PRODUCE PROCESS PROSPER

भाकृ अनुप
ICAR

वार्षिक प्रतिवेदन

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केन्द्रीय कटाई-उपरांत अभियांत्रिकी एवं प्रौद्योगिकी संस्थान

CENTRAL INSTITUTE OF POST-HARVEST ENGINEERING & TECHNOLOGY

LUDHIANA

Website : www.ciphet.in

EXECUTIVE SUMMARY

CIPHET scaled new heights in terms of research and extension activities during the reported period 2012-13. Various in-house and externally funded project outputs along with dedicated technology transfer activities such as training programmes scripted this success story. The research projects covered the areas of development of machines for ber, litchi, maize, berseem-chicory, spices, fish, and poultry, value addition of food grains, oilseeds, spices, fruits, vegetables, packaging of fruits and vegetables, non destructive quality analysis of milk and fruit juices for adulterants, microencapsulation of bacteriocins, development of nano-functionalized packaging materials and production of high value products from crop residues and diversified value added products from meat, dissemination of technologies, publications, presentations and training of entrepreneurs and farmers.

Spectral library of pure adulterants (water, urea, detergent/shampoo, vegetable oil, sugar, lactose, soymilk) at different concentrations in water were created using UV, visual and IR spectroscopy in the wavelength range of 190-1100 nm. Milk adulterated with urea and detergent could be detected to perfection. The controlled release behaviour of pediocin loaded in delivery systems of different wall materials *viz.*, nanoliposomes (lecithin, phosphatidylcholine); capsules of alginate plus guar gum; hybrid capsules of alginate plus guar gum incorporated with nanoliposomes was studied. Encapsulated pediocin was found to be more effective in inhibiting bacterial growth than directly added pediocin. Hybrid capsules of alginate and guar gum incorporated with pediocin loaded nanoliposomes of phosphatidylcholine were found to be the best delivery system for controlled release of pediocin. To meet humane-animal treatment regulations, an electric stunner has been developed to stun the pig/sheep. Process for preparation of alcoholic beverage from Kinnow peels having ethanol content of 5-6% (v v) and characteristic flavor and aroma of wine and antioxidant potential has been standardized. Shelled green peas were stored under MAP in LDPE bags of 107 µm thickness, 6 perforations, in the temperature range of 4 to 10 °C and 90-94% RH to extend shelf-life up to 24 days. Mangoes (*var. Dashehari*) dipped in culture filtrate of *Pseudomonas* sp. (10^5cfu/ml for 2h), air dried, packaged in polypropylene film (38.4µm) with 2 perforations (0.3 mm dia.) and low density polypropylene (thickness 85 µm) with 1 perforation (0.3 mm dia.) had shelf life of 28 days at 13±2 °C. The effect of vacuum packaging (VP) and incorporation of pomegranate peel extract (PPE) in ground goat meat and cooked nuggets during refrigerated storage (4±1 °C) showed that VP and PPE had a synergistic antioxidant effect and VP extended the shelf life of goat meat and nuggets under refrigerated conditions. Partial dewatering process for onion for value addition and safe storage was developed.

An indigenous cryogenic spice grinding system was designed and developed with a capacity of 30 to 50 kg/h depending on type of spice. The grinding system consists of a self pressurized liquid nitrogen cylinder (185 L), cryo-precooler and a grinder (pin mill and hammer mill). The 100% barnyard millet based muffins with sensory acceptalibilty at par with maida based muffins and with higher iron and fiber content were successfully developed. Quick cooking wheat *dalia* was prepared using sprouted wheat with cooking time of 3.2 min. Non-dairy probiotic drink was developed utilizing sprouted wheat, barley, pearl millet and green gram separately with oat meal, stabilizer and sugar using *L. acidophilus*- NCDC14; with soymilk and distilled water as liquid portion. Diversified food uses of pearl millet were explored to improve the pearl millet food utilization. Process protocol for development of probiotic soy yoghurt containing *Streptococcus faecalis* T110 was standardized. Berseem-chicory seed separator (an aspirator cum grader; capacity: 50-60 kg/h), has been developed. The process and machine for dry degerming of maize at small scale was developed and tested. Deoiled sesame cake flour incorporated biscuits were developed with higher protein and fibre content. Instant corn based *kheer* mix and energy bar were successfully prepared.

