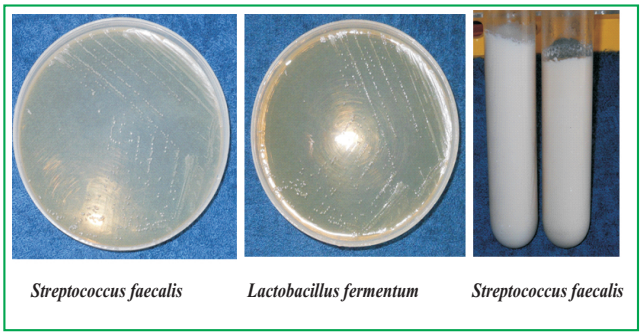


Fig. 40 Microgranisms and fermented milk using these cultures

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

Manisha Mangal and Sangita Bansal

Aflatoxin producing as well as non producing molds were identified, purified and Isolated from infected samples and their cultures are being maintained in the lab by frequent subculturing. In addition, fungal isolates with a characteristic aflatoxin production potential were procured from IMTECH, Chandigarh for validation of research results and effect of different media (Fig. 41).

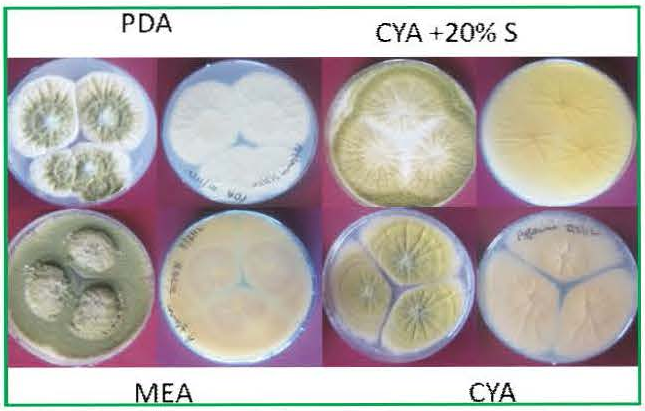


Fig. 41 Colony morphology (front view as well as reverse view) of *Aspergillus flavus* on different media

Development of an ohmic-heating system for heating solid and liquid foods

Devinder Dhingra, Sangeeta Chopra

Ohmic heating is based on the passage of alternating electric current through a food product that serves as an electrical resistance and thereby heat is generated instantly inside the food. The amount of heat generated is directly related to the current induced by voltage gradient applied and electrical conductivity of the food. This technology provides rapid and uniform heating whereas the absence of a hot surface in ohmic heating reduces fouling problems and thermal damage to a product. The electrical conductivity (EC) of foods is a key parameter of the electrical properties due to its potential influence on ohmic heating. The electrical conductivity of full fat raw rice bran was evaluated to design and evaluate an ohmic heating system for its stabilisation on small scale.

Effect of temperature on electrical conductivity (EC)

Changes in electrical conductivity (EC) of rice bran at 20, 30 and 40 m.c. % w.b. respectively, with variations in temperature, during ohmic heating, were obtained in a band shape as depicted in Fig. 42 (a-c). Electrical conductivity was observed to vary linearly with increase in temperature for all the three moisture contents used in the study. The linear relationship between EC and temperature (with R^2 ranging from 0.90 - 0.92) is also presented in Table 12. The observed increase of EC at high temperature could be attributed to the ionic mobility.

Variation of EC with temperature necessitates its quantification at all temperatures beginning with room temperature. In our experiments, the EC of rice bran increased till 95-100 °C and later on decreased at the critical temperature of 101, 98 and 100 °C for rice bran at 20, 30 and 40 m.c. % w.b. respectively. While the critical temperature decreased with the increasing moisture content the applied voltage gradient did not have any effect on the critical temperature at $p>0.05$. However steam formation at the boiling point of water posed a difficulty to measure EC of rice bran after critical temperature.

Effect of moisture content on electrical conductivity (EC)

Ohmic heating has not been found suitable for EC values less than 0.01 S/m and above 10 S/m because very large voltages or very large amperage values, respectively would be needed to generate the amount of heat required for raising temperature substantially by the Joule effect. In our experiments, the observed EC values for rice bran at 20 % moisture content were in the range 0.01 - 0.06 S/m within the entire temperature range of 25-100 °C. Whereas, they were observed to be 0.04 - 0.14 and 0.08 - 0.23 S/m, respectively for rice bran at 30 and 40 % m.c. (w.b.). Generally EC increased with increase in moisture content for the range of temperature from 25-100 °C and voltage gradients from 44 – 72 V/cm respectively (Fig 42). Within the test temperature range of 25 – 100 °C, EC values for the least moisture content was also at the lower limit and as the moisture content was increased the EC also increased significantly ($p<0.05$). This means that the presence of moisture in rice bran has a critical importance to obtain an efficient heating process as an increase in water molecules resulted in proportional increase in ion solvation and thus higher ionic mobility and higher flow of electric current.

Effect of voltage gradient

The effect of applied voltage gradient on the EC of rice bran samples during ohmic heating was not observed to be statistically significant ($p>0.05$) during application of voltage gradient in the range of 44, 50, 56, 63 and 72 V/cm (Table 13). The observed variation in EC could be expressed in terms of variation up to 98 % w.r.t. temperature and 2 % due to voltage gradient, respectively. It could be largely due to cell disruption during ohmic heating and further electrical breakdown, during application of different voltage gradients did not affect EC significantly. However higher voltage gradients were seen to be beneficial to achieve faster heating of rice bran at all the moisture contents used in the study (Fig. 44). At all the three moisture contents used in this study, EC of rice bran varied in a narrow band in the temperature range 20-100 °C, as the voltage gradient increased from 44 to 72 V/cm (Fig. 1(a-c)). A 30 cm rice bran column in a prototype designed to provide electric field strength in the range of 140- 225 V/cm, will require voltage gradient in the range of 4200 – 6750 V. A high voltage source is expensive and also there is more chance of fatal electric shock. Lower electric field strengths (44 - 72 V/cm) were thus chosen to design a cost effective and safe ohmic heating system for rice bran, maize flour and other products. The experimental data in this research indicated that electrical conductivity (EC) of rice bran was largely influenced by temperature (T) and moisture content (M) and slightly by voltage gradient (Vg).It is represented in terms of a multiple linear regression equation (Eq. 2) as follows:

$EC = -0.165 + 0.000964\ (T) + 0.00619\ (M) + 0.000151\ (Vg),\ R^2 = 0.90$.....(2)

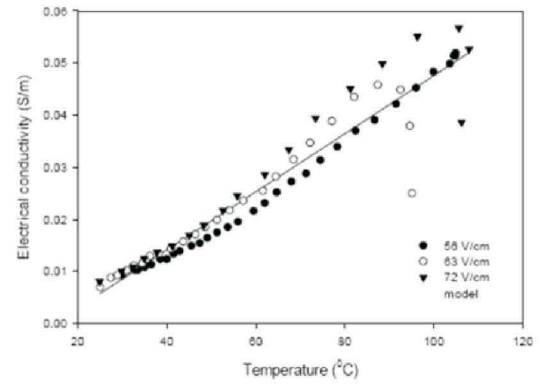
The EC, T, M and Vg were measured in S/m, oC, % w.b. and V/cm respectively. The constant term, coefficients of temperature and moisture content were observed to be significant at 1% (p value < 0.001); whereas the coefficient of voltage gradient was nonsignificant with p-value of 0.0438, which led to the conclusion that electrical conductivity can be estimated from a linear combination of moisture content and temperature alone (Eq 3) as follows:

$EC = -0.155 + 0.000968\ (T) + 0.00613\ (M),\ R^2 = 0.90$.....(3)

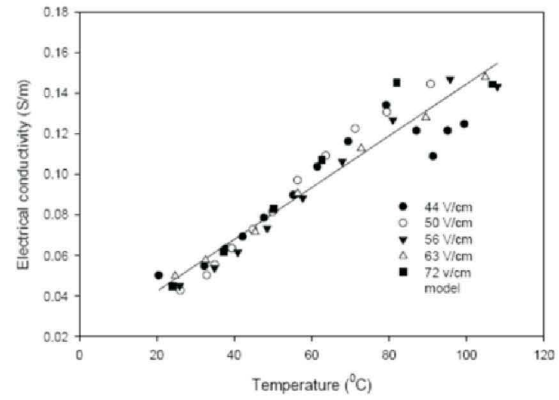
The EC, T and M were measured in S/m, °C and % w.b. respectively.

Heating rate during ohmic heating

The rate of change of temperature of rice bran at 10, 20 and 30 % m.c. (w.b.) is presented in Fig 42. As is apparent from Fig. 42 as the applied voltage gradient was reduced from 72 to 44 V/cm for rice bran at 30 and 40 % m.c., the time required to reach the desired temperature of 100 °C increased approximately by 2.3 and 2.7 times, respectively. Also at particular moisture content, as voltage gradient increased, a significant decrease in ohmic heating time was observed. This was largely due to impact of amount of heat generated during ohmic heating, which was directly related to current induced by the voltage gradient in the applied electric field as reported earlier by different researchers. At moisture content of 20 % (w.b.) the low EC of rice bran did not allow the temperature of sample to rise at voltage gradients of 44 and 50 V/cm (Fig. 43). Heating rate varied between 0.5 – 1.5 and 0.95 - 2.6 °C/s for rice bran having moisture content 30 and 40 % respectively as voltage gradient increased from 44 – 72 V/cm; however it varied from 0.25 – 0.45 °C/s for rice bran at 20 % moisture content as voltage gradient varied between 50 – 72 V/cm (Fig. 43). This was mainly due to the increase in the current flow through the material at higher voltage gradient. The heating rate was faster in rice bran at higher moisture content (Fig. 44). While rice bran at 40 % m.c. reached 100 °C in 30 s at a voltage gradient of 44 V/cm, the heating time for samples at 20 % m.c. to the similar level was 340 s. Higher electrical conductivity of rice bran at 40 % m.c. allowed an increased flow of current which resulted in higher rate of rise of temperature.



(a)



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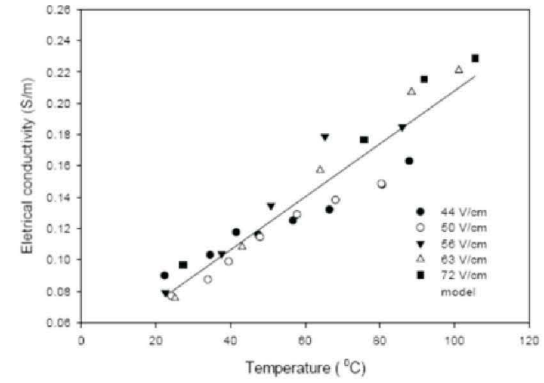
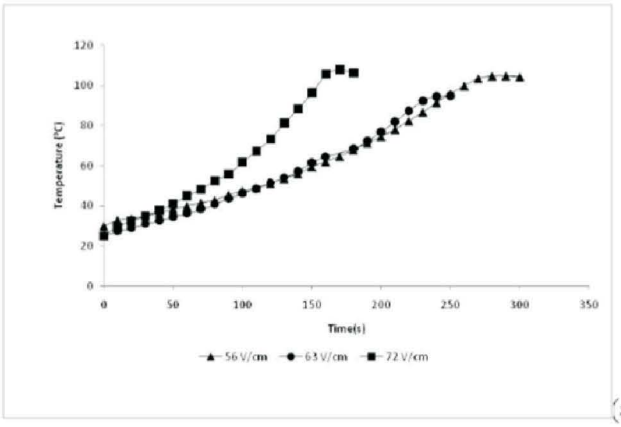
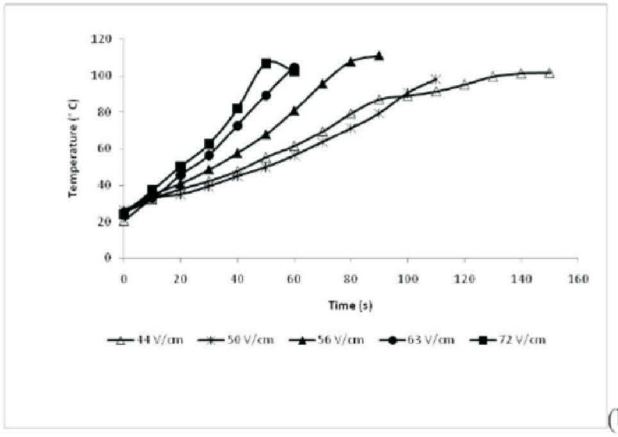


(c)

Fig. 42 Electrical conductivity of rice bran at 20, 30 and 40 % m.c. (a,b and c respectively) during ohmic heating at indicated voltage gradients



(a)



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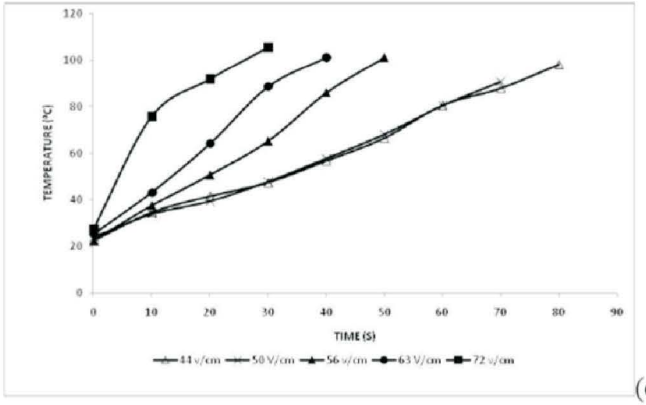


(c)

Fig. 43 Ohmic heating curves of rice bran having moisture content (a) 20 % (b) 30 % (c) 40 % at different voltage gradients

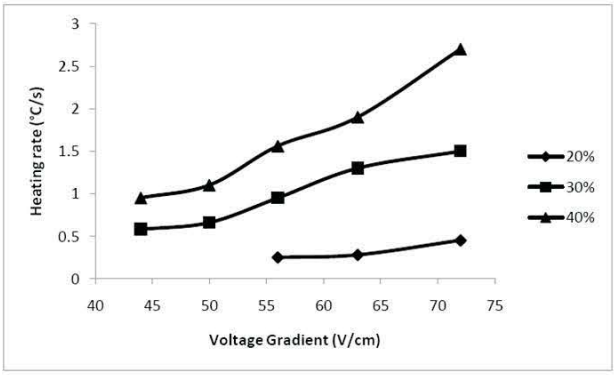


Fig. 44 Heating rate during ohmic heating of rice bran at 20, 30 and 40 % moisture contents

Table 12: Electrol Conductivity Temperature relationships at different moisture contents

Moisture Content (%)	EC-Temperature relation	Regression Coefficient (R^2)
20	EC = -8.7E-03+5.58E-04 (T)	0.93
30	EC = 0.0169+1.28E-03 (T)	0.93
40	EC = 0.039+1.69E-03 (T)	0.90

Table 13: ANOVA for effect of voltage gradient on electrical conductivity

Source of Variation	SS	df	MS	F	P-value	Fcrit
Temperature	0.030508	7	0.004358	166.74	5.98E-17	3.63
Voltage gradient	0.000144	3	4.8E-05	1.83	0.17	4.87
Error	0.000549	21	2.61E-05			
Total	0.031201	31				

HORTICULTURAL CROPS PROCESSING

A Value Chain on Commercial Exploitation of Underutilized Fruits of Tribal Zones of Rajasthan

R.K. Gupta, R.K. Viswakarma, V. Eyarkai Nambi and Ramesh Kumar

Ber Gummibuster

A study was conducted with the aim of optimizing different fruit pulp ratios and to standardize the process parameters for ber gummibuster preparation by response surface methodology (RSM) using Design expert (8.0.2). The pulp obtained from the Ber, Pineapple, and Carrot were mixed in the proportions based on the RSM design. Based on the preliminary trails the ingredients have been fixed mixed fruit pulp (ber pulp, carrot juice, pineapple juice) 70g. Sugar 32.5g, Pectin 1.75g, Citric acid 0.22g, Amla shreds 1.5g, Rose extract 25g. The mixture of fruit juices were poured in a stainless steel vessel and cooked it at 100°C for 2-3 min to make the pulp mixture homogeneous. As the mixture started to boil, sugar, citric acid and aonla shreds were added and cooked again to thicken the mixture (56-58°B). The pectin paste which was prepared by dissolving in small quantity of boiled juice and cooked up to 68-70°B. Finally the prepared mix has been poured in a tray, smeared with glycerol at the bottom, to avoid the stickiness after setting. After cooling the tray was kept in the refrigerator at 7-10° C to lay down (Fig. 45). After setting the sample was cut it in to square shape with the help of knife and packed in the LDPE pouches till further analysis.

The prepared products were evaluated for sensory and colour, textural properties, water activity, moisture content, TSS, acidity, vitamin C, total sugars, reducing sugar, fat content, anthocyanin, tannin content and ash content were estimated. Based on the sensory evaluation, the RSM design has been analyzed, surface plots have been drawn and optimal combination was identified. The optimized values of the ingredients for mixed fruit protein enriched ber based soft candy is ber, pineapple and carrot are 38.5, 11.4 and 20 respectively. The developed ber based soft candy should be kept at refrigerated conditions to retain its characteristic quality parameters.