Litchi peeler and destoner was developed with a capacity of 80-100 kg/h. It can be operated manually or with 1.0 hp electric motor. A novel fruit grader was

designed and developed for grading of cylindrical fruits like *ber*. The capacity of machine is 300 kg/h with grading efficiency of 90-92%. The optimized treatment of pectin methyl esterase enzyme and calcium chloride enhanced the shelf-life to 10 days in case of whole strawberry and 6 days in case fresh-cut strawberry when stored at low temperature (7±2 °C and 80±5% RH). Mint fortified *jamun* RTS beverage and squash were developed. The *aonla* fruit cultivar NA-7 was assessed for its shelf life under ambient condition.

A number of sponsored training programmes on post-harvest technology for rural catchments and tailor made training programmes on soybean processing, chilli processing and groundnut processing were conducted for farmers and entrepreneurs from across the country in collaboration with NABARD, state governments organizations and NGOs. Results suggested considering participant interest, educational background, present occupation, capacity to invest, skill and attitude towards developing business before conducting such training programme. The year witnessed production of two documentary films on successful technologies, more than 100 news-clippings in leading regional and national dailies and you tube channel has been started for wider dissemination of technologies. Five television programmes on CIPHET technologies and events were broadcasted on leading channels including Zee News, PTC News, and Fastway etc. The institute has started a You Tube channel under the name of **"ciphetmedia"** for dissemination of films and making them available throughout the world. Interface meeting on milk quality assurance and dairy based health foods was organized at CIPHET, Ludhiana in collaboration with NDRI, Karnal, and Punjab Halwai Association. Fish descaling machine was developed, which can remove the scales of an average 500 g Catla fish in 38 s with 99% efficiency. Low cost fish descaling hand tool was designed and developed, which can remove the scales of an average 500 g Catla fish in 75 s with 98% efficiency. Fish processing table and display cum storage unit was designed and developed. Impact assessment of entrepreneurship development programmes (EDPs) conducted by CIPHET was undertaken to examine the adoption of technology. To assess occupational health hazards among workers, agro processing units were surveyed. The studies revealed higher level of dust concentration and noise levels in agro processing units. Thousands of visitors came to this institute to get knowledge about the different machines, equipments and technologies developed for agro processing and value addition. CIPHET showcased its technologies in ten exhibitions and farmer fairs held throughout the country.

AICRP on PHT developed number of novel technologies. Phycocyanin was extracted from algae to replace synthetic colour in food industry using phosphate buffer, citrate buffer and hydrochloric acid at different concentrations. Small scale oil dewaxing /refining unit (capacity 30 kg/batch @ 8 h) has been developed for minimal refining of sunflower oil. Technology for production of probiotic and synbiotic juice from guava, kinnow and mango juice fortified with probiotic strains, *Lactobacillus acidophilus* and *Lactobacillus casei* individually and in combination was developed. The shelf life of juice was one month with stable and viable beneficial bacteria content in the recommended dose (10^6cfu/ml). Power operated jaggery moulding machine was developed. It has been provided with two vertical shafts for smooth vertical movement of the rotor pistons into the static moulding frame. Multiplex PCR technique for rapid detection of *Escherichia. coli* O 157 H:7, *Salmonella spp* and *Staphylococcus aureus* from meat and meat products has been developed and standardized.

AICRP on APA had successfully developed and tested the technologies at its different centres. Frames and structures were developed to hold the plastic film in the fish pond to enhance the growth of peri-phyton. Plastic mulching for summer groundnut (GG-6) cultivation showed reduction in weeding requirement by 15 to 18%, with increased pod yield by 15 to 20% as compared to bare soil. Insect net-houses of 50 and 60 mesh sizes were found suitable to prevent the entry of tiny insects such as whitefly, aphid and hopper etc. The effect of four colours of plastic mulch viz., black, transparent, white and yellow poly sheets on tomato crop were studied and the black mulch recorded significant increase in plant height, fruit weight per plant, average fruit weight and fruit yield per square meter.

RESEARCH ACHIEVEMENTS

AGRICULTURAL STRUCTURES AND ENVIRONMENT CONTROL DIVISION

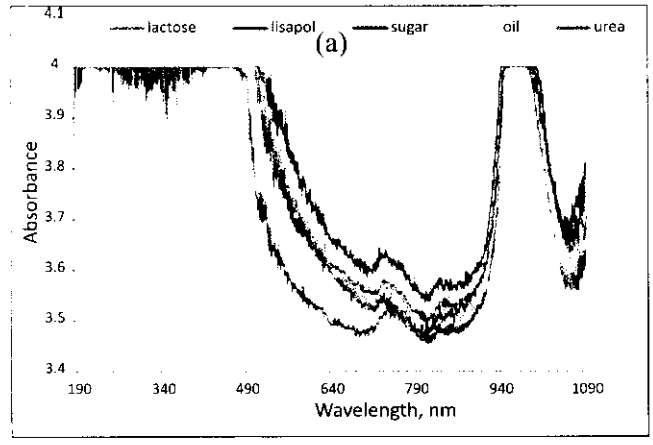
Development of spectroscopic methods for detection and quantification of adulterants and contaminants in fruit juices and milk

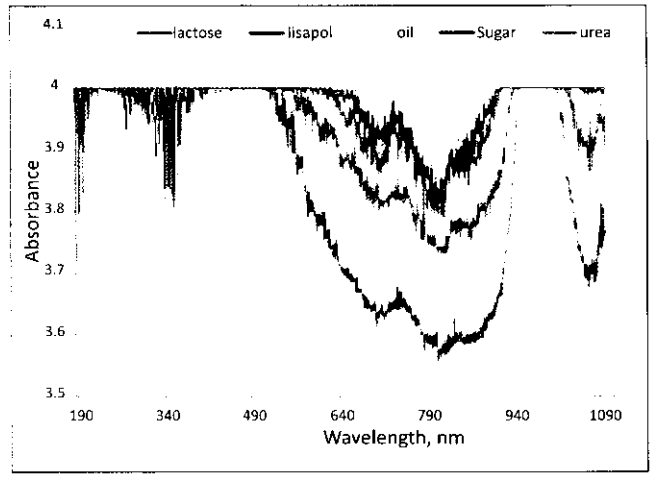
S.N. Jha, Pranita Jaiswal and Manpreet Kaur Grewal

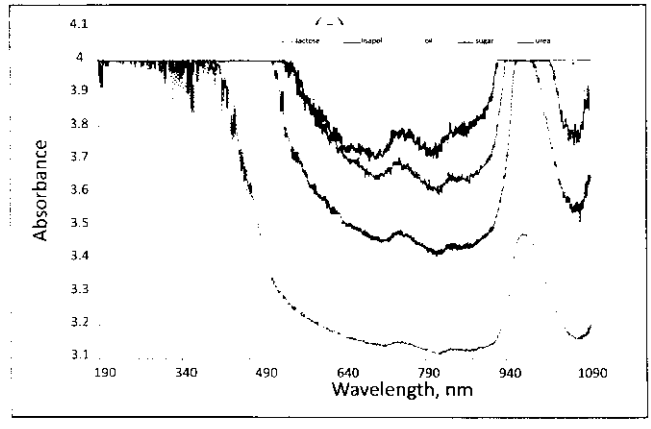
A sample holder for acquisition of spectra of liquid sample was designed and fabricated, followed by fixation/finalization of limits of different adulterants and contaminants in milk.

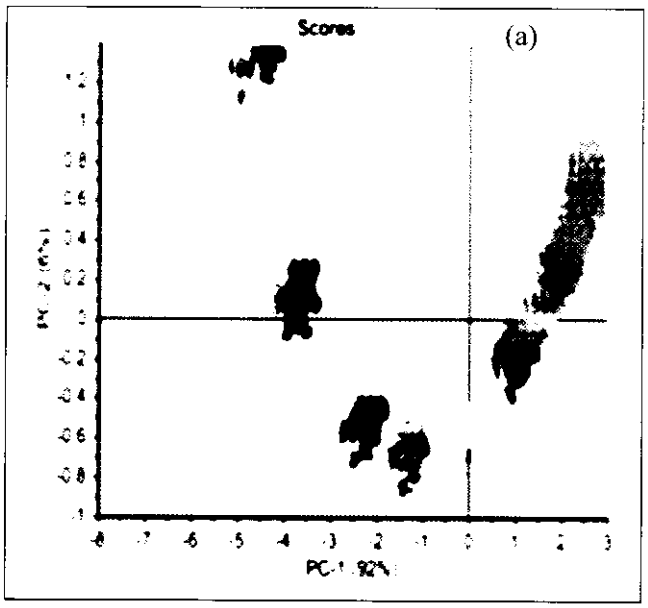
Spectral library of pure adulterants (water, urea, detergent/shampoo, vegetable oil, sugar, lactose, soymilk) at different concentrations in water were created using UV, visual and IR spectroscopy in the wavelength range of 190-1100nm. Cow, buffalo and mixed (cow and buffalo milk mixed in 1:1 ratio) milk collected from GADVASU, Ludhiana was homogenized at 25°C for 10 min. The time and temperature combination for sonication was initially optimized to obtain the clear distribution of fat globules and then the homogenized milk (cow, buffalo and mixed) was spiked with defined levels of adulterants. The spectra of homogenized milk with and without adulterants (lactose, sugar, oil, lisapol, urea) were acquired at different temperatures (15, 20, 25, 30°C) in the wavelength range of 190-1100 nm. The temperatures of samples were maintained by keeping them in cuvette and holding the cuvette in water bath for pre-specified time. The typical spectrums of adulterated milk are presented in Fig. 1.