Automatic custard apple pulper machine

Custard apple pulper was developed. The pulper works on three mechanism viz. fruit cutting mechanism, fruit scooping mechanism and pulping mechanism. Fruit cutting and scooping mechanism are made with pneumatic actuators and electronic controls. This invention is fully automatic, assisted

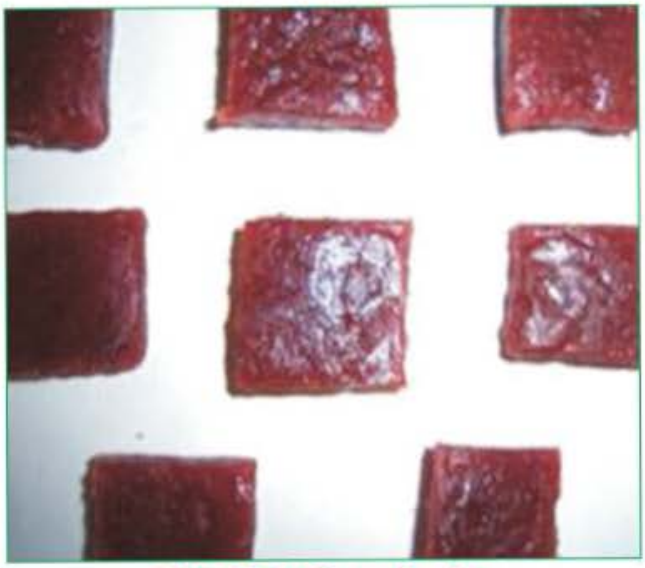


Fig. 45 Ber Gummibuster

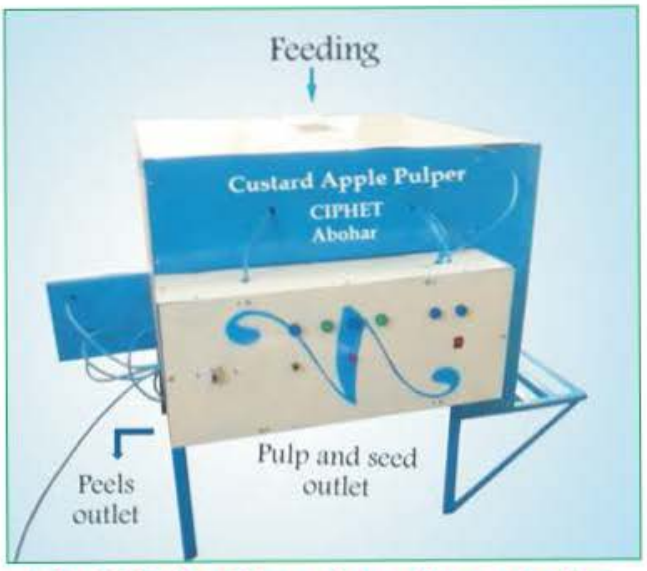


Fig. 46 Fruit cutting and scooping mechanism

with pneumatic power and controlled electronically. The overall dimensions of fruit cutting and scooping mechanism were 180 x 120 x 140 cm and the overall dimensions of pulping mechanism were 100 x 75 x 80 cm (Fig. 46).

Fruit cutting mechanism

It consists of two opposite rotating rollers with fruit holding cups. The cups are arranged to hold the fruit without damage and guide the fruit for cutting as well as falling on the guide plate. The fruit holding cups are rotated by pneumatic actuator attached with one side rotating rack and pinion mechanism. For cutting, a small pneumatic actuator of 2.5 cm bore diameter and 10 cm displacement have been provided with cutting knife. The cutting knife is fixed with the actuator rod for reciprocal movement. The guide plate provided below the cutting knife supports the knife and helps the two halves of fruit to fall downwardly (cutting side facing down). At the bottom of the guide plate, peel stopper is provided to remove the peels from the peel holding sieve while return stroke. An electronic PCB circuit controls the reciprocal motion of the actuator through 24V DC solenoid valve.

Fruit Scooping Mechanism

Peel Holding Sieve

Peel holding sieve contains a SS sieve in a movable frame of size 45cm × 37.5 cm. The sieve is made of 5mm diameter SS rods. The gap between the rods is 1.25 cm. In the front side of sieve, the rods were bent to about 2.5 cm towards down and fixed in a sieve platform for easy removal of peels. The movable frame contains fruit pushing hand which helps to move the fruit halves from guide plate to the peel holding sieve. The frame is operated by a pneumatic actuator of 2.5 cm bore diameter and 20 cm displacement along with 24V DC solenoid valve. This actuator is controlled by the centralized electronic PCB controller. Peel collecting trays are attached with the movable frame. It collects the peels after removal of pulp by scooping mechanism.

Pressing Mechanism

Pressing mechanism contains a pressing plate attached with pneumatic actuator of 2.5 cm bore dia and 15 cm displacement along with 24V DC solenoid valve. This actuator is also controlled by the centralized electronic PCB controller.

Scooping Mechanism

Scooping mechanism contains a scooping blade made with SS and a pneumatic actuator of 2.5 cm bore diameter and 30 cm displacement along with 24V DC solenoid valve. This actuator is also controlled by the centralized electronic PCB controller. The scooping blade was made with curved cuts which are properly aligned with the peel holding sieve to reduce the pulp loss along with the peel.

Pulping Mechanism

This part of machine resembles the commercially available pulper but it contains a special slotted sieve and pulping shaft with beaters with specific inclination. The sieve is made with food grade SS sheet with straight slot of size of 30mm ×5mm. The entire straight slot is parallel to the pulping shaft and made in spiral path towards the output. One side of the beater has pulping brush and

Fig. 47 Fruit Pulping Mechanism

the other side of the beater has beating rod. The inclination of the pulping chamber is 27°-29°. The speed to get higher recovery of intact pulp is around 600rpm. The pulper has a pulp outlet and seed outlet separately. At the pulp output, a separator is provided which has a shaking arrangement to separate the fine pulp and intact pulp from output of the pulper (Fig. 47).

Working sequence of the machine

The whole cutting and scooping machine works with the help of pneumatic power and controlled electronically. The fruits are fed in to the fruit holding cups. Then the PCB controller activates the fruit holding cups to rotate oppositely leads to cut the fruit into two halves and fall down on the fruit guiding plate. Besides this, the cutting knife is operated continuously by another actuator. Then the peel holding sieve is activated by actuator and moves forwardly. At the time forward movement, fruit pushing hand pushes the cut halves and allow it to fall on the peel holding sieve from guide plate. Then the pressing mechanism is activated and it presses the cut halves. While pressing, the pulp along with seeds comes out through peel holding sieve and the peel is retained on the top of the sieve. After pressing, the scooping mechanism is activated and the scooping knife removes the pulp along with seed and it will be collected in pulp outlet. Then the peel holding sieve and frame move backwardly for next cycle. During backward movement of the frame, the peel stopper which is given below the fruit guide plate removes the peel from the peel holding sieve and collected separately in peels outlet. Time for single cycle is 3-5sec. these sequences of operations continue till the machine in operation. The separated pulp along with seed is fed into the pulping mechanism for separation of pulp and seed. From the pulping mechanism, the seeds are collected in separate outlet and the pulp is separated into two forms viz. fine and intact pulp by pulp separator (Fig. 47).

Capacity of peeling machine is about 120 Kg/h with pulp recovery of 94%, pulp wastage along with peels of 6% and peel in pulp outlet 11%. The pulp removing machine has capacity of 120 kg/h, coarse/intact pulp recovery of 70-72% and fine pulp recovery of 28-30%.

This technology has been transferred to NexGen Drying Systems Pvt. Ltd. Pune on 26th February 2012 for Rs. 1,85,000.

Development of Litchi peeler and destoner

R.K. Vishwakarma, V.E. Nambi, R.K. Gupta

A litchi peeling machine was designed, and fabricated. The machine consists of two SS rollers of 6.5 cm diameter and 45 cm length. The rollers rotate in opposite directions towards each other. Half length of on roller is knurled whereas nails are provided on the half roller length of other roller. The first half of roller length is plain to orient the fruits in rest position. A food grade endless belt is provided above rollers to press the fruits and convey the peeled fruits towards outlet (Fig. 48). When the litchi is fed between two rollers, the rotating motion of both rollers orients the fruits in rest position. The belt conveys the litchi towards nails. The nails make a cut of peel of fruit whereas the knurled surface provides sufficient friction to remove the peel. The peel passes through the gaps between rollers. Peeled litchi is conveyed towards outlet by belt. The machine gave peeling efficiency of about 92% with 2% pulp loss.

Fig. 48 Litchi Peeling Machine

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

Sunil Kumar, Ramesh Kumar and V. Earkay Nambi

Effect of pectin treatment on fresh cut fruits of strawberry

An experiment was conducted to examine the effect of external application of pectin on fresh cut of strawberry for extending the shelf-life of fresh-cuts. Fresh-cut fruits were treated with pectin prior to enzyme application by immersing strawberries in the solution of 1.0 to 8.0% pectin for 15, 30, 45, 60 and 75 min. A solution containing 2% pectin and an immersion time of 45 min was found to be optimum for pectin coating. However, while evaluating the shelf-life of these fresh-cuts, it was found that pectin treatment led to internal spoilage and fungal attacks when compared to the control/untreated fruits.

Shelf-life of strawberry as affected by storage environment

The fruits were treated with different enzyme concentrations (50-500 units), its time of treatment (5-90 min) and divalent ions (calcium lactate) The fresh-cut fruits from each treatment were maintained under low (Temperature 7±2 °C; relative humidity 80±5%) and ambient (Temperature 25±2 °C; relative humidity 60±5%) temperature conditions for evaluating the shelf-life with the help of response surface methodology- Box- Behnken design (RSM) (Table 14). Calcium lactate was used as source of divalent cations keeping in view that, the lactate will impart low pH and calcium will give firmness.

Fig. 49: Strawberry incubation at 35±2 °C (water bath) in 0.05 M acetate buffer (pH= 4.0)

Table 14: RSM applied for fresh-cut strawberry

Standard	Run	Factor1 (A): enzyme units (unit)	Factor 2 (B): treatment duration (min)	Factor 3 (C): Calcium lactate conc. (%)	Designated run number (exp.)
14	1	275.00	52.50	1.75	1
4	2	500.00	90.00	1.75	2
8	3	275.00	90.00	3.00	3
9	4	50.00	52.50	0.50	4
6	5	275.00	90.00	0.50	5
5	6	275.00	15.00	0.50	6
3	7	500.00	15.00	1.75	7
15	8	275.00	52.50	1.75	14
12	9	500.00	52.50	3.00	8
13	10	275.00	52.50	1.75	15
10	11	500.00	52.50	0.50	9
11	12	50.00	52.50	3.00	10
2	13	50.00	90.00	1.75	11
7	14	275.00	15.00	3.00	12
1	15	50.00	15.00	1.75	13

However, calcium lactate imparted bluishness to the product, so calcium lactate was replaced with calcium chloride. For further refining the time of treatment and enzyme concentration and to optimize the effect and concentration of calcium chloride, the ranges of enzyme concentration and its application time were further narrowed down experimentally and a modified RSM matrix was used for further experimentation (Table 15). Appropriate physico-chemical and microbiological parameters were determined at each step to compare treated fresh-cuts with control ones. The optimized parameters for strawberry fruits are as follow:

Optimization of time of enzyme treatment and concentration of $CaCl_2$ for fresh-cut fruits of strawberry

All the experiments were conducted as per the RSM matrix (Table 15). A separate experiment was conducted for further differentiation between treatment number 12 (300 unit, 17.5 min and 2% $CaCl_2$) and 13 (300 unit, 30 min and 1.25% $CaCl_2$). Finally, it was deduced that 300 units of enzyme applied for 30 min with 1.25% $CaCl_2$ was optimum for shelf-life of fresh-cuts of strawberry.

Table 15: Final RSM matrix for further experimentation

Standard	Run	Factor 1 (A): enzyme units (units)	Factor2(B): treatment duration (min)	Factor 3 (C): $CaCl_2$ conc. (%)	Designated run number (Exp.)
9	1	175.00	5.00	0.50	1
12	2	175.00	30.00	2.00	3
13	3	175.00	17.50	1.25	2
3	4	50.00	30.00	1.25	9
4	**5**	**300.00**	**30.00**	**1.25**	**13**
14	6	175.00	17.50	1.25	14
15	7	175.00	17.50	1.25	15
10	8	175.00	30.00	0.50	4
2	9	300.00	5.00	1.25	10
11	10	175.00	5.00	2.00	5
5	11	50.00	17.50	0.50	7
7	12	50.00	17.50	2.00	8
6	13	300.00	17.50	0.50	11
16	14	175.00	17.50	1.25	16
1	15	50.00	5.00	1.25	6
17	16	175.00	17.50	1.25	17
8	17	300.00	17.50	2.00	12

Standardization of enzyme concentration for strawberry

The experiment was performed as per the matrix of RSM (Table 15) for all the combinations (1-17 designated run number) in case of full strawberries. The enzyme was applied at 35±2°C in 0.05 M acetate buffer (pH= 4.0) (Fig. 49). The data revealed that 300 enzyme units were optimum (designated run number 12 and 13) for shelf-life of fresh strawberries.

Effect of sodium benzoate as antifungal agent

To overcome the problem of fungal attack after enzymatic treatment, an experiment was conducted with or without antifungal agents *viz.* sodium benzoate (0.1%), kinnow peel extract and pomegranate peel extract. The parameters evaluated were total antioxidant capacity, ferric reducing antioxidant power, lipoxygenase activity, polyphenol oxidase activity, colour, texture,

physiological loss in weight, total plate count, *Salmonella*, *Staphylococcus*, *E. Coli* etc. The fruits treated with antifungal agents exhibited better shelf-life as compared to its untreated control fruits (Table 16; Fig. 49).

Table 16: Shelf life of fresh-cuts of strawberry

Storage	Temp. (^{0}C)	Rh (%)	Fresh-cut strawberry	Shelf -life (days)
Ambient	25±2	60±5	Control	01
			Treated	02
Low temperature	7±2	80±5	Control	06
			Treated	10-11

Fig. 50: Showing plant growth and crop canopy under different mulches

Impact of different mulching on soil microclimate in strawberry (*Fregaria ananassa*) and okra (*Abelmoschus esculentus*) fields

Jitendra Singh, R.K. Gupta and D.D. Nangare

Mulching is a practice of covering the soil surface around the plant to make conditions more conducive for plant growth through *in-situ* moisture conservation, weed control, better CO_2 exchange for root system and soil structure maintenance. Use of dry leaves, straw, hay etc as a mulching material has been prevalent for ages. However, the introduction of plastic film and jute as mulch increases the efficiency in terms of conserving moisture and controlling weeds and consequently increases in yield. Keeping in view, black ordinary and white transparent (TP) polythenes of 7 and 25µ thickness in three replicates of each were used. Similarly, single, double and triple layers of unwoven jute (175g/sq m density) in three replicates of each was also tested as mulch material in strawberry field. Along with various types of mulching, drip irrigation system was installed for controlled irrigation for the conservation of water and fertilizers i.e. fertigation. To find out actual picture of soil fauna and flora, analysis parameters such as microbial population and enzyme activities analysis were aimed (Fig. 50).

Plant growth under different mulching was affected significantly by the mulching materials. Jute single mulching has indicated healthier plants growth in terms of flowering and fruiting. Over all comparisons, highest fruit yield was observed in single jute mulched plots, which followed by black plastic mulching. On other hand, adverse effects were observed in soil enzyme activities and microbial population in soil under double and triple layered mulched plots.

Dehydrogenase enzyme activities

A prominent increase in enzyme activity was found 13.03% and 10.36% in black (25µ) and white (7µ) polythene mulched plots, respectively after 15 days. Similarly increase in enzyme activity was also observed in white 7µ thick polythene (TP) mulched plots up to 30 days. Whereas, 11.15% and 22.18% decreased dehydrogenase activity was observed in jute double and triple layer mulched plots, while no such decreases were observed in jute single layer mulched plots (Fig. 57). After 45 days of mulching a significant decrease in dehydrogenase activity was observed in all the treated plots except jute single layer mulched plots and here 4.3% increase was obtained. It was also highest among all the

treatments, which indicated that jute single layer may be constructive to maintain soil fertility. Although some significant increase in dehydrogenase activity was observed in black 7µ thick and black 25µ TP mulched plots during 75 and 105. Finally dehydrogenase activity under jute double and triple layer mulched plots remained lower than the control throughout the experiment (Fig. 51).

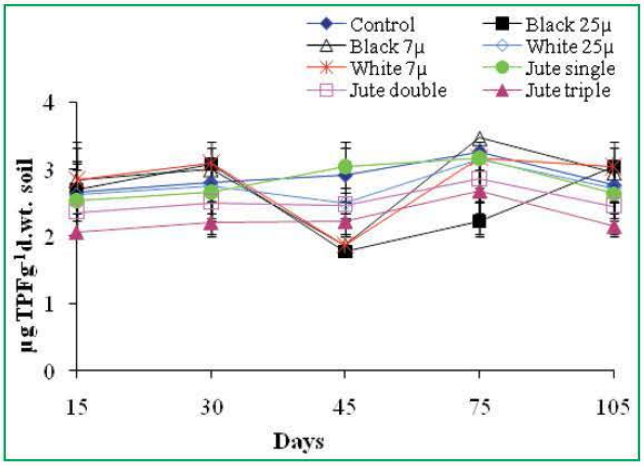


Fig. 51: Dehydrogenase activity (µg TPFg^{-1}d.wt. soil) after application of different mulching in strawberry field

Nitrate reductase enzyme activity

After 15 days of mulching, 10.68% increment in nitrate reductase activity was observed in white 7µ TP mulched plots. In comparisons to all treatments white 7µ TP mulched plots have indicated a significant increase in nitrate reductase activity (fig. 58). Nitrate reductase activity was found further increased in this plot up to 9.52%. Whereas, 25.27% decrease in nitrate reductase activity was found in white 25µ TP mulched plots in 45 days samples. During this period 13.92% increase in nitrate reductase activity was recorded in jute triple layer mulched plots. In white 7µ TP mulched plots lowest enzyme activity (34.0% less than control) was observed. Black 7µ mulched plots have been indicated 26.68% decrease in nitrate reductase activity. Similar trend of decrease in nitrate reductase activity was observed 20.89%, 18.41% and 12.75% respectively in jute double layer, white 25µ thick and black 25µ mulched plots (Fig. 52). After 105 days, nitrate reductase activity was found decreased continuously in all the treatments except in white 7µ TP mulched plots.

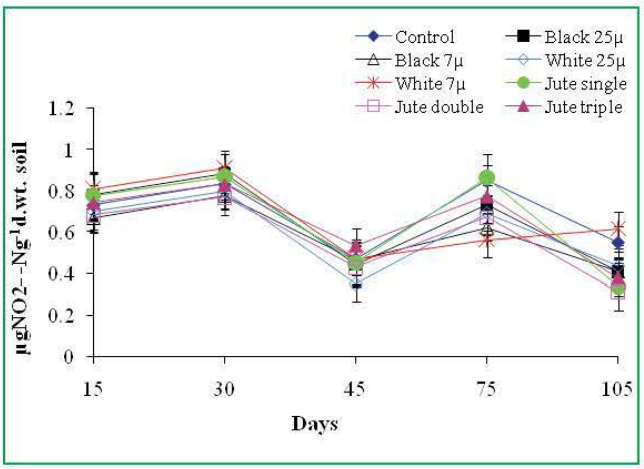


Fig. 52: Nitrate reductase activity (µg NO_2-Ng^{-1} d.wt. soil) after application of different mulching in strawberry field.

Phosphomonoesterase enzyme activity

phosphomonoesterase enzyme involves in phosphorus metabolisms in soil. Alkaline phosphomonoesterase enzyme activity also correlates the microbial population in soil. After 15 days of mulching 12.89% increase in enzyme activity was found in white 7µ TP mulched plots (Fig. 53). Similarly in jute double layer mulched plots enzyme activity increased 17.66%. Whereas, 9.67% decrease was observed in jute triple layer mulched plots and no such types of increase or decrease in enzyme activity was found in jute single layer mulched plots (Fig. 59). The trend of increase in enzyme activity under different mulching was observed up to 30 days. Highest increase in enzyme activity was observed in jute double layer mulched plots, which was 63.34% more than the control, followed by 36.15% more in white 25µ TP mulched plots and third highest was 27.68% in jute triple layer mulched plots. After 45 days of treatment, 39.7% increase in enzyme activity was observed under white 7µ thick mulching.

Finally, in 105th days samples considerable

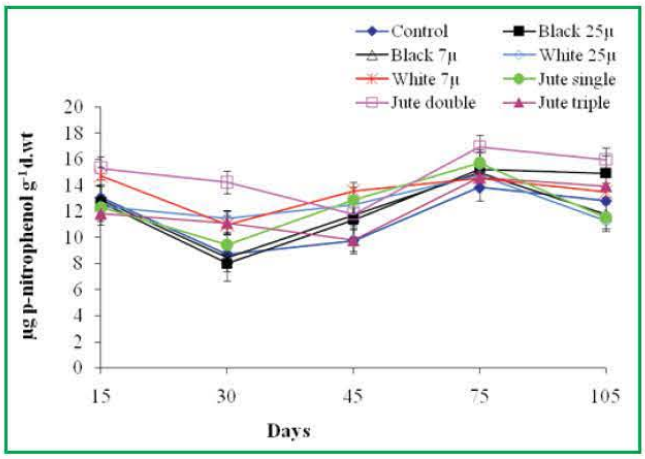


Fig. 53: Phosphomonoesterase enzyme activity (µg p-nitrophenol g^{-1}d.wt. soil) after application of different mulching in strawberry field

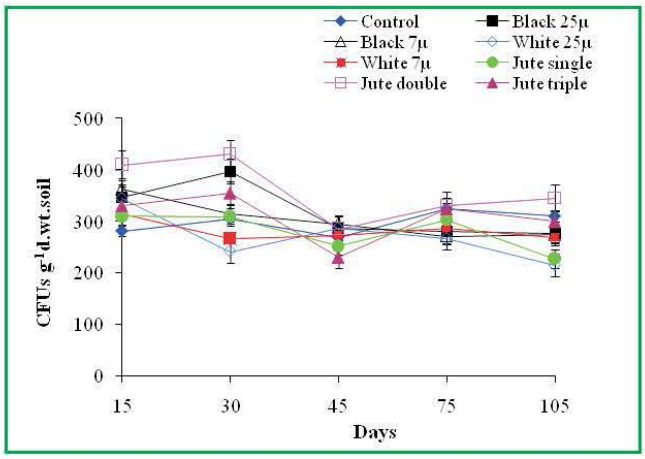


Fig. 54: Bacterial population (CFUs g^{-1}d.wt.soil) after application of different mulching in strawberry field

increase in enzyme activity was found in black 25µ jute double and jute triple layer mulched plots. Whereas, a remarkable decrease was observed in black 7µ, white 25µ TP and jute single layer mulched plots (Fig. 59).

Bacterial population

After 15 days of mulching significant increases in bacterial population was observed in all the treatments. Among all these treatments highest increase (45.91%) in bacterial population was observed in jute double layer mulched plots and second highest increase in bacterial population was found in both black 25µ and 7µ TP mulched plots. Trend of bacterial population increase was found continued up to 45 days in both black 25µ and 7µ TP mulched plot. Whereas, in 75 and 105 days samples a considerable decrease in bacterial population was observed in both black 25µ and 7µ TP mulched plots. Finally, 10.97 and 11.61% decrease in bacterial population was found in both black 25µ and 7µ TP mulched plots respectively (Fig. 60). In case of both white 25µ and 7µ TP mulched plots bacterial population continuously decrease from 15 days of mulching to 105 days. In 105th day samples 30.64 and 13.55% decrease was found in both white 25µ and 7µ TP mulched plots respectively (fig. 54).

Jute mulching has also played a significant role in changes of bacterial population in all three types of treatments. In jute double layer mulched treatments a throughout increase in bacterial population was found during whole the experiment. In 105 days samples, 11.29% more bacterial population was observed in jute double layer mulched plots. Whereas, some decrease in bacterial population was found in jute single layered plots, but all were insignificant and may recovered very soon. Conclusively, more or less all the jute treatments have indicated a stimulatory effect for bacterial population (Fig.54).

Azotobacter population

Black 25µ TP mulching has indicated 18.06% increase in *Azotobacter* population whereas 33.33 and 20.83% increase in jute single layer and double layer mulched plots were observed, respectively (Fig. 55) after 15 days. In black 7µ TP mulched plots 23.71% increase in *Azotobacter* population was observed after 30 days, which continued up to 105 days (53.76%). Similarly, white 25µ TP has also indicated a significant increase in *Azotobacter* population in 30th days sample and thereafter a considerable decrease was found in 45 days samples. Contrary to this, 65.59% increase in population was

recorded in 105-day samples. Almost similar increase in *Azotobacter* population was found in white 7µ TP mulched plots, whereas, in 30th day's sample 22.27% decrease of the population was recorded. Among all the jute treatments, single layer treatment was found more suitable in terms of *Azotobacter* population increase. Conclusively, jute treatments were found significantly effective to enhance the *Azotobacter* population in soil (Fig. 55).

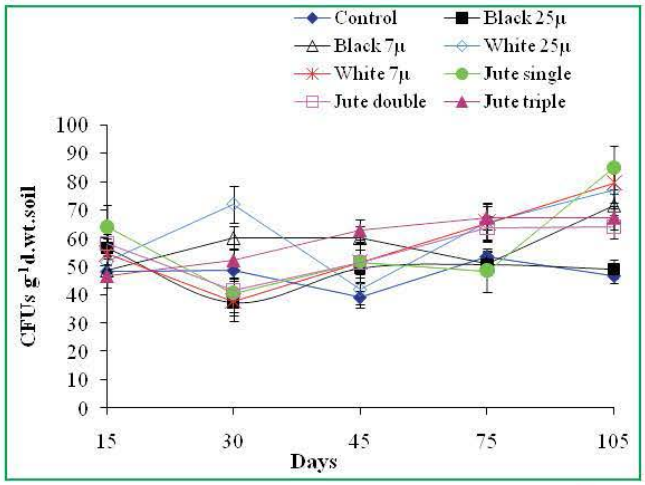


Fig. 55 *Azotobacter* sp. population (CFUs g^{-1} d.wt.soil) after application of different mulching in strawberry field

Fungal population

Fungal population in soil play a significant role for the biodegradation of crop residues and other complex materials in soil and makes nutrients available to the plants. After 15 days of mulching a significant increase in fungal population was observed in all the mulching treatments, except black 7µ mulched plots. The trend of fungal population enhancement continued up to 30 days of mulching (Fig. 62). Trend of fungal population increment was found continued throughout the experiment in black 25µ mulched plots, such as it was 82.08% more than the control after 15 days and similarly 23.26% greater after 105 days of the mulching. But in case of black 7µ mulched plots increase and decrease of fungal population was found discontinued and finally after 105 days sample 11.63% increase in fungal population was recorded. Similarly, white 7µ TP was found suitable for mulching in terms of fungal population increase because a significant increase in fungal population was found throughout the experiment under this treatment (Fig. 56). Comparatively among the jute mulches, single, double and triple layer mulched plots; highest fungal population was found in jute single layer mulched plots.

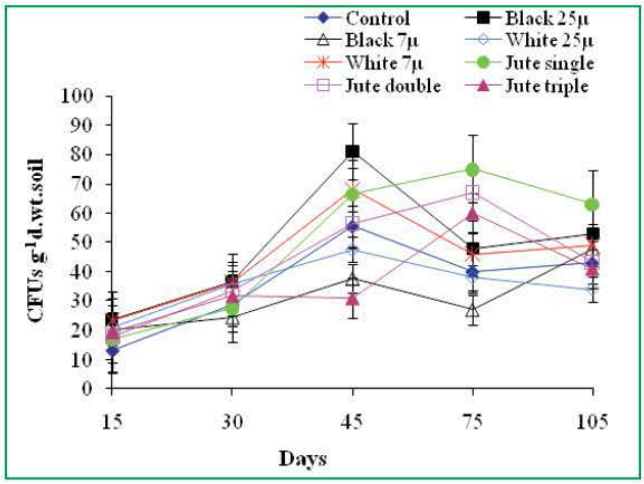


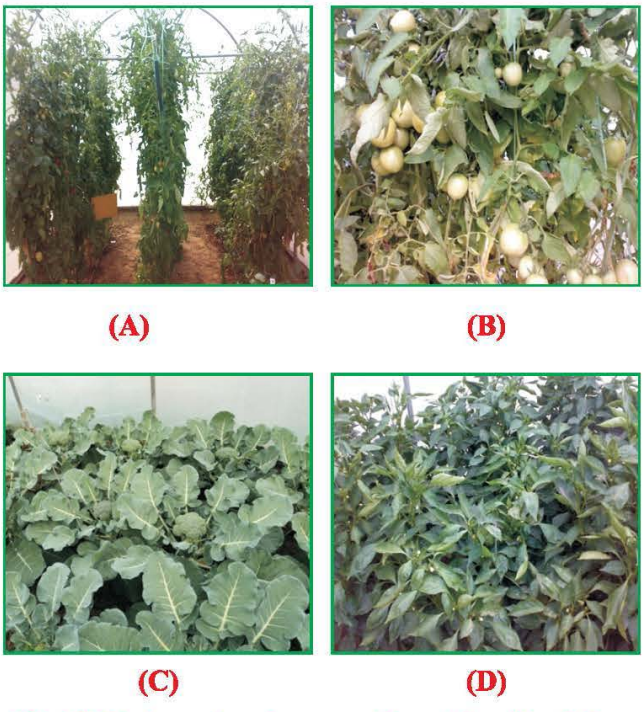
Fig. 56: Fungal population (CFUs g^{-1}d.wt.soil) after application of different mulching in strawberry field

Evaluation of insect net for insect dynamics and microclimate inside net-house for vegetable production.

Jitendra Singh, D.D. Nangare and V.S. Meena

Four net-houses of 6 x 3 x 3 m were constructed and separately covered with 25, 40, 50 and 60 mesh size of net. Two big elastic springs were fitted in each gate for auto door closure to avoid entry of the tiny insects through gate when workers or others open the gate. All other precautions such as closed irrigation system i.e. drip irrigation was installed to avoid the contamination of tiny eggs and larvae of the insects. It was also avoided in water storage tank and water was sucked by the pump from more than one meter depth where egg and larval contamination were not possible. Entire net-house structures were protected to prevent the insect entry through secondary sources.

Tomato, broccoli and capsicum were transplanted inside the net-houses as well as in open field, to study the insect pest and disease infestation. Tomato was transplanted at 100 cm row to row and 50 cm plant to plant spacing and similarly, broccoli and capsicum were transplanted at 50 x 50 cm spacing. As compared to open field crops, very good plant growth of tomato, broccoli and capsicum was achieved under net-houses. In terms of project objectives, no pest and disease infestation was found in 50 and 60 mesh size net-houses. Whereas, leaf curl infestation caused by whitefly was experienced in tomato and capsicum under 25 and 40 mesh size net-houses. Thus higher yield of tomato, broccoli and capsicum with good quality was found in 50 and 60 mesh size net-house produce (Fig. 57).



(A) (B)

(C) (D)

Fig. 57 Picture showing growth and health of the plants

Aphid score counts was found, 550-600 and 330-400 on apical five leaves of capsicum and tomato, respectively, in open field conditions. Whereas, 40-50 aphid counts were found on capsicum and tomato leaves under 25 mesh size net-house conditions and no aphid infestation was found inside 40, 50 and 60 mesh size net-houses. Compared to open field, healthy plant growth was obtained inside all the net-houses in terms of plant height, vigour, flowering and fruiting. Around 40% leaf curl infestation was found in capsicum plants inside 25 and 40 mesh size net houses. Whereas, no such type of infestation was found under 50 and 60 mesh size net-houses. Results of quality analysis, indicated highest TSS in tomato under 60 mesh net-house and followed by 40 mesh net-house produce. Vitamin C content (mg/100 g fruits) and acidity (sourness) was also found higher in net-houses produce as compared to control. Highest lycopene content (3.45 mg/100 g) was found in tomato under net house as compared to open field (1.8 mg/100 g). The average weight of broccoli was found 94.4 g (open field) compared to 313 g in 60 mesh nethouse. The size i.e diameter of broccoli was observed more in net-house as compared to open field. Average fruit weight and yield of the capsicum were also found more in net-house as compared to the open field. Due to aphid and whitefly infestation lowest fruit weight and yield were found in open field conditions. Conclusively, more tomato yield was obtained in 25 mesh net-house and 40 mesh net-houses. During winter, 3-5°C more temperature and reduction of solar radiation was found inside net-houses. In terms of insect dynamics no infestation of whitefly and other tiny insects was found under 50 and 60 mesh size nets. Thus, nets of 50 and 60 mesh size may be recommended to prevent infestation of tiny insects.

Optimization of shade net design to create a suitable climate for cultivation of vegetable, cut flowers in semi-arid region

D D Nangare, Jitendra Singh and V.S. Meena

Shade net houses with three different shading (35, 50 and 75%) and three different heights (2.5, 3 and 3.5m) were constructed. Tomato (*Cv. Naveen and Namdhari*) and capsicum (*Cv California Wonder*), Marigold, broccoli and cauliflower were cultivated in nine shade nets and in open field.

Yield and quality of tomato, capsicum and marigold

In Tomato, the maximum average plant yield of 3.49 kg/plant was found in 35 % shading net followed by 2.87, 1.83, 1.71 kg/plant in open, 50 and

75 % shading net, respectively (Fig. 58). Also, the marketable value of tomatoes were found better in 35 % shading net as compared to open field because the tomato produced in open field was infested by the pest (*Helicoverpa armigera*) and diseases early blight (*Altenaria solani*) and blossom-end rot (Fig 59). No significant effect was observed in TSS, Acidity and ascorbic acid under all three shadings i.e. 35, 50 and 75%. But ascorbic acid was found better in tomatoes produced in shade net house as compared to open field. The dry matter of tomato was found maximum of 335 g in 35 % shading net followed by open (313 g), 50 % (165 g) and 75 % (141 g) shading net. The average fruit weight was found maximum in 35 % shading net as compared to 50 and 75 % shading net house.

Fig. 58 Tomato plant in 35% shading net with 3 m height

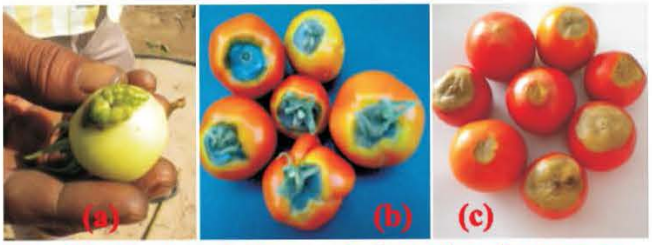


Fig. 59: Pest and disease infestation in tomato (a) fruit borer (b) early blight diseases (c) end blossom rot, in open field

In capsicum, the maximum average yield was found 310 g/plant in 35% shading net followed by open field (254 g), which was found significantly higher than the 50 and 75 % shadings nets. The negligible or very less total yield was observed under 50 and 75% shade net-houses. This may be due to reduced penetration of solar radiation inside shade

(A) (B)

Fig. 60: Marigold under 35% (A) and 50% (B) shade net-houses

net-houses as compared to open field and in 35% shading net-house. The quality of capsicum i.e. size and shape and colour was found better in 35% shade net-house as compared to open field. The mean fruit weight was found 62.3 g, which was significantly higher as compared to open field (36.8 g).

In Marigold (Fig. 60), the maximum yield of flowers/plant was observed in 35 % shading net-house (338.2 g) followed by open field conditions (309.8 g), 50 % (179.5 g) and 75 % (113.1 g) shading net-houses. The average flower weight was found 32.67 g under 35 % shading net-houses, followed by open field (21.60 g), 50 % (17.39 g) and 75 % shading net-houses (6.53 g).

Cultivation of Tomato, Cauliflower and Broccoli in shade net house

Raised nursery of tomato (NS-545 Namdhari) and cauliflower (Coral white) and transplanted in shade nets during July 2011. Broccoli was transplanted in different shade net house in November 2011. The 50% flowering was recorded in tomato crop up to mid October 2011. While in November end full flowering were noticed in all shade nets. Root-knot nematode and early blight infestation was observed in tomato, which was controlled periodically. Highest TSS (4.8%) was observed in shade net while highest acidity found in control. Lycopene was found higher (2.03 mg/100 g) in shade net as compare to control (1.8 mg/100 g). No significant effect was observed in TSS, Acidity and ascorbic acid under all three shadings i.e. 35, 50 and 75%. In cauliflower earliest initiation of curd was noticed after 59 days after transplanting (DAT) on 35

% shade net house. The curd weight has been recorded in range of 260 - 1950 g in shade net house. Higher curd weight and curd diameter was recorded in 35 % shade net house as compared to 50 and 75 % shade net house Floret opening in Gladiolus observed in March 2012. Spike length of gladiolus recorded in range of 10-15 cm. Average curd weight of broccoli was found more in shade net (287.8 g) as compared to open field (107.6 g). The size/diameter of broccoli was found more in 35 % shade net house as compared to other shade net house (50 and 75 %) and open field. The colour of broccoli floret powder was observed more greenish in broccoli harvested from shade net than from open field (Fig. 61).

(A) (B)

Fig. 61: Cultivation of broccoli (A) shade net (B) open field

From the study, it was observed that the 35 % shading net house was found better for the cultivation of tomato, capsicum, cauliflower and broccoli and marigold in terms of yield and quality, as compared to open field and 50 and 75 % shading net houses in the semi arid region of Punjab.

TRANSFER OF TECHNOLOGY

Mobilizing Mass Media Support for Sharing Agro-Information

D. R. Rai, S. Chopra, Jitendera Singh

The major activities included production of three films on successful technologies/success stories in northern region of the country, more than 190 news-clippings in leading regional and national dailies, showcasing for dissemination of technologies, a new series of a radio program 'Do Dooni Chaar' focused on development of rural entrepreneurship and a media meet to provide interactive platform to farmers, scientists and media.

Coverage in print media

More than 190 news-items were published, which included success stories, transfer of technology events, training programmes, institute activities and visits of the important personalities etc. The news coverage appeared in leading regional, national dailies and generated considerable impact.


रिक्शाचालक का कमाल, फूड प्रोसेसिंग मशीन बनाई

Fig. 62 News-item related to success story of multi-purpose machine inventor

Radio Programmes

The institute in collaboration with All India Radio, Jalandhar, had initiated agriculture informative programme on post technologies harvest "Do Dooni Char" series of 10 programmes on successful technologies to motivate farmers was broadcasted. Here, experts from CIPHET and successful farmers/entrepreneurs create awareness among farmers about entrepreneurship development based on latest technologies in post harvest sector. The programme also motivated farmers and entrepreneurs to join training at CIPHET. The coverage of this programme has drawn huge response in form of queries/requests/responses across northern region. The programme is broadcasted through out Punjab, parts of Haryana, Himachal Pradesh, Uttranchal, Jammu & Kashmir and Rajasthan.

Video Films

Visual medium is an effective form of communication and under this project three films have been produced based on successful technologies. These included 'Change Maker'-success story of multipurpose food processing machine inventor, 'Sultan of Fisheries'-success story of Sultan Singh in fish seed and 'The NET house of Hope'-a success story of KVK Ropar in protected cultivation. These films are on important events/exhibitions/visits for creating awareness and motivating farmers/entrepreneurs to replicate successful models.

Fig. 63 Recording of a radio programme

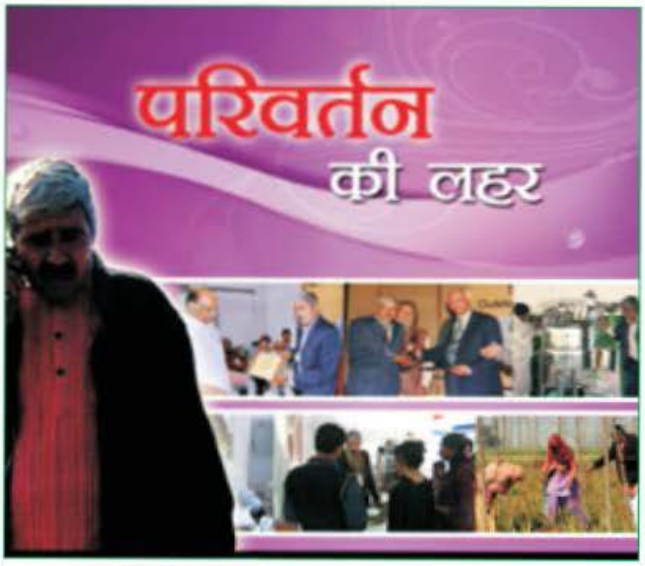


Fig. 64 Cover page of a video film

Fig 65. Exhibition held at CIPHET

Showcasing of technologies

For providing opportunities to all stakeholders in post harvest sector, an exhibition on showcasing of technologies was organized on September 28, 2011 at CIPHET. The exhibition was represented by food processing industries, agricultural universities, ICAR institutes including Adani Agri Logistics Ltd, Cremica Industries Ltd, Ricella Health Foods Ltd, Tru Milk, Kashmir Aparies, Punjab Agricultural University, PAU Kisan Club, Guru Angad Dev Veterinary & Animal Science University, Indian Agricultural Research Institute (IARI), New Delhi, Directorate of Wheat Research (DWR), Karnal, Center Potato Research Institute (CPRI), Shimla. Besides, financial institutes like NABARD, Punjab & Sind Bank, Punjab National Bank and innovative farmers displayed their products/ technologies in the exhibition. Dr B.S Dhillon, Vice-Chancellor, Punjab Agricultural University, was the Chief Guest on the occasion. The event got wide media publicity and also provided opportunity to farmers/entrepreneurs to sell their developed products.

Television Programmes

Eight television programmes on CIPHET technologies and events were broadcasted on leading channels including Doordarshan, Zee News, PTC News etc. The coverage included technologies

Table 17 Achievements at a Glance

Activity	Achievements
News Clippings	194 news-clippings were published in leading regional and national dailies
Radio Programmes	10 Radio programmes titled "Do Dooni Chaar" on CIPHET developed technologies were broadcasted
TV Programmes	Eight news-reports and programmes on Doordarsha, Zee Punjabi, PTC etc
Video Films	• Change marker-based on success story of inventor of multipurpose machine • Sultan of fisheries-based on success story of Sultan Singh • Nethouse of hope-based on KVK Ropar success story
Showcasing of Technologies	Exhibition was organized on September 28. 2011 to provide platform to all stakeholders in post harvest sector at regional level
Media Meet	Media meet was organized on sidelines of National Farm Innovators meet on Sept 5. 2011

developed, exhibition and farm innovators meet organized at CIPHET.

Media Meet

A meet was organized on sidelines of the farm innovators meet on September 5, 2011 to provide an interactive scientist farmer-media interface. The event helped in generating many success stories and around 18 news-clippings got published in various newspapers, while programme was also broadcasted by All India Radio Jalandhar.

Refinement and evaluation of fish descaling machine and entrepreneurship development

Nilesh Gaikwad, Tanbir Ahmad and Ajeet Singh

The fish descaling machine is designed and developed with important components such as descaling head, flexible shaft, safety shield, power drive mechanism, AC drive and stand for fixing motor and A.C drive.

Descaling head is a part of fish descaling machine which is used for the removals of scales from the outer surface of the fish. It is made up of food grade stainless steel (grade 304) materials. Four types of descaling heads developed are presented in Fig. 72.

A flexible shaft was used for the transmission of motions and to provide flexibility in operation. The application of flexible shafts help in transmission of energy from motor drive to descaling head. Total length of flexible shaft is 1.7 m and diameter for power transmission shaft is 18.0 mm. 3 phase AC motor of 1 hp was used. A safely cover is provided for safeguarding the hand of the person carrying out descaling and it also avoids the spreading of scales. It is made of metal sheet of length 8 cm. and fixed on hand piece of flexible shaft.

Performance evaluation of the descaling machine was carried out with different type of

13 slots descaling head (slot depth 5 mm) | **Inverted v shaped descaling head (slot depth 2.5 mm)**

26 slots descaling head (slot depth 2.5 mm) | **Diamond shaped descaling head (slot depth 2.5mm)**

Fig. 66. Different components of fish descaling machine

descaling heads and speeds (1440, 2000, and 2800 rpm) as independent variables and capacity (No. of scales removed /second), efficiency of descaling, damage inflicted to fishes and energy consumption as the dependent variables to arrive at optimum parameters. The speed of 2800 rpm and the diamond shaped descaling head found was to be best suited (Table 18). The next best descaling head was inverted 'V' shaped followed by the 13 slots and 26 slots.

Table 18. Performance Evaluation of fish descaling machine

Performance Parameters	Average Value
Capacity (No. of scales removed)	31.50
Efficiency (%)	99
Damage (%)	0
Energy Required (kwh)	0.25

The fish descaling machine reduced drudgery in descaling operation and also reduced the time required in descaling from 120 s to 40 s for descaling of average 500 g fish vis a vis traditional hand tool in practice.

Assessment of poultry, goat, sheep and fish processing and its refinement and upgradation through technological interventions

Tanbir Ahmad, Nilesh Gaikwad and Yogesh Kumar

A poultry processing table for poultry butchers & small poultry meat entrepreneurs was :

Designed taking into consideration both ergonomics standard and hygiene required for the dressing of the poultry carcasses. The design of table was optimized for minimum space requirement and maximum ease of operations owing to space constraint faced by poultry meat retailers.

The table is in arc shape having 91 cm height. The main utilities provided on the table are sink, dicing board, double jacketed temporary meat holding bowl (for low temperature temporary storage of the unsold meat), water tap, weighing balance and money drawer.

There is a provision to dress the bird after the slaughter in the hanging position. Unidirectional flow is maintained as per the basic hygiene requirement during processing of birds.

A poultry slaughter cone as designed

The design of slaughter cone is based on morphological parameters of the poultry bird. Three cones are mounted on a central rod of 150 cm length, at an angle of 120° from each other, with the help of two discs. The top disc is placed just below the upper edge of the cone and bottom disc is placed above the lower edge of the cone. For collecting the blood, a tub is mounted on the central rod below the three cones. The tub can be detached easily for cleaning. In order to prevent splashing of blood outside the tub, the cones are mounted in inclined position towards the centre. The cone restrains the bird and the bird is slaughtered.

Fig. 67 Poultry Slaughter Cone

Assessment of occupational health hazards among workers in agro processing units

Indu Karki and Nilesh Gaikwad

Agro Processing Centres and rice mills located at Moga and Faridkot were visited for data collection. The main problems faced by workers were dust, noise, repetitive work etc.

The major activity of the workers in rice mill was related to loading and unloading of paddy and rice bags. This activity was critical and affects workers' health. The backpain, headache, body ache, skin allergies/rashes, hearing related problems and respiratory problems have been reported during interviews of workers.

The health hazards perceived in the involved high working environment temperature at the distillation unit. The storage of deoiled cake at low moisture content in the summer seasons leads to slow burning of the cake eventually sometimes leading to major fatal accidents.

Fig. 68 a) Work in unsupported position b) working with uncovered machine parts

Outreach and inhouse studies on power factor correction systems far agro processing equipments

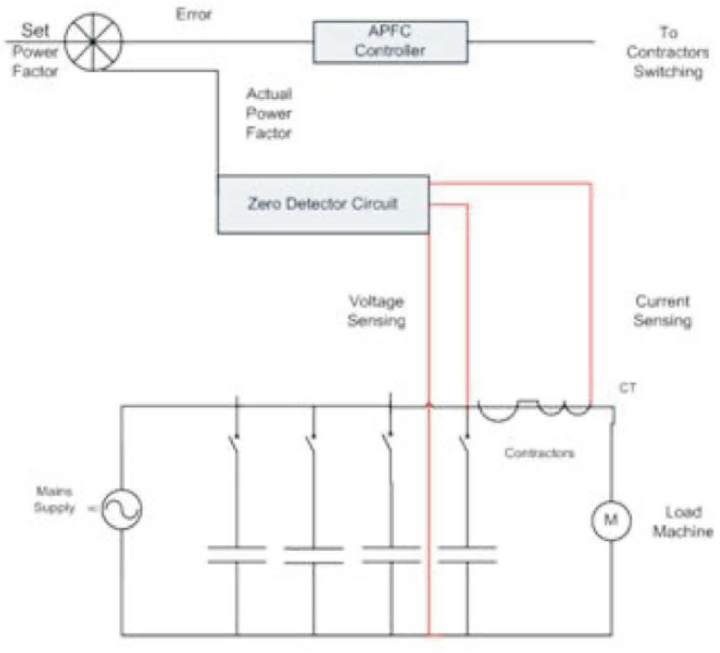
Sangeeta Chopra and Devinder Dhingra

The power factor of hammer mill, horizontal pelletizer, vertical pelletizer, blender in cattle pilot plant at no load and on full load was 0.61 - 0.75, 0.22 - 0.39, 0.27-0.45; 0.87-0.9, respectively. The power factor of burr mill, dhall mill, grain pearler, and seed cleaner cum grader in Agro Processing Centre was 0.33-0.77; 0.95-0.99; 0.33-0.68; 0.56-0.70 respectively from no load to full load. There is a need for correcting the power factor of the machines and thus automatic power factor corrector (3 phase) for these machines was designed. The correction for reachive power (kVAR) was worked out for each machine from its capacity, actual and the desired power factor (Table 19). The design of the automatic power factor correction system (APFC) was done for 7 kVAR APFC system for 2 – 10 hp machines and 12 kVAR APFC system for 10-25 hp machines. The APFC consists of a number of capacitors that are switched by means of contactors based on zero current detection using current and voltage feedback through current and potential transformer of suitable rating (Fig 69). These contactors are controlled by a regulator that measures and rectifies power factor automatically in an electrical network.

The power factor correction system (APFC) has been used with the composite cattle feed pellets pilot plant. On connecting the APFC the power factor of the horizontal pelletizer increased 0.76, 0.79, 0.85, 0.89, 0.92 and 0.99 as the six capacitor banks were switched serially. On automatic mode, the power factor automatically gets corrected to 0.95-0.99 under load and no load condition. The power factor correction system has been used with the machines of Agro processing centre, and on automatic mode the power factor of these machines automatically gets corrected to 0.95-0.99 under load and no load condition.

Table 19: Corrected kVAR and actual power factor for the machines

Machine of APC, pilot plant	Power factor (on load)	Power factor (on no load)	Corrected kVAR
Agro processing centre			
Grain pearler (5 hp)	0.35±0.05	0.11±0.05	6.74
Seed cleaner cum grader (5 hp)	0.7±0.02	0.55±0.02	2.00
Burr Mill (5 hp)	0.75±0.08	0.33±0.05	1.48
Dhal Mill (2 hp)	0.99±0.02	0.95±0.03	3.17
Hammer mill (10 hp)	0.74±0.07	0.59±0.02	3.17
Cattle Feed Pilot plant			
Vertical pelletizer (20 hp)	0.45±0.06	0.27±0.05	11.19
Horizontal pelletizer (15 hp)	0.42+0.11	0.21±0.04	0.31
Blender (5 hp)	0.87±0.04	0.99±0.01	9.38
Grinder cum mixer unit (5 hp)	0.71+0.07	0.68±0.02	1.89
Oil expeller (7.5 hp)	0.44±0.05	0.23±0.07	8.71
Single screw extruder (5 hp)	0.48+0.03	0.35+0.02	5.01



Automatic Power factor correction system

APFC panel consists of APFC controller , Zero detector, Current transformer, capacitors

Fig. 69 Automatic power factor correction system

Trainings organized

- The technology of making green chilli powder/puree was introduced to the prisoners of Ludhiana Central Jail on April 6, 2011. Dr Dilip Jain, Senior Scientist, explained the process of making powder and puree from the green chillies. Dr

Jain also informed that small scale industrial unit could be set up with cost of less than Rs 3 lakhs.

- With aim to provide exposure of global best practices in packaging, CIPHET conducted the 14-day NAIP sponsored National training on "Smart Packaging Techniques for Shelf Life Enhancement and Retention of Bioactive Compounds in Food" during 11-24 October, 2011. Dr Deepak Raj Rai, Head Transfer of Technology Division was the course director of the training programme. Sixteen scientists/researchers across the country took part in the training programme and Dr Eva Almenar, Assistant Professor, School of Packaging of Michigan State University, USA updated about new technological developments in smart packaging. During the training, the participants were made aware about the food packaging concepts, controlled atmosphere technology, storage structures for perishables, micro-perforation mediated improvement of package environment, need and techniques to establish suitable space, packaging of perishables using bio-based appropriate plastics in food packaging, antimicrobial active packaging of food, antioxidant active packaging of food, metallic oriented framework and permeability of thermo plastic polymers etc.

- A training programme of three day duration on soymilk and tofu was conducted during 3-5 November, 2011. The programme aimed at development of entrepreneurship and self employment among youth.

- Two-day training programme on turmeric processing from 6-7 January, 2012 was conducted. Five farmers from different parts of Punjab underwent this training. During training programme; the farmers were given hands-on-experience on turmeric processing so as to equip them to run their own production units at commercial level.

- A five-day training programme during January 16-20, 2012 on Post Harvest Technology for Rural Catchments was conducted for the participants from Jalgaon, Maharashtra. Fourteen farmers including one woman took part in it. The training programme focused on various aspects of post harvest

technologies and processes such as minimal processing, modified atmosphere packaging of vegetables, scientific methods and quality assessment in food crops, surface covered cultivation, value addition technology for guava, post harvest management of fruits and vegetables, low cost storage of fruits and vegetables and preparation of composite cattle feed from waste potato etc

- Five-day training programme on 'Post Harvest Technology of Rural Catchments' was conducted during February 16-20, 2012. The farmers of Diara region of Bihar participated in it. The programme

was sponsored by the Diara Development Project, Bihar.

- Five-day training was conducted during February 21-25, 2012 on Post Harvest Technology for Rural Catchments. Sixteen farmers from Vaishali, Bihar took part in training, which was sponsored by ATMA (Agricultural Technology Management Agency). The major technologies under the training programme included post harvest management and value addition of fruits and vegetables, low cost storage of fruits and vegetables, preparation of composite cattle feed from waste potato, food packaging for quality and safety, processing and value addition of soybean, agro processing techniques, cereal crops for value addition, fruit fly traps, chili/turmeric processing and practical on extrusion processing etc.

- A training programme on soybean processing and value addition was organized during February 27-28, 2012. Four participants from Punjab and one from Uttar Pradesh attended the programme.

- Conducted training on processing and value addition of small millets during 24-26 February 2012, 19-21, March and 29-31, March 2012 under Centre of Excellence project.

- Training on soybean processing and value addition was conducted during March 26-27, 2012 for the participants from Bhatinda, Punjab. Three participants took part in the programme. They were given hands-on-training in preparation of milk and tofu from soybean.

- Training on post harvest technology for value addition was conducted during 9-14 April, 2012 under Farmer's Technology Transfer Fund (FTTF) programme of NABARD.

Participation in Exhibitions

- CIPHET participated in the Krishi-Dhan-2011 Exhibition organised by TERI, Mumbai from 28-30 April, 2011.

- CIPHET participated in ICAR-Industry Meet 2011 at NASC Complex, ICAR New Delhi on 23rd May 2011. The technologies of the microencapsulated pro-biotics products and meat cutter pulled heavy crowd. Union Minister of Agriculture and Food Processing Industry Sh. Sharad Pawar showed keen interest in the technologies developed by the CIPHET while visiting the institute stall at the exhibition.

- CIPHET Participated in 8th Inter States Horti Fair Sangam 2011 at Pragati Maidan, New Delhi from 27 to 30 May, 2011.

- CIPHET participated in India International Trade Fair 2011 at Pragati Maidan, New Delhi from 14-27 Nov. 2011 and showcased technologies to the visitors from all across the country.

- CIPHET participanted in "National Workshop on Farmer-Led Innovations" held at CCS HAU, Hisar during December 23-24, 2011. It was jointly organized by CCS HAU, Haryana Kisan Ayog, ICAR, TAAS (Trust for Advancement of Agricultural Sciences), PPV & FRA (Protection of Plant Varieties and Farmers' Rights Authority) and NIF (National Innovation Foundation). The innovative farmers including award winners from

different states of the country attended and discussed about their innovations in technical sessions and shared their success stories. The exhibition on various items was also displayed which was inaugurated by Dr. S. Ayyappan, Hon'ble DG, ICAR.

- In an effort to reach the farmers of the Jammu and Kashmir, CIPHET participated in Kisan Mela at

SKUAST (Jammu) at Shere Kashmir University of Agricultural Sciences and technology- Jammu during 19-20 March, 2012. CIPHET stall was visited

by the farmers and shown keen interest in the technologies. Some of them underlined the need of pomegranate aril extractor for processing of the wild pomegranate which available in plenty in the state which otherwise remains unutilized and wasted as such on plants. The technology of the EC room was also appreciated by the farmers.

Programmes organized

- Aiming to provide a common platform to farmers doing innovations in post harvest technology across the country, CIPHET organized first 'National Farm Innovators Meet' on 5th September 2011.

Farmers from states like Punjab, Haryana, Kerala, Himachal Pradesh, Gujarat, Bihar, Jammu and Kashmir, Uttar Pradesh, Uttarakhand, Jharkahnd, and Odisha participated in it. The farmers gave presentations besides displaying their products and explained their technologies in the area of agro-processing, value addition, farm structures, shelters, reduction of post harvest losses. This meet opened up new avenues for collaborative research between farmers and scientists and further improvements of technologies developed by the farmers on their own level.

- A regional level exhibition on showcasing of agriculture technologies was organized by CIPHET on 28th September 2011, under NAIP Sub-Project "Mobilizing Mass Media Support for Sharing Agro Information". The exhibition was represented by top food processing industries including Adani Agri

Logistics Ltd, Cremica Industries Ltd, Ricella Health Foods Ltd, True Milk, Kashmir Aparies, Punjab Agricultural University, PAU Kisan Club, Guru Angad Dev Veterinary & Animal Science University, ICAR institutes like Indian Agricultural Research Institute (IARI), New Delhi, Directorate of Wheat Research (DWR), Karnal, Central Potato Research Institute (CPRI), Shimla.

- National seminar on "Post-Harvest Packaging, Cold-Chain Logistics and Instrumentation Techniques for Quality and Safety of Perishables" was organized on 19-20 December, 2011 with financial support from National Horticulture Board (NHB) and National Bank for Agriculture and Rural development (NABARD). The seminar aimed to address the initiatives as well as the new developments such as smart packaging, image

processing techniques, non-destructive quality evaluation, bio sensors and instrumentation

techniques to address the quality, shelf-life and marketing aspects to identify the critical gaps and their possible corresponding solutions.

- The minimal processing technology was demonstrated to the group of 30 farmers at the field of progressive farmer Mr. Shamshad Ahmad at Abbaspura, Malerkotla on December 22, 2011. The machines such as basket centrifuge developed by the CIPHET, band sealer with gas flushing attachment,

hand sealer and packaging materials such as PP and LDPE were shown. The farmers were apprised about the cleaning, washing process and removal of surface moisture by using the basket centrifuge and were educated about the types of the polyethylene films and their selection for the packaging. The farmers showed keen interest in the technology as they were convinced about the potential of the technology in fetching high income.

- CIPHET organized a special function to celebrate its 22nd foundation day on December 29, 2011. A visit of school children was held for creating awareness regarding institute's facilities. A small

exhibition of value added products prepared from aonla and guava was also displayed.

Recording of programme on All India Radio

- A programme on showcasing of agricultural technologies was aired by All India Radio (AIR) Jalandhar on September 29, 2011.

- A live programme on post harvest and value addition was aired at AIR, Jalandhar on 30th March, 2012.

AICRP on Post Harvest Technology

Impact assessment of technologies developed under AICRP on PHT

S K Nanda, Anil Kumar Dixit and S K Aleksha Kudos

The impact accrued as a result of technology intervention is evident from economic and social prospective. The results indicate that enhanced recovery and reduction of post harvest loss were found in many cases, besides, augmenting the income and employment generation. The annual profit to the entrepreneurs as a result of technology were found as: Aloevera processing (Rs. 22.72 lakh), Bottling of sugarcane (Rs. 9 lakh), Garlic bulb breaker (Rs 6.85 lakh), Tamarind dehuller deseeder (Rs 24.75 lakh), Farm level washing machine (Rs 15.40 lakh), Solar tunnel dryer (Rs. 8.3 lakh). It is worth mentioning that technology like Vivek thresher cum pearler, 'Apricot kernel decorticator, Cumin thresher, Maize dehusker, Garlic bulb, Aloevera juice/gel extraction machine, Pedal operated ice breaker, Tamarind dehuller- deseeder, pineapple slicer helped in reduction of human labour drudgery, as reported by intended beneficiary. Nonetheless, the technologies like holi colour power from tapioca, extraction of apricot kernel oil are environmentally safe as utilize by products which usually goes waste and has demand in the local market, can be called as green technology.

The estimated economic benefits of the technologies (ready for commercialization), is as: Jaggery Chocolate and Nuggets, capacity 5 kg/ day (Rs 7.85 lakh/unit), Manufacturing of Dehumidified Air Dryer with Heat Pump System, 25-30 kg/batch (Rs. 6.80 lakh/unit), Complete Package for Honey Processing, 50 kg/batch (Rs. 3.85 lakh/unit), Plum Appetizer, 1055 bottle/day (Rs 3.70 lakh/unit), Production of Virgin Coconut Oil, 20 kg VCO per day (Rs. 11.68 lakh/unit). Keeping in view the economic potential of these technologies, there is a need to popularize them with processing industry and promising entrepreneurs.

Further APC models (pioneered and successfully implemented by AICRP on PHT) were found suitable, convenient and economically viable to capture huge potential for processing of agricultural commodities in production catchment. It is interesting to note that the consumers are more benefited than the entrepreneur, as a result of improved recovery, because most of the milling/oil extraction in unorganized sector is done on custom hiring basis. The social benefits were found in terms of employment generation, proper allocation of family labour, positive health impact on dairy animals, improving crop productivity (in some cases) through backward integration and women empowerment. Finally, it appears that AICRP on PHT technologies have able to establish linkages with lower stratum of the population in rural and semi urban catchment, and the impact of technologies in terms of adoption, financial sustainability, physical capital accumulation and improving crop productivity (in some cases) through backward integration is clearly visible.

Design, development of testing of groundnut Testa Remover (Jabalpur centre)

The groundnut testa removing machine for removal of testa from roasted kernel has been developed and tested for different surfaces of concave such as nylon fiber mat, Denim cloth and Canvas cloth and the nylon fiber mat was found to yield high coefficient of static friction with respect to the groundnut kernel and provides good cushion effect to avoid breakage during removing testa.

The machine has a capacity of 40 kg/h with groundnut kernel peel removal efficiency of 66.68% in single pass. The approximate cost of the machine is Rs. 35000 with the cost of operation being Rs 0.45 per kg.

Groundnut Testa Remover

Development of small scale oil refining unit (Bhubaneswar centre)

Small scale oil refining unit of capacity 30 kg/batch had been developed consisting of degumming unit, vacuum dryer and filtration unit for minimal refining of sunflower oil. Preliminary evaluations have showed a process time requirement of 8 hours per batch. The approximate cost of the system is Rs 1 lakh. Physical refining of crude sunflower oil has been carried out during January - March 2012. Peroxide value, gum and wax content reduced during the refining process.

Minimal Oil Refining Unit

Development of mini millet pearler and process protocols for bakery and extruded products from pearl millet (Jodhpur centre)

A small capacity pearler was developed for pearling of pearl millet. The mill rotors consist of two 98 mm diameter and 13 mm thick carborundum grinding wheels driven by one hp electric motor. Each wheel is separated by 5 mm and clearance of 2.5 mm is maintained between tip of wheels and pearling chamber. The grain is fed through the top and passes through rotating wheels. The pearled grain is collected at the bottom. The biochemical properties of different fractions of pearl millet were determined.

Bajra Biscuis Multinutrient Animal Feed Block

The effect of pearling on changes in lipids of pearled pearl millet flour during storage was also studied. After 28 days of storage the fat acidity value (mg KOH /100g meal) and free fatty acid content (%) were 36.6 and 18.4 for pearled millet respectively compared to those values of 78.9 and 39.6 respectively for unpearled millet. Products viz. bajra biscuits and multinutrient animal feed block have been developed using bajra millets.

Development of products of commercial importance from minor millets *Setaria, Paspalum* and *Panicum* sp. (Kharagpur centre)

Kodo:corn:Bengal gram (A1) kodo:corn:soy (A2), proso:corn:Bengal gram (B1), proso:corn:soy (B2), all in 1:1:1 proportion were extruded at 20% moisture content and 120 °C temperature. Screw and

feeder speeds were 300 and 30 RPM respectively and a 2 mm diameter die was used. Physical attributes like bulk density, expansion ratio, hardness, crispiness and colour; chemical attributes like moisture, protein, fat, crude fiber ash, carbohydrates and energy of the extrudates were studied. Sensory evaluation of the selected six samples was carried out. Extrudates were coated with spice seasoning and 6 point hedonic scale was followed to select the most acceptable formulation. It was observed that kodo blended with soya proves to be most nutritious extrudate due to highest protein, fat, ash and crude fibre contents.

Development of a pearling unit for minor millets (Coimbatore centre)

An abrasive type conical shaped pearler has been developed consisting of a tapered stone roller, a concave is fitted over the abrasive roller, an aspirator and a cyclone to separate the dust from the milled grain. The milling unit is operated by 3 hp motor and the aspirator is operated by one hp single phase motor and costs Rs 50000/- including motors. The minor millets (fox tail millet, little millet, common millet) dried at 12% and pearled at 1200 RPM were found to be optimum.

Eco friendly control of storage insects in milled rice (Bangalore centre)

The technology involves mixing of pea protein (1%) or commercially available Aurvedic Zandu Parad® tablet @1% (not powdered) with milled rice grains and storing the rice in a plastic or metallic container. Recent research on protein-enriched pea flour (Protein-enriched pea flour -protein 60%, starch 30%) has shown that it has both toxic and repellent properties, while Zandu Parad tablet (made from Parad 60 mg and Khatika 120 mg; each tablet weighing 2g) is known to have repellent properties. However, pea protein is not commercially available. Zandu Praad Tablets can be separated by hand picking the tablets before washing the rice for cooking and the pea protein is washed out in water just before cooking.

Management of safe storage of pulses (Kharagpur centre)

Fluidized bed heating at different temperatures (40-80°C) and exposure times (40-120 sec) had statistically significant effect on moisture reduction and insect mortality of stored green gram (Malviya-12). Moisture reduction and insect mortality both increased with increasing temperature and exposure time.

Mechanization of Petha Industry and technological interventions for process/product improvement (Aligarh and Hisar centres)

A mechanized petha pricking machine (capacity 200kg/h) has been developed under the technical guidance of PHT centre Hisar. Initial trials revealed that the pricking nails of lesser diameter are required instead of the existing size i.e. 3.40-3.50mm which causes excessive damage to raw petha pricking process. Hence, the diameter of nails was reduced to 2.25-2.30 mm (according the pricker available in market) through a locally available grinder. The performance of machine was evaluated by Aligarh centre and found satisfactory. Comparative study showed that the shelf life of petha developed in the laboratory was 60 days while that of market petha is 40 days.

Development and Popularization of Underutilized Jackfruit based Dairy Products (Bangalore centre)

Jackfruit pulp could be successfully incorporated for preparation of peda. The pulp was blended at 30 per cent based on the quantity of khoa along with 20 per cent sugar. The resultant product was found highly acceptable. Preparation of jack based kulfi as per the PFA standards is in progress.

Minimal Processing of Jack fruit bulb, seed and rind (Bangalore centre)

Confirmatory trials on vacuum packaging of minimally processed jackfruit bulbs treated with and without citric acid were taken up. A reference strain of lactic acid bacteria (MTCC 6061) was procured

from Microbial Type Collection Centre, Chandigarh for use in microbial fermentation of fruit and vegetable juices. The microbiological and biochemical analysis of the vaccum packaged, minimally processed Jackfruit bulbs stored under refrigerated and deep freezing temperature at weekly intervals were undertaken.

Briquetting of mango stone husk (Coimbatore centre)

Quality characteristics of mango stone shell briquettes for its density, durability and shatter indices has been determined and the values varied from 1032.49 - 1281 kg/m^3, 85.93-94.31% and 81.54-95.21%, respectively, depending on the method used and treatment combinations. The calorific value of mango stone shell was found to be 4468.67 kcal/kg. Minimum calorific value of 3546.23 kcal/kg was noticed when briquettes are made with 20 % binder level.

Development of cocoa pod breaker (Coimbatore centre)

A table model prototype of the cocoa pod breaker has been developed. The mechanism was tested for its functionality at laboratory level and found

Cocoa Pod Breaker Split Halves of Cocoa Pod

satisfactory. As per preliminary evaluation the capacity of 75-100 no. of pods per hour, in comparison to 25 pods by a labourer per hour in the traditional method. The unit has been placed at a cocoa plantation for evaluation and further improvement based on the field evaluation and feedback from the user.

Development of farm level fruits ripening chamber (Coimbatore centre)

Preliminary studies were taken up on the production of ethylene gas at laboratory level. A ripening chamber (500 L capacity) made up of polyethylene sheet has been developed for conducting the ripening studies at laboratory level.

Development, Evaluation and Modification of Processing Gadgets/ Equipments for Coconut (Kasargod centre)

Manual coconut slicing machine (modified) with a capacity of 20 coconuts/h was developed. The saving in time over manual slicing was found as 31.6% and the slicing efficiency was 85.7% whereas it was 86% in manual slicing. Coconut milk expeller consists of Teflon coated Stainless Steel Screw and Compact reduction gear (Bonfiglioli) which can be operated with 1.5 HP motor was developed. The capacity of the expeller is 50 coconuts per h for three extractions. Multi user coconut grating machine made up of stainless steel, consists of 4 grating heads and common collecting tray and operated with 1hp induction motor was developed. The capacity of the machine is 220nuts/h.

Development of technology for enhancing shelf life of onion in hot and humid region of West Bengal (Kharagpur centre)

To enhance the shelf life of onion, ethanol vapor was used as a pre-storage treatment on onion bulbs. About 3 kg of onions per replication, (*Nasik* cv., size 45-65 mm diameter) were placed in a closed airtight container with ethanol @ 5, 10 and 15 ml per kg of onion applied on filter paper for 24 h at 20 °C, while the control was left untreated. The entire experiment was conducted under ambient temperature of 30-35 ^{0}C. after 60 days of storage period the PLW (%) and total soluble solids increased with the advancement of storage period. The onion bulbs were then placed in a carton and stored at ambient temperature in the dark for 3 months. Relative humidity in the storage room was not controlled. Physiological loss in weight (PLW), rotting and sprouting percentage, and estimation of sugar content (reducing sugar, non-reducing sugar, and total sugar percentage) of stored onion bulbs were determined. The storage of treated

onion bulbs has not showed any loss due to rot, but untreated bulbs were affected by bulb neck rot disease (possibly *Botrytis spp.* is the causal agent).

Sprouting percentage was significantly low in onion bulbs treated with absolute ethanol concentration of 10 ml per kg of onion at 90 DAS compared to other treatments. At this concentration the loss in weight and also rotting % of onion bulbs was minimum while the percent total sugar was second only to treatment with 15 ml per kg ethanol concentration. Total sugar content was found minimum in the control.

Development of an integrated system for processing of cashew nut (Kharagpur centre)

To facilitate easy removal of the testa layer in cashewnut kernel, hot air drying at 70 °C for 6 h or more, followed by cooling and conditioning under normal room temperature is done as a pre-conditioning treatment before peeling. A mechanised cashew kernel peeler has been developed and optimisation of process parameters has been done. Based on the results, an upscaled model of peeler is being fabricated.

Standardization of method for pectin extraction and precipitation of pectin from apple pomance (Solan centre)

Apple pomace contained highest level of pectin followed by peel among different fruit parts. The pomace being a rich source of sugars, acid and minerals, also contained appreciable amount of pectin and fibre. Pectin in apple pomace from commercially processed apples (mixed cultivars) at HPMC Parwanoo was 2.33% as calcium pectate. The method for extraction and precipitation of pectin from pomace extract was standardized. Pectin extraction with 'Acid Extraction Method' followed by 'Alcoholic Preciptation' was optimized for commercial adoption from apple pomace. Acid extraction in sulphuric acid followed by precipitation in 95% ethanol in 1:2 proportion (extract: ethanol) resulted in significantly higher pectin yield (8.79% dwb) as compared to aluminium chloride precipitation (4.81%).

Development of jet washing system for cassava starch (Trivandrum centre)

A high pressure (50 kg/cm^2) low volume (25 lpm) starch washing system was developed for crushed cassava tubers. Whiteness index of starch improved from 85.80 for conventional process to 89.64 for starch washed with the system developed. Viscsoity of the starch washed with machine was 319-558 cP whereas for the traditionally washed raw starch it was 210-310 cP.

Production of organic jaggery from planting to processing (Anakapalle centre)

Experiments were carried-out at RARS, Anakapalle under both irrigated and rainfed conditions to study the effect of organic farming practices, from planting to processing, on yield and quality of jaggery in relation to those affected by inorganic farming practices in sugarcane. Normally lower cane yield as well as jaggery yields were obtained in organic plots compared to those obtained in inorganic plots. However, application of FYM @25t/ha (in two splits) + liquid manuring of *Jeevamruth* thrice during the crop growth improved cane yields considerably, e.g. 61.8 t/ha and 49.9 t /ha under irrigated and rainfed conditions respectively.

Quality characterization of jaggery agglomerates (>3.0mm size) obtained during granular jaggery making (Anakapalle)

The agglomerates kept for storage showed changes in their biochemical constituents, especially sucrose, reducing sugars and total nonsugars during March, 2011 when compared to May, 2010 depending on the imposition of treatments viz., heated and ground and simply ground. Sucrose content reduced from 4.1-4.8% in control, 4.0-4.9% in heated and ground and 4.3-4.9% in only ground in all sizes of agglomerates. Reducing sugars increased from 2.5-2.6% in control, 1.2-2.1% in heated and ground and 1.4-2.1% in only ground in the agglomerates. Similarly, the total nonsugars increased from 1.6-2.3 in control, 1.9-2.8% in heated and ground and 2.4-3.3% in only ground agglomerates of <3.0mm+>3.0mm and all other

sizes when compared to standard granular size of < 3.0 mm which recorded 1.1,1.6 &1.4 percent respectively for control, heated and ground, and only ground.

Design and development of batch type mechanical tray dryer and solar dryer (Anakapalle)

In ploy house solar dryer, the process of drying of granular jaggery was faster. It took 11 h to reduce moisture content from 9.8-1.6% db whereas the open yard drying took about 17 hours to reduce the moisture content from 9.8-1.8% db. Temperature was found to be higher in poly house (51°C with 59% RH) compared to open yard (32°C with 77% RH). No significant reduction of time was observed for drying of granular jaggery in bagasse-fired mechanical tray dryer compared with open yard. About 220 kg of fuel (baggasse and cane trash) was utilized for this drying process. Quality analysis was done for granular jaggery before and after drying. It was observed that there was reduction in sucrose and reducing sugar content in open yard, polyhouse and mechanical drying with increase in total nonsugar in that order.

Development slaughterhouse waste incorporated high protein pet food (Aligarh centre)

Freshly slaughtered by-products namely liver, kidney, stomach and trims meat of Indian *Murraha* buffalos of 5 years of age was collected for the development of dog kibble. The ingredients such as meat- Tripes, liver, beet root pomace, carrot pomace, oat flour, wheat flour, rice flour, salt, edible oil and preservative were used. Turmeric extract treatment was done at 1% level. The process includes grinding, mixing, moulding, baking (230°C for 10 min), cooling (natural cooling) and packing (combination film pouches). The samples of kibbles were kept at ambient temperature for 60 days. Various quality attributes like physico-chemical (pH, moisture content, fat content, protein content), microbiological (TBA number, total plate count and yeast and mold count Coliform, *Staphylococcus and Salmonella*.) and textural analysis of samples as a function of time were evaluated at 20 days intervals up to 60 days of storage period.

Development of pet food, pet treats and pet snacks from poultry and pork slaughter waste (Chennai centre)

Pet treats were processed from poultry head meal, feet meal, giblet meal, intestine meal, vegetable market waste and fruit market waste. Pet snacks were also processed from pig head meal, ear lobes, tongue, liver, spleen, heart, lungs, vegetable market waste and fruit market waste. The samples processed were subjected for proximate analysis and microbial analysis. Pet treats from chicken and pork slaughter waste powder, vegetables waste powder and fruits waste powder were bound with gruel to mould as bones. The processed products were subjected to proximate analysis. The samples were also subjected for pets acceptability studies.

Shelf-life enhancement of fish sausage in natural casing by using identified natural preservatives (Mangalore centre)

An attempt was made to extract and study the antioxidant properties of potato peelings to prevent or retard the oxidative deterioration of fats and oils in food processing.. The procurement of the peelings was made from Ace Foods Pvt. Ltd, Industrial area, Yeyyadi, Mangalore. The antioxidant extracts were prepared by washing drying the potato peel at 50 °C for 72 h followed by grinding to pass through 60 mesh screen, fat removal using petroleum ether, drying the residue, ethanolic extraction (90%) of dry residues, concentration of combined filtrates using rotavapor, freeze-drying of aqueous extracts at -60°C and storing the freeze-dried extracts in air-tight containers at 5°C until used for the analyses of antioxidant activity. Two methods (method of Abe et al, 1998 and Yen and Wu, 1999) were followed for assessing the scavenging ability of natural antioxidant extracts in comparison with synthetic antioxidant, butylated hydroxyl toluene (BHT). The evaluation of antioxidant activity of potato peel extracts (PPE) showed an excellent result (81.05%) at 350 mg/L which was comparable with BHT at a

legal limit of 200 mg/L. A case study was made on cellulose casings to study the quality and stability in comparison to synthetic casing (Krehlon / polyvinyldichloride) for fish sausages. The cost of cellulose casing was found to be 10 times cheaper than synthetic casing.

Ready-to-eat fish sausages in Cellulose casings

The process development of fish sausage in natural casing along with optimization of smoking treatment (time 2 h and temperature 70 °C) has been done in a pilot scale smoking kiln. The shelf life of the smoked sausage packed in polythene bags was observed to be around 30 days at refrigerated storage conditions.

Development of fish vending and display unit (Mangalore centre)

The fish vending and display unit was tested for its load carrying capacity, leaks, ease of working and insulation capacity of storage box. The storage box was filled with crushed ice to test the insulation capacity. The ice in storage box remained for 48 h with little melting. Two types of fish i.e. fatty fish (Indian Mackerel) and lean fish (Pink perch) were selected for the test and were arranged in ice in the ratio of 1:1 (fish: ice). Periodic sampling was done to check the freshness quality of both fishes using biochemical test such a peroxide value (PV), free fatty acid (FFA), trimethylamine nitrogen (TMA-N) and volatile base nitrogen (VBN) by Conway's micro diffusion technique followed by microbiological examination by total plate count (TPC) method.

Tests on freshness of fish stored in storage box of

Fish display unit

unit showed that the fish remained in good condition for 3-4 days. The storage section of the unit filled with ice showed a good insulation capacity in both indoor and outdoor conditions. Further modifications in the design are underway to reduce the cost of the unit.

Development of Fish Ham and Patty and its storage stability with natural antioxidant extracts (Mangalore centre)

The fibrous casings were procured from Vee-Tech International Pvt. Ltd., New Delhi, for studying its suitability for preparation of fish ham and shelf life evaluation. They were dipped in clean water at room temperature for 20-30 minutes to obtain good rigidity before used for the preparation of fish ham. Threadfin breams (*Nemipterus japonicus*) were procured from the commercial fish-landing centre, Mangalore, India. The fishes were thoroughly washed to remove blood, slime and dirt, and washed with chilled potable water (0-2 °C) containing 2 ppm chlorine. Then the fish meat was separated from bone and skin using meat separating machine and mixed with sheep or goat or pork meat to prepare high quality products with increased nutritive value. The color of the meat (myoglobin and hemoglobin) is fixed by the addition of sodium or potassium nitrate and/or nitrite (0.01 to 0.02 %). The other curing agents used are salt (2-2.5%), sugar (2-3%), phosphate (0.2-0.3%) and spices (0.4-0.6%). The cubes of tuna are mixed with the curing mixture in a mixer and stored at 0-4 °C for 2-3 days for color fixation. Phosphate is added to adjust the pH of the

meat and to get the meat fibers or protein well hydrated. Spices and preservatives are incorporated to get acceptable characteristic flavor, control of bacterial growth in the product and to avoid deterioration during storage.

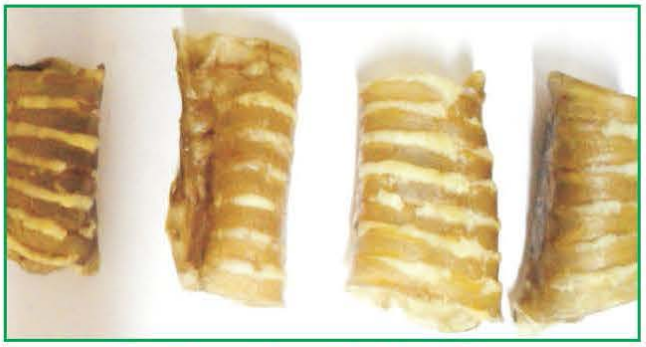
Fish Ham prepared in Synthetic, Fibrous and Cellulose Casings

The fish hams prepared with different casings were intact without any damage or rupture giving very good shape to products. It was revealed from the sensory evaluation that the fish ham prepared in fibrous casings showed a good overall acceptability.

Utilization of buffalo slaughter house by-products for manufacturing of pet treats (Mumbai centre)

Trachea samples were collected from freshly slaughtered buffalo at Deonar abattoir for preparation of tracheal rings (pet treats). An average of 500-700 g of trachea from each animal was collected in clean, dry plastic bags just after the slaughter of buffalo at Deonar abattoir. The tracheal samples were washed with disinfectant and then rinsed with clean potable water and stored at -18°C until further use.

The tracheal rings were blanched using hot water for the removal of remnants of fat and fascia; and was soaked in 5% SO_2 for 30 min, rinsed with potable water and dried thereafter. the tracheal rings were kept for drying using both sun drying and hot air oven drying methods. Sun drying required 36 h whereas hot air oven drying (60±2 °C) required 7-8 h for complete drying of the trachea. On an average 150-200 g of fine tracheal rings were obtained from each buffalo trachea (Figure 1). All the products after preparation were packed in a polyethylene bags and sealed and exposed to UV light for a period of 15 minutes.



Pet Treats from Tracheal Rings

Development of Process Technology for Micro-encapsulation of Fish oil (Raichur centre)

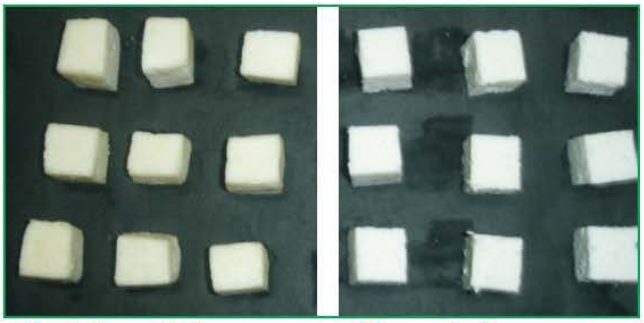
The peroxide values of microencapsulated fish oil powder samples stored under vacuum and in previous to air condition, both at 5±0.5 °C and ambient temperature were analyzed statistically in order to obtain lowest possible peroxide value and acid value.

Fish oil powder using skim milk powder | **Fish oil powder using Gum arabic**

Fish oil powder using Methyl cellulose | **Fish oil powder using Chitosan**

Development of Process for low-calorie high-fiber milk paneer (Pantnagar centre)

Process protocol for low carorie but high fiber paneer was developed by Pantnagar centre. Paneer incorporated with combination of dietary fibers (fiber-mix) has been found more acceptable by the sensory panel. The shelf life of paneer is found considerably increased by about 3-4 times (1-4 days at 30 °C and 7-15 days at 5°C) by applying protein-based edible coating.



Protein coated paneer **Uncoated paneer (control)**

Central Sector Scheme

Demonstration of Post Harvest Equipments (COMPONENT- 3) and Training of Farmers, Entrepreneurs and Scientists (COMPONENT-4) of Central Sector Scheme were implemented by different centres of AICRP on Post Harvest Technology with the view to promote Post Harvest Technology in production catchments so as to improvise the lower end of the spectrum of post harvest management since 2008-09 and also continued during 2011-12.

Agro Processing Centres (APC)

More than 80 Agro Processing Centres established in production catchments under AICRP on PHT were effectively monitored by respective cooperating centres. Most of the APCs are on sound financial position with conspicuous impact on social and economic fronts.

Assessment of Post Harvest Losses

Conducting a second *Assessment of Quantitative Harvest and Post Harvest Losses of Major Crops/Commodities in India* (2012-15) has been undertaken by AICRP on PHT. The study is being sponsored by the Ministry of Food Processing Industries with an approved budget outlay of Rs 539.29 lakhs.

AICRP on Application of Plastic in Agriculture

The AICRP on Application of Plastics in Agriculture is operative at eleven centres including two new centres started in XI plan period i.e. in April 2009. The project has contributed in development or modification of technologies related to plasticulture in horticulture, irrigation, intensive fish culture and animal housing as per the need of the mandated area of the centres. Following are the achievements made by co-operating centers in bullet form.

- A modified naturally ventilated polyhouse has been designed and fabricated by PAU, Ludhiana centre having 24 x 8 m^2 with top ventilation of 1 x 1 m^2 windows spaced at 3 m on the top ridge line. This modified design was found to have better climatic conditions as compared to other naturally ventilated polyhouses.

Modified naturally ventilated polyhouse

- A low cost detachable roof greenhouse (12 x 4.5 x 2 m high at side and 3 m in centre with double door entry chamber of 2 x 2 x 2.2 m size) was developed at **BAU, Ranchi centre** with profile and gripper system in such a way that cladding material can be replaced easily. It is suitable for round the year cultivation, as during summer the roof polythene can be replaced by shadenet so that temperature and light intensidty can be controlled conveniently.
- **SKUAST-K, Srinagar centre** has worked on determining shading and ventilation requirement in naturally ventilated Gothic shape poly house (20 x 8 m) in temperate conditions. The 36% ventilation opening of the total area of the polyhouse with two side ridge ventilation opening was required in order to achieve the temperature below 35°C in the favourable for the crop growth. "Green + Black colour shade net" covered top roof reduce was found beneficial to save the plants from extreme harsh sunlight radiation and temperature reduction.

Walnut propagation in polyhouse

- Grafted Walnut plant development was found better in walk-in-tunnel (17.5 m x 3.5 m x 2.2 m) polyhouse at **SKUAST-K, Srinagar centre**. Grafting success (68%) was better than open field conditions (32%). The benefit cost ratio of **2.54** with such intervention was found economically viable.
- A plant spacing of 45 x 45 cm^2 was found optimum for tomato and capsicum cultivation in polyhouse at **CSKHPKV, Palampur centre.**

- **CSKHPKV, Palampur** center found application of vermicompost at 10 t/ha significantly increased fruit yield of capsicum (24.57% over control yield of 5.69 kg/m^2), pod yield of French bean (20.78% over control of 5.42 kg/m^2) in capsicum-fresh bean sequence.
- The economic analysis of low cost bamboo frame polyhouse cultivation of brinjal – broccoli indicated that a net return was R 244 per m^2 per year at CAEPHT, **Gangtok centre**. A major percentage (85%) of the cost of construction of the poly house (Rs 287 per m^2) can be recovered within one year.

Brinjal cultivation in bamboo frame polyhouse in Sikkim

- **CAEPHT, Gangtok center** study round the year cultivation of flowers. Gerbera flowers after two months of transplanting gave average number of flowers per plant as 11.1 that come to 78 per m^2. A net profit of Rs 191 per square meter in one season with additional income of Rs 10 per m^2 was also made by planting bulbs of gladiolus along the borders of the gerbera plot.
- In a field experiment, the low tunnel 0.75 cm high was found optimum for capsicum cultivation during winters by **PAU, Ludhiana centre**. It produced highest with drip irrigation scheduled at IW/CPE of 0.75 (296.41 q/ha).
- **CIPHET, Abohar center** found 35% shadenet beneficial to tomato (116.3 t/ha), and capsicum of 310 g/plant (6.20 t/ha). Maximum yield of marigold flowers was found 517.8 g/plant in 35 % shading net with 3.5 m height and minimum was 76.6 g/plant in 50 % shading in same height 3.5 m respectively. A 28 nos. aphid/plant was found in 35% shade net houses whereas no aphis in 50 and 75%.

Shadenet houses constructed for climate evaluation

- In the study on insect dynamics and microclimate inside nethouse by **CIPHET, Abohar center,** it was found the 5-8 aphids in 25 mesh net house and as compared to outsides 450-600 aphid counts on yellow sticky band. No infestation of aphid and whitefly has been found in 50 and 60 mesh, whereas, infestation of whitefly i.e. leaf curling was recorded in capsicum under 25 and 40 mesh size net-houses.
- The shade net based farm storage structure indicated increase in shelf life of tomato up to 4 days and 2 days for spinach in the net house (75%) with less weight loss and decay at **JAU, Junagadh centre**.

Shadenet hosue constructed at JAU, Junagadh centre

- Salt & moisture distribution in the soil profile under drip irrigation with different saline water application treatments was worked out by **PAU, Ludhiana centre** to make strategies for use of poor quality water in south Punjab.
- Field experiment was conducted on the response of sugarcane (var CoJ 88) to drip fertigation under paired row trench planting method at **PAU, Ludhiana centre**. The best drip irrigation treatment (trench planting with IW/CPE 0.80 and 75% recommended dose of fertiliser) gave an increase of 24.9% of yield and 91.6% of WUE over conventional method (74.69 t/ha, 4.427 q/ha-cm).
- The impact analysis on FRP Carp Hatcheries technology was conducted by **CIFA, Bhubaneswar center** for 11 hatcheries, 17 seed producers, 20 fish producers and in 2 seed markets (in Naupada and Puri districts). The hatchery operation as well as seed production was found to be highly profitable enterprises, but its full utilisation is not being made due to several constraints.

Portable FRP Carp Hatchery Installation

- A preliminary fish seed transportation trial was conducted in PET transparent containers of capacity 6 litter having airtight PP lids by **CIFA, Bhubaneswar centre**. The fish fry mortality was recorded to be 6, 2.28 and 1%, in the containers stocked @ 100, 75 and 50 numbers, respectively. This was 30 and 6.24 % in the containers stocked @ 150 and 125 numbers, respectively.
- **MPUAT, Udaipur centre** conduced a trial to compare plastics (PC) roofed and cemented roofed cattle housing with calves. Resutls indicated better growth, comfort and pleasant environment to the animals under plastic roof during winters.
- A pedal operated winnower cum cleaner grader has been designed, developed and fabrication of various components was made using FRP sheets at **VPKAS, Almora centre**. Winnowing and cleaning cum grading fans fabricated using FRP have resulted into reduction not only in weight (0.6-1.0 q) but in mechanical vibrations as well in a comparison to fans of MS sheet of the same size and shape. The cleaning efficiency 94-97 % and winnowing efficiency 96-98 %.
- Iron handles of kutla, khurpi, hand fork, and sickle were coated with plastic grip at one point while handles of line maker, hand hoe and garden rake at two points at **VPKAS, Almora centre**. This intervention resulted into provision of better grip, maneuverability (iron handles become chilled in winters), better life and high capacity, which made them popular among hill farmers and adopted under various schemes operated by State Government of Uttarakhand.
- Develop methods of plastic packaging of whole/ sliced/processed fish after harvest along with its package of practices at **CIFA, Bhubaneswar centre**.
- **JAU, Junagadh center** has developed MAP packaging of sapota and mango fruits. The shelf life of sapota and mango was observed to be 49 and 42 days at 6°C and 10°C temperature in 25 µ LDPE bags for 5%O_2 +10% CO_2 and 6 % O_2 + 5 % CO_2 gas concentration with minimum changes in physical, biochemical and sensory parameters. Total cost of packaging of sapota

and mango per kg was estimated Rs. 4.25 and Rs. 5.03 respectively.

Modified Atmospheric Packaging of sapota & mango

- **JAU, Junagadh centre** assessed the transportation losses for sapota and tomato with seven types of containers/bags. Minimum damage and loss for both the fruits was observed in foldable plastic box with cells and maximum with gunny bag. Net saving per tonne was found to be ₹ 1461 and 1417, respectively for sapota and tomato by using foldable plastic box with cells as compared to gunny bag during transportation.
- **JAU, Junagadh center** developed polyhouse solar type dryer for marine fish drying in participatory mode. For salted Croaker, average drying rate was found to be 1.55 g/h/100 g bone dry weight in solar drying as compared to 1.31 g/h/100 g bone dry weight in sun drying. Similarly, for salted Golden Anchovy fish the corresponding figures were found to be 0.56 and 0.41.

Polyhouse type Tunnel Dryer for fish drying

- The low cost plastic ripening chamber was designed and tested for ripening of mango by **BAU, Ranchi center**. The operating cost for ripening for mango is less than five paisa per kilogram.
- **MPUAT, Udaipur center** studied the transportation losses of custard apple and found that the fruits packed in plastics foam sheet have minimum mass loss (0.67%) and hardness loss (3.02 %) where in bubble plastic sheets 0.82 and 3.47% respectively.

Plastics mango ripening chamber

- Transparent mulch resulted in significantly taller plants, higher number of stems per plant, more number of tubers / plant, and significantly higher potato yield (429.3q/ha) followed by black mulch (390.3 q/ha) and significantly lowest (246.9 q/ha) in no mulch treatment at **CSKHKV, Palampur center**. Ridge planting had better growth and yield characters. Better nutrition in 125% RDF treatment.
- In a field experiment on effect plastics mulch on groundnut cultivation at JAU, Junagadh center, the pod yield was found highest (1731 kg/ha) for biodegradable plastic mulch film while highest moisture retention (14.52%) was recorded for wheat straw mulch.

LIST OF ON-GOING RESEARCH PROJECTS

INHOUSE & COLLAOBRATIVE PROJECTS

Sr. No.	Project Name	Name of Project Leader & Associates
1.	Production of potato flour and starch and its use for product diversification and value addition.	Dr. Sanjeev Kumar Tyagi (PI) Dr. Mridula Devi (Co-PI) Dr. Devinder Dhingra (Co-PI) Dr. Rajbir Singh (Co-PI)
2.	Packaging and allied applications for bioactive compounds, antioxidants and microbiological safety of fresh and fresh cut fruits and vegetables.	Dr. Manjunatha M (PI from August 2010) Dr. Deepak Raj Rai (PI upto August 2010 and Co-PI upto 31-03-2011) Dr. R.K. Anurag (Co-PI w.e.f. 01/04/2011) Dr. P. Jaiswal (Co-PI upto 31-03-2011)
3.	Shelf life extension of meat and meat products using natural extract and vacuum packaging as hurdles.	Dr. Suresh K. Devatkal (PI) Dr. K. Narsaiah (Co –PI upto 31-03-2011) Dr. D.R. Rai (Co-PI w.e.f. August 2010 to 31-03-2011)
4.	Development of microorganisms based ripening/anti-ripening agent for mango and banana.	Dr. P. Jaiswal (PI) Dr. S.N.Jha (Co-PI upto 31-3-2011)
5.	Development of process and technology for dry degerming of maize at small scale.	Dr. P.Barnwal (PI) Dr. D. M. Kadam (Co-PI)
6.	Development of dairy analogues from peanut kernal and utilization of deoiled cake for food purposes.	Dr. Deep Narayan Yadav (PI) Dr. S.N. Bhowmik (Co-PI)
7.	Development of Litchi peeler cum destoner	Dr. R.K. Vishwakarma (PI) in place of Dr. A.K. Thakur (PI) Dr. R.K. Gupta (Co-PI) Er. V. Eyarkai Nambi (Co-PI w.e.f. 01-04-2011)
8.	Impact assessment of entrepreneurship Development Programme (EDP) conducted by CIPHET	Dr. Sangeeta Chopra (PI upto 31-03-2011) Dr. Dilip Jain (PI w.e.f 01-04-2011 to August 2011) Dr. A K Dixit (Co-PI & PI from August 2011 in place of Dr. Dilip Jain.) Dr. Indu Karki (Co-PI w.e.f. 02/09/2010)
9.	Impact assessment of technologies developed under AICRP on PHT	Dr. S.K.Nanda (PI) Dr. Anil Kumar Dixit (Co-PI) Dr. S.K. Aleksha Kudos

Sr. No.	Project Name	Name of Project Leader & Associates
10.	Development of partial dewatering process for onion for value addition and safe storage.	Er. Manpreet Kaur Grewal (PI) Dr. S.N. Jha (Co-PI)
11.	Design construction and evaluation of bulk storage structure for food grains.	Dr. Devinder Dhingra (PI) Dr. D.R. Rai (Co-PI upto 31-03-2011) Dr. Manjunatha M. (Co-PI)
12.	Rapid identification and detection of microbes in poultry meat using IR spectroscopy and chemometrics.	Er. Manpreet Kaur Grewal (PI) Dr. Pranita Jaiswal (Co-PI)
13.	Development of novel value added meat products (pastries & spreads) with or without use of non meat ingredients.	Dr. Yogesh Kumar (PI) Dr. Tanbir Ahmad (Co-PI) Er. Manpreet Kaur Grewal (Co-PI)
14.	Development of nutritive functional flour & food products.	Dr. Mridula D. (PI) Dr. M.R. Manikantan (Co-PI) Ms. Monika Sharma (Co-PI) w.e.f. 27-11-2010)
15.	Characterization, fortification, cooking and quality evaluation of soft rice.	Dr. Mridula D. (PI) Ms. Deepika Goswami (Co-PI)
16.	Development of enzyme assisted technology for effective dehulling of pigeonpea via agriculturally important microorganisms.	Dr. S.N. Bhowmik (PI) Dr. M.R. Manikantan (Co-PI upto 31-03-2011) Ms. Deepika Goswami (Co-PI)
17.	Development of pilot level process and technology for the production of protein rich flour from deoiled sesame and sunflower seeds.	Dr. M.R. Manikantan (PI) Dr. D. N. Yadav (Co-PI) Dr. R.K. Gupta associated as Co-PI w.e.f. 14.03.2012
18.	High pressure processing of primary products of fruits for preservation and value addition.	Er. R.K. Vishwakarma (PI) Er. V. Eyarkai Nambi (Co-PI) Dr. R.K. Gupta (Co- PI upto31-03-2011)
19.	Outreach and Inhouse Studies on Power Factor Correction Systems for Agro Processing Equipments.	Dr. Sangeeta Chopra (PI) Dr. D. Dhingra (Co-PI)
20.	Refinement and evaluation of fish descaling machine and entrepreneurship development.	Dr. Gaikwad Nilesh Nivrutti (PI) Dr. Tanbir Ahmad (Co-PI)

Sr. No.	Project Name	Name of Project Leader & Associates
21.	Structured outreach training modules for rehabilitation of inmates of Central Jail, Ludhiana. Sub Project A: Activity for men jail: Agro-processing training activities for men jail inmates. Sub Project B: Activity for women jail: Development and execution of a woman specific post-harvest training module.	Dr. Gaikwad Nilesh Nivrutti (PI of Project A) Dr. Sangeeta Chopra (PI of Project B) Dr. A.K. Dixit (Co-PI) Dr. Deepak Raj Rai (Co-PI)
22.	Assessment of poultry, goat, sheep and fish processing and its refinement and upgradation through technological intervention.	Dr. Tanbir Ahmad (PI) Dr. Gaikwad Nilesh Nivrutti (Co-PI) Dr. Yogesh Kumar (Co-PI)
23.	Standardization of process parameter for the production of leafy vegetables powder.	Dr. S.K. Aleksha Kudos (PI) Dr. D.M. Kadam (Co-PI)
24.	Evaluation of Insect net for Insect dynamics and microclimate inside net house for vegetable production in semi-arid region.	Dr. Jitendra Singh (PI) Dr. Ramesh Kumar (Co-PI upto 31-03-2011) Er. D.D. Nangare (Co-PI) Sh. V.S. Meena (Co-PI w.e.f. 01-04-2011)
25.	Optimization of shade net house design to create suitable climate for cultivation of vegetables and cut flowers in semi arid region.	Dr. D.D. Nangare (PI) Dr. Jitendra Singh (Co-PI) Dr. R.K. Gupta (Co-PI upto 31-03-2011) Dr. Anil Kumar Dixit (Co-PI)
26.	Development and testing of Berseem –Chicory seed separator	Dr. V.K. Bhargav (Co-PI) upto Jan. 07, 2011 Dr. P. Barnwal Co-PI) w.e.f. Jan. 07, 2011
27.	Enhancement of shelf-life and microbial safety of meat and meat products applying high pressure, vacuum packaging and natural extract.	Dr. S.K. Devatkal (PI) Dr. P.S. Rao, Asstt. Prof., IIT, Kharagpur (Co-PI)
28.	Development of non-dairy based probiotics foods.	Dr. Sangita Bansal (PI) Dr. S.N. Bhowmik (Co-PI upto 19-10-2011) Dr. Satish Kumar Co-PI w.e.f. 22.02.2012
29.	Development of PCR based diagnostic process for the detection of potential aflatoxin producing molds during post harvest handling in rice.	Dr. Manisha Mangal (PI) Dr. Sangita Bansal (Co-PI) Dr. H.S. Oberoi (Co-PI)

Sr. No.	Project Name	Name of Project Leader & Associates
30.	Extraction of dietary fibres from byproducts of selected coarse cereals and pulses and development of functional foods.	Dr. Satish Kumar Sharma (PI) Dr. Sangita Bansal (Co-PI) Dr. Anil Dixit (Co-PI) Dr. P. Barnwal (Co-PI)
31.	Development of functional and convenience foods based on maize and sorghum.	Ms. Monika Sharma (PI) Dr. Mridula D. (Co-PI) Dr. Dilip Jain (Co-PI)
32.	Development of screw configuration for efficient oil recovery from dehulled mustard & sunflower.	Dr. Dilip Jain (PI)
33.	Process technology for shelf stable millet flour and gluten free baked products.	Ms. Deepika Goswami (PI) Dr. R. K. Gupta (Co-PI) Dr. S.N. Bhowmik
34.	Development of an ohmic-heating system for heating solid and liquid foods.	Dr. Devinder Dhingra (PI) upto October 04, 2011. Dr. Sangeeta Chopra (Co-PI) Dr. Manisha mangal (Co-PI w.e.f 22-2-2011)
35.	Shelf life enhancement of fresh-cut fruits using enzyme technology.	Dr. Sunil Kumar (PI) Er. V. Eyarkai Nambi (Co-PI) Dr. Ramesh Kumar (Co-PI)
36.	Assessment of occupational health hazards among workers in agro processing units.	Dr. Indu Karki (PI) Dr. Gaikwad Nilesh Nivrutti (Co-PI)

EXTERNALLY FUNDED PROJECTS

Sr. No.	Project Name	Name of Project Leader & Associates
1.	Optimization of parameters for utilization of paddy straw, Kinnow pulp and pea pods for production of cellulases, ethanol and feed supplements. (Externally funded project under AMAAS with NBAIM being co-ordinating centre)	Dr. H.S. Oberoi (PI) Dr. D.S. Uppal (Co-PI from 19-7-2006 to 31-3-2007) Dr. V.K. Bhargav (Co-PI) 10-3-2008 to 27-11-2010 Dr. Pranita Jaiswal (Co-PI) 04-4-2009 to 11-08-2010
2.	Design and Development of foam mat dryer for selected liquid foods.	Dr. D.M. Kadam (PI) Dr. Balasubramanian (Co-PI upto 31-03-2011) Dr. D.R. Rai (Co –PI) Dr. K. Narsaiah. (Co-PI upto 10-09-2010) Ms. Monika Sharma (Co-PI 10-09-2010)
3.	Development of nondestructive systems for evaluation of microbial and physiochemical quality parameters of mango.	Dr. S.N. Jha (CPI) Dr. K.Narsaiah (CCPI) Dr. Ramesh Kumar (CCPI) Dr. Pranita Jaiswal (CCPI)
4.	Value Chain on Potato and Potato Products	Dr. Sangeeta Chopra (CCPI) in place of Dr. D. Dhingra w.e.f. 20.10.2011
5.	Efficient expelling and extraction of oil from seeds and utilization of deoiled cake. (Development of Technology for oil expelling of dehulled flaxseed (linseed) kernel and utilization of de-oiled cake)	Dr. K.K.Singh, (PI) upto 18-02-2010 Dr. Mridula Devi (Co-PI) and PI from 25-03-2010 Dr. P. Barnwal (Co-PI)
6.	Sub project on Value chain on commercial exploitation of underutilized fruits of tribal zones of Rajasthan.	Dr. R.K.Gupta (CCPI upto 20-10-2011) Dr. Ramesh Kumar (CO-CPI) Er. R.K. Vishwakarma (CO-CPI) w.e.f. 19-01-2010 & CCPI w.e.f. 21-10-2011 Er. V. Eyarkai Nambi CO-CPI w.e.f. 03-08-2010
7.	Novel biotechnological process for production of high value products from rice straw & baggasse.	Dr.H.S. Oberoi (CPI) Dr. V.K.Bhargav (CO–CPI upto 27-11-2010) Dr. M. Manjunatha (Co-CPI w.e.f. 04-05-2011)
8.	Studies on cryogenic grinding for retention of flavour and medicinal Properties of some important Indian spices.	Dr. K.K.Singh, (CPI) upto 18-2-2010 Dr. S. Balasubramanian (CPI) in place of Dr. K.K. Singh upto 22-06-2011 Dr. D.M. Kadam (Co-CPI) upto 04-02-2011 Dr. P. Barnwal, (Co-CPI) w.e.f. 10-08-2011

Sr. No.	Project Name	Name of Project Leader & Associates
9.	Assessment of gender issues and identification and refinement of selected women specific technologies in horticultural crops. [Network Project of ICAR and Directorate of Research on Women in Agricultural, Bhubaneswar]	Dr. R.K. Gupta (CCPI upto 25.08.2011) Dr. R. K. Vishwakarma, Co-CPI upto 25-08-2011 and CCPI w.e.f 26-08-2011 Dr. V. S. Meena (Co-PI) w.e.f 17.10.2011. Dr. Ramesh Kumar (Co-PI upto 31-03-2011)
10.	A value chain on composite dairy foods with enhanced health attributes.	Dr. S. Balasubramanian (CCPI) upto 22-06-2011 Dr. D.N. Yadav (Co-PI) & CCPI in place of Dr. S. Balasubramanian
11.	Livelihood improvement and empowerment of rural poor through sustainable farming systems in North East India.	Dr. Devinder Dhingra (Consultant)
12.	Value chain on novelty pork products under organized pig farming system.	Dr. K. Narsaiah (CCPI) Dr. S.K. Devatkal (Co-CCPI)
13.	Mobilizing mass media support for sharing agro-information under the National Agricultural Innovation Project	Dr. D.R. Rai (CCPI) Dr.(Mrs.) Sangeeta Chopra (Co-CCPI) Dr. Jitendra Singh (Co-CCPI)
14.	Development of technologies for pelletization, delignification and saccharification of cellulosic biomass such as rice straw, cotton stalk, sweet sorhum, switchgrass, *Prosopis juliflora and Lantana camara.*	Dr. H.S. Oberoi (PI) Dr. V. K. Bhargav (Co-PI) upto 27-11-2010 Dr. R. T. Patil (Co-PI) upto 21-06-2011 Dr. K. Narsaiah (Co PI upto 31-3-2011) Dr. Rahul Kumar Co-PI w.e.f 01-04-2011
15.	Developing Commissioning, operating and managing and online examination System for NET/ARS-Prelims. Exam for ASRB, ICAR	Dr. R.T. Patil (CCPI) upto 21-06-2011 Dr. D. Dhingra (CCPI) upto 4-10-2011 Dr. R.K. Gupta (CCPI) w.e.f. 22-06-2011 Dr. U.S. Shivhare (CCPI), w.e.f. 23-3-2012 Dr. M.R. Manikantan (Co-PI), w.e.f. 5-10-2011
16.	Microencapsulation methods for bacteriocins for their controlled release	Dr. K. Narsaiah (PI) Dr. S.N. Jha (Co-PI) Dr. M.R. Manikantan (Co-PI)
17.	Improvement the microbial safety and nutritional quality of fresh meat using a low cost refrigerated cabinet for retail marketing of meat in street meat shops.	Dr. Suresh Devatkal (PI) Dr. Manjunatha M. (Co-PI)
18.	Centre of Excellence(CoE) National Lab. Facility for processing and value addition of small millets at CIPHET	Dr. M. R. Manikantan (PI) Dr. Indu Karki (Co-PI) Ms. Deepika Goswami (Co-PI)
19.	Up-gradation of Quality Control Food Testing Laboratory	Dr. S.N. Jha (PI) Dr. Suresh Kumar Devatkal (Co-PI) Dr. H.S. Oberoi (Co-PI) Dr. Rahul Kumar (Co-PI)

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INSTITUTE ACTIVITIES

Licensing and Commercialization of CIPHET Technologies in the year 2011-2012

During the year 2011-12, three patents have been granted. The year was marked by commercialization of 15 technologies and work on two consultancy projects resulting in revenue of Rs 342,000/-. Eight more technologies are ready for commercialization. The technologies commercialized and consultancies provided by the Institute during 2011-12 are listed as under:

S No.	Name of the technology	Contracting party	License fee	Date
1.	Custard Apple Pulper	Mr.Shivananad M. Shelge, M/s Nexgen Drying Systems, # C902 Sigma One building, Pune -411038	Rs.1,85,000	25-02-2012
2.	Autoclavable Microencapsulator	Mr. Parvinder Singh S/o Sh. Sudarshan Singh Scientific Glass Works, Rajguru Nagar Ludhiana.	Rs.50,000	25-02-2012
3.	Soymilk and Paneer	Sh. Amandeep Singh S/o Sh. Gurmail Singh, VPO: Kartarpur, PO: Lehal, Teh: Payal.	Rs. 11,000	04-10-2011
4.	Soymilk and Paneer	Sh. Paramdeep Singh S/o Sh. Gurcharan Singh, VPO: Talwandi Khurd, Teh: Jagraon Dist: Ludhiana.	Rs. 11,000	13-09-2011
5.	Soymilk and Paneer	Sh. Jasbir Saini S/o Sh. Ajaib Singh, Vill: Begowal, Teh: Malerkotla Dist: Ludhiana	Rs. 11,000	13-09-2011
6.	Ginger Processing	Mr. H. Zorempuia S/o Mr. Van Lalliana, A/97, Sihphir Vengthar, Aizawl, Mizoram -796036	Rs. 11,000	27-08-2011
7.	Breads and Biscuits from Black Rice	Mr. V. Gowthman, F-3 Sree Patham Apartments, 33/4, Sir C.V. Raman Road, Alwarpet, Chennai-600018, (Consultancy project)	Rs. 25,000	04-07-2011

S No.	Name of the technology	Contracting party	License fee	Date
8.	Ohmic heater for Rice bran Stabilization	Mr. V. Gowthman, Surya & Co., F-3 Sripatham apartments, 33/4, Sir C.V. Raman Road, Alwarpit, Chennai- 600018	Rs. 50,000	23-08-2010 to 02-07/2011
9.	Soymilk and Paneer	(Consultancy project) Mr. Sansari Lal S/o Sh. Telu Ram, Near Railway Station, Bhucho Mandi, Bhatinda (9463332580)	Rs. 11,000	30-06-2011
10.	Tomato Processing	Shaikh Ashfaque Ismail S/o Sh. Ismail J. Shaikh, At Post Vinchur,Taluka: Niphad , Dist Nashik, Maharashtra State Pin:422305	Rs. 11,000	23-05-2011
11.	Tomato Processing	Ushir Santosh Murlidhar S/o Sh. Ushir Murlidhar Kandogi, At Post Vinchur,Taluka: Niphad , Dist Nashik, Maharashtra State Pin:422305	Rs. 11,000	23-05-2011
12.	Tomato Processing	Jaiteshwan Singh S/o Sh. Satinderpal Singh 12 -A Raj Guru Nagar Ludhiana	Rs. 11,000	13-05-2011
13.	Soymilk, Paneer and Curd	S. Manmohan Singh S/o S. Darshan Singh, H.no:2674,St.No 1,New Janta Nagar Ludhiana	Rs. 11,000	10-05-2011
14.	Ground nut milk, curd and paneer	Mr. Sandeep Garg S/o Sh. Krishna Lal, 12A/82 Shiv Puri Dhuri Dist. Sangrur	Rs. 21,000	26-04-2011
15.	Ground nut milk, curd and paneer	Sh. Sh. Baldev Raj S/o Sh. Chander Lal, Gali Atama Singh Wali, Tarntaran	Rs. 21,000	26-04-2011
16.	Meat processing and value addition	Mr. Bhupinder Singh S/o Maninder Singh, Punjab Broilers, Ludhiana, #100, ESE Road Ludhiana.	Rs. 21,000	20-04-2011

S No.	Name of the technology	Contracting party	License fee	Date
17.	Green Chili Powder and Puree.	Mr. Rajesh Sharad Rao Misal, 128 - Sahkar Nagar Khanmla, Near Gajanan Maharaja Mandir Nagpur - 440023	Rs. 11,000	18-04-2011
18.	Green Chili Powder and Puree.	Meva Singh S/o Sukhram Singh, VPO Bahmanwala, The. Ratia, Dist. Fatehabad - 125051	Rs. 11,000	18-04-2011
19.	Package of six technologies 1) CIPHET Tomato grader – Machine design/drawing, 2) Porous Bricks-Process 3) Modified atmospheric packaging of different vegetables 4) Low cost technique for enhancing shelf life of tomato- technique, 5) Shrink wrap packaging of fruits and vegetables- Process and 6) Process of vermi drain - a liquid plant growth tonic	Sh. (Dr.) Jatinder Singh Dhaliwal, Project, Krishana Foods and Seed Processor, Plot no: 26, Industrial Area, Gurdaspur - 143521(Punjab)	Rs. 50,000	18-04-2011
20.	Soybean processing into milk & Tofu	Sh. Karamjeet Singh S/o Sh. Mewa Singh, Vill: Bhardala, Teh: Samrala, P.O - Manki, Distt:Ludhiana	Rs.11, 000	04-04-2011
21.	DPR on Turmeric Processing	Ms. Sukhwinder Singh Grewal,Vill. kotli, The. Payal Distt. Ludhiana	Rs.11, 000	29-03-2011

National Committee on Post Harvest Technology and Value Addition:

The first meeting of national committee was held on 10-11 June, 2011 in New Delhi to assess the present scenario of post harvest technology of important agricultural commodities and research infrastructural facilities of the ICAR institutes. The purpose of the meeting was to identify the researchable issues in post harvest processing and value addition and formulate the collaborative research projects among the ICAR institutes to address the identified post harvest problems. The meeting was chaired by Dr.M.M.Pandey, Deputy Director General (Engg.) and attended by Dr. K.K.Singh, ADG (PE), Dr.R.T.Patil, Director, CIPHET, Ludhiana. Directors of CIAE, IINRG,

CIRCOT, NIRJAFT, IIHR, IIVR, CISH, CPRI, CTCRI, CPCRI, DMAPR, CIFT, NRC on Meat and Head of the Divisions of CIPHET also attended the meeting. Dr. M.M.Pandey, DDG (Engg.) urged all the institutes to identify and consolidate their post harvest researchable issues and prioritize them for formulation of collaborative research proposals after assessing their strength in order to attain tangible results. The important issues which emerged during deliberations are as under:

- With respect to prioritization, identified problems in quantifiable terms need to be taken up.
- Simple technology for the silage making and feed processing is required.
- Up scaling and commercialization of developed technologies
- Acceptable climbing devices for coconut plantation need to be developed.
- Pilot plant facilities/Technology incubation centre at certain identified pockets need to be established.
- Every variety is to be tested for processing properties before releasing them.
- Efforts should be made for NABL accreditation of all institute laboratories.
- Technology for grain protection during rainy season is the need of the hour.
- As all 3600 slaughter houses are in bad shape, clean and hygiene meat production is very much needed.
- Difficulties and procedural wrangle in collaborative projects need to be addressed.

IRC Meeting 2011

The 20th Institute Research Council Meeting was held during August 05-06, 2011 at CIPHET Ludhiana. The completed, ongoing and new research project proposals were discussed. Dr. K.K. Singh, ADG (PE), ICAR, New Delhi and Dr. A.K. Singh, Professor, Department of Processing and Food Engineering, PAU, Ludhiana graced the occasion as Experts.

Dr. R.K. Gupta, Director (Acting) CIPHET stressed upon the need to adhere to the mandate of the division as well as institute in taking up the projects. He also emphasized the importance of post-harvest management, packaging and value-addition of food crops to increase the farmer's return. He said that appropriate machinery/ equipment hand tools are required for post harvest processing and value addition of food crops and scientists should work in that area. Dr. K.K. Singh hoped that there is a lot of potential in CIPHET for evolving need based post harvest interventions. He informed that PHT is getting more emphasis in ICAR and Planning commission. Mega projects on secondary agriculture and health foods are expected and hence more funds will be available in 12th plan for research in PHT sector. He also urged that minimization of post harvest losses, enhancement of processing and nutritional level of processed products should be given priority during formulation of research projects. He also listed other priorities such as extraction of high value ingredients, food quality & safety, agricultural structures & environmental control for animal comfort, high pressure processing, pulsed electric heating and ohmic heating.

During the IRC Meeting, 16 RPF-I, 6 RPF-III and 30 RPF-II were presented and discussed. New project proposals in the emerging area of high pressure processing, probiotics, functional foods,

extrusion processing, enzyme technology, ohmic heating were presented.

Brain storming meeting on Health Foods and Secondary Agriculture:

The Brain Storming meeting on Health Foods was held under the chairmanship of Dr. M.M. Pandey DDG (Engg), ICAR at IASRI, New Delhi on 17th November, 2011. Dr. R. P. Kachru, Ex ADG (PE) and Dr. Narpinder Singh, Professor and Dean, GNDU were invited as experts for this brainstorming meeting. Scientists from CIPHET, other ICAR institutes and SAU's participated in this meeting. Dr P. Chandra, Director CIAE, Bhopal highlighted some of naturally occurring health foods and also emphasized the need for characterization of raw material and then processing for converting them into health foods. The presentations of fourteen individual concept notes on health foods by participating scientists were also made.

The meeting on "Secondary Agriculture" was held under the chairmanship of Dr M.M. Pandey DDG (Engg), ICAR at IASRI, New Delhi on 18th November, 2011. Scientists from different ICAR institutes and SAUs participated in the meeting. During his opening remarks, Dr M. M. Pandey, DDG (Engg) emphasized on establishing the efficacy of the enterprise by indulging in secondary agriculture. Dr. R. P. Kachru, Ex. ADG (PE) and expert, said that secondary agriculture should be linked with primary agriculture and the impact of this project will be going to revolutionize the present agriculture system and for that he emphasized innovative and integrative approach.

QRT meeting of CIPHET and AICRP (PHT):

The QRT meeting of CIPHET and AICRP (PHT) was held at CIPHET, Ludhiana on 25th November, 2011. Dr. M. M. Pandey, DDG (Engg.), ICAR, Dr. N. C. Patel, VC, JAU, Junagarh & Chairman QRT, CIPHET; Dr. R. P Kachru, Ex-ADG (PE), ICAR & Chairman QRT, AICRP on PHT; Dr. K. K. Singh, ADG (PE), ICAR, Dr. G. S. Chauhan, Member QRT, CIPHET; Dr. N. J. Thakore, Member QRT, CIPHET; Dr. R. K. Jain, Member QRT, CIPHET; Dr. J. B. Prajapati, Member QRT, CIPHET; Dr. Narpinder Singh, Member QRT, AICRP on PHT; Dr. S. K. Roy, Member QRT, AICRP on PHT; Dr. J. Sahoo, Member QRT, AICRP on PHT; Dr. Rakesh Nigam, Member QRT, AICRP on PHT; Dr. B. Ranganna, Member QRT, AICRP on PHT; Dr. R. K. Gupta, Director, CIPHET; Dr. S. K. Nanda, PC (AICRP on PHT), CIPHET, Ludhiana; Dr. H. S. Oberoi, Secretary QRT, CIPHET; Dr. D. N. Yadav, Secretary QRT, AICRP on PHT were present during the meeting. Dr. M. M. Pandey emphasized that each Institute/ PC unit must concentrate on the thrust areas of the research. Dr. R. P. Kachru mentioned that the post harvest technology (PHT) is the key area of business today and would play a pivotal role in the country's economy in the years to come. Dr. K. K. Singh stressed on the need of region specific research and emphasized on the value chain concept. He also mentioned that CIPHET must concentrate on prototype development, which is a key thrust area for the Institute.

RESEARCH ADVISORY COMMITTEE

Research Advisory Committee of CIPHET for the period of three years w.e.f. 01.08.2011

Sr. No.	Name & Address of RAC Members	Designation	Contact/Fax No/Email
1.	**Dr. S.M. Ilyas** Project Director, Distance Education National Institute of Rural Development Rajendra Nagar, Hyderabad- 500 030, Andhra Pradesh.	Chairman	Ph.: 040-24008417 Fax : 040-24008585
2.	**Dr. D.C. Joshi** Dean, Faculty of Food Processing, Technology & Bio Energy, Anand Agriculture University, Anand - 388 110 Gujarat)	Member	Ph.: 02692-261302 (O) Mobile : 099980-09965
3.	**Dr. B. Ranganna** Professor Emeritus University of Agricultural Sciences J- Block, GKVK Campus Bangalore – 560065, Karnataka	Member	Ph: 080-23330353 (O) Extn : 346 Fax : 080-23336977
4.	**Dr. R.K. Pal** Acting Head Division of Post Harvest Technology, IARI, New Delhi.	Member	Phone: 011-25842155 Fax: 011-25842155
5.	**Dr. A.M. Paturkar** Professor & Head Department of Veterinary Public Health Bombay Veterinary Collage Parel, Mumbai- 400012. Maharashtra	Member	022-24131180 24137030 Extn : 137
6.	**Dr. T.K Srinivasa Gopal** Director Central Institute of Fisheries Technology Matsyapuri P.O., Cochin 682029, Kerala	Member	Phone: 0484-2666880, 2667727 Fax: 0484-2668212 Cell: 09446393249
7.	**Dr. (Mrs.) Maninder Arora** Head Department of Microbiology, College of Basic science, PAU, Ludhiana – 141004 (Punjab).	Member	098887-13419 (M)
8.	**Dr. U.S. Shivhare** Director Central Institute of Post-harvest Engineering and Technology, P.O. : PAU, Ludhiana 141 004 (Pb)	Member	0161-2308669 (O) 0161-2313102 (O) 0161-2308670 (Fax)
9.	**Dr. K.K Singh (Ex-Officio)** ADG (PE) ICAR, Krishi Anusandhan Bhawan - II, Pusa, New Delhi- 110012.	Member	Telefax Fax: 011-25846492 Mobile: 095825-62695 E-mail: kksingh@icar.org.in
10.	**Dr. Deepak Raj Rai** Head Division of Transfer of Technology Central Institute of Post Harvest Engineering & Technology PO: PAU Campus, Ludhiana - 141004 Punjab	Member Secretary	Ph : 0161-2313115 (O) 0161-2819934 (R) 94173-66034 (M) 94780-28524 (M) d_r_rai@yahoo.com

QUINQUENNIAL REVIEW TEAM (QRT)

List of Quinquennial Review Team (QRT) of CIPHET, Ludhiana, for the Period 01-04-2007 to 31-03-2012

Sr. No.	Name & Address of RAC Members	Designation	Contact/Fax No/Email
1.	**Dr. N.C. Patel** Vice Chancellor Junagadh Agriculture University Junagadh - 362 001, Gujarat	Chairman	Ph. : 0285-2671784 Fax: 0285-2672004 Email : vc@jau.in
2.	**Dr. G.S. Chauhan** (Former Director) NRC for Soybean, Village Raipur Ki Mandia, P.O. Raipur Jaspur Distt. - U.S Nagar, Uttarakhand	Member	Mobile : 09837393527 Email : gschauhan_46@yahoo.co.in
3.	**Dr. N.J. Thakur** Professor & Head Department of Agric. Process Engineering Dr. B.S. Konkan Krishi Vidyapeeth Dapoli - 415 712, Maharashtra	Member	Ph. : 02358-282721 Mobile : 09420906951 Email : nayan07@gmail.com, nayan07@rediffmail.com
4.	**Dr. J.B. Prajapati** Professor and Head Department of Dairy Microbiology, SMC College of Dairy Science Anand Agricultural University Anand - 388 110, Gujarat	Member	Ph. No. 02692- 264170, 226651 Mobile No. 09879105948 Email: prajapatijashbhai@yahoo.com
5.	**Dr. R.K. Jain** Principal, AD Patel Institute of Technology Post Box 52, Vitthal Udyog Nagar- 388 121, Gujarat.	Member	Ph. No. 02692- 233680 Mobile No. 09099063001 Email: rkj_123@sify.com, principal@adit.ac.in
6.	**Dr. Sandeep Kapur** Professor Department of Business Management Punjab Agricultural University Ludhiana- 141 004, Punjab	Member	Mobile No. 09814106170 Email: drsandeepkapur@gmail.com
7.	**Dr. H.S. Oberoi** Principal Scientist Central Institute of Post Harvest Engineering and Technology P.O. PAU, Ludhiana- 141 004 Punjab	Secretary	Mob. 09417426649 Email: hari_manu@yahoo.com

PERSONALIA

Dr. U.S. Shivhare joins as Director CIPHET

Dr. U.S. Shivhare has joined Central Institute of Post Harvest Engineering and Technology (CIPHET) Ludhiana on March 23, 2012 as Director CIPHET. He did his B.Tech. (Agric Engng) from JNKVV (Jabalpur); M.Tech. (Process & Food Engng) from GBPUA&T (Pantnagar); and, Ph.D & PDF (Food Engng) from McGill University (Canada). He has served as faculty member in GBPUA&T (Pantnagar); SLIET (Longowal); GNDU (Amritsar); Panjab University (Chandigarh); including short-term adhoc assignment at CIPHET. He has also been a visiting scientist to McGill University (Canada) in 2002 and 2007.

Dr. Shivhare has been actively involved in research on shelf-life, thermal processing, rheology, quality control, process- and product- development. Dr. Shivhare has supervised five Ph.D theses and 15 master's thesis in food processing. The results of these studies have been published (90) in reputed national/international journals and books (04). Two patents have been filed in India on development of a pre-treatment method and development of a dehuller for guar seeds. He is a recipient of NN Mohan Memorial Award (1999) by Food Processors Association (India) and received best research paper award on product development published in Journal of Food Science & Technology (2009). His contribution to original research has been reflected in the invitation from Food & Bioprocess Technology (FABT)- An International Journal (Springer, USA) to join as the member of the editorial board. At present, he is the Associate Editor to FABT. His research papers have been widely cited with 926 total citations (h-index=19; source: Google Scholar). In addition, Dr. Shivhare is the professional reviewer to several international journals, including J Food Engg (USA); J Food Sci (USA); Biosystems Engg (UK); LWT (UK); Intern J Food Properties (USA); Drying Technol (USA); J Agric & Food Chemistry (USA); J Textural Studies (USA); J Food Process Engg (USA); and, J Food Science & Technol (India).

Dr. R.T. Patil Completes Tenure as Director, CIPHET

Dr R.T Patil, relinquished the charge of Director, CIPHET on completion of his five year tenure on 21-6-2011. The institute observed substantive growth and made extensive linkages with different agencies during his tenure.

Dr. R.K Gupta worked as Director (Acting) CIPHET

Dr. R. K Gupta, Head, Horticultural Crops Processing Division, CIPHET, Abohar, worked as Acting Director, CIPHET Ludhiana during 22-6-2011 to 22-3-2012.

Awards/ Recognition

- Dr. S. N. Jha, Head AS & EC Division was elected fellow of National Academy of Agricultural Sciences (NAAS), India and also elected fellow of Institution of Engineers (India).
- Dr. K. Narsaiah received Distinguished Service Certificate award of ISAE for significant contributions in the field of Agricultural Engineering in 46th Annual Convention and International Symposium of Indian Society of Agricultural Engineers organized during February 27-29, 2012 at Pant Nagar.
- K Narsaiah, SN Jha, H.M Mandge, M R Manikantan and RA Wilson (2012) got best poster awardat ISAE international symposium on grain storage held at GBPUAT, Pant Nagar during 27-29 February, 2012. Development of droplet

generator for microencapsulation and emulsification of food ingredients.

- Dr. D. M. Kadam selected for BOYSCAST Fellow by DST for carrying out research at Iowa State University of Science and Technolgy (ISU), USA.
- Dr. Suresh K. Devatkal was awarded DBT-CREST Award for advanced research training in non-thermal processing.
- Dr. R.K. Gupta was awarded Hon. fellowship award by Hi-Tech Horticultural Society, SVPUA&T, Meerut.
- Dr. D.R. Rai was awarded best poster award for "Estimation of Controlled release of Trans ZE Hexanal under Varying Relative Humidity Conditions for Food Packaging Applications" at ICFOST, 2012 held at Pune, January 20-21, 2012.
- Dr. M.R. Manikantan, Sr. Scientist received Jwaharlal Nehru Award on 17th July, 2011 for outstanding doctoral thesis research in Agricultural and allied sciences, 2010 in Agricultural Engineering.

हर कदम, हर डगर
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