Score plot following Principal Component Analysis (PCA) showed clear segregation of different concentration of urea in water in the wavelength range of 190-287nm (100– 2000 ppm). The variance explained by PC1 and PC2 was 92 and 6 % for 100-900 ppm urea (Fig. 2a) and 89 and 4 % for 1100-2000 ppm urea in water (Fig. 2b).









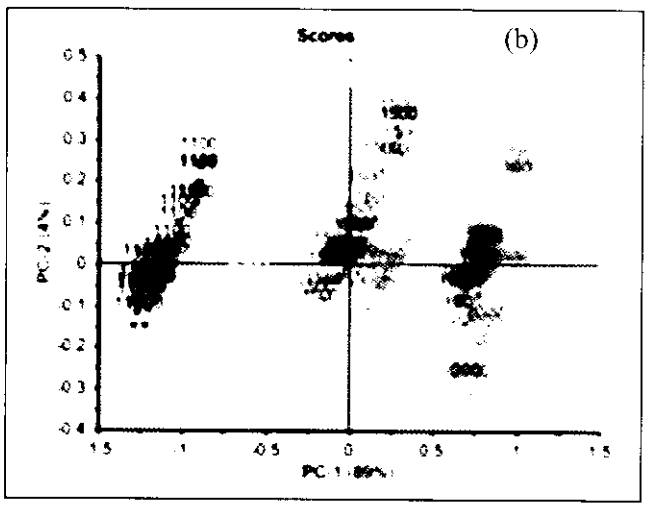


Fig. 2. Principal component scores plot of urea in water in wavelength range of 190-287nm for 100-900 ppm urea (a) and 1100-2000ppm urea (b) in water.

Different levels of urea in milk matrix could also be separated through score plots following PCA. The sum of variance explained by PC1 and PC2 was found to be 94% without any spectral transformations, indicating potential of spectroscopy in detection of urea in milk matrix (Fig. 3)

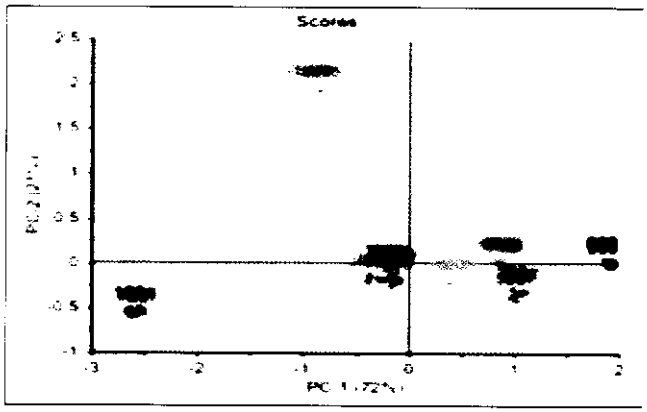


Fig.3. Principal component scores plot of urea in milk at 25°C in wavelength range of 190-1100nm showing grouping of samples according to concentration

Different levels of detergent, lactose and common sugar in water and milk matrix could also be separated through score plots following PCA. The sum of variance explained by PC1 and PC2 was found to be more than 94%.

Multivariate techniques namely Soft Independent Modelling of Class Analogy (SIMCA) classification was used to predict class memberships. Milk adulterated with urea, above permissible limit of 700 ppm could be detected 100 % correctly when sample temperature is 20 °C, while below this permissible limit only 75% samples could be correctly classified in the wavelength range of 566 – 1071 nm. Detection of detergent however was 100 % at 20 °C in the wavelength range of 190–1100 nm.

Micro-encapsulation methods for bacteriocins for their controlled release

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

Nanoliposomes and hybrid alginate nanoliposome delivery systems for slow release of pediocin

Pediocins are small anti-Listerial polypeptide bacteriocins. Direct addition of pediocin has been studied so far and is found to be effective only for a limited duration. The controlled release or slow

release is an efficient method to prolong the effectiveness of pediocin and other such antimicrobials. Encapsulation is one of the numerous strategies that can be employed for achieving controlled release. Diverse wall materials such as phospholipids, proteins and carbohydrate polymers and combinations of these are used to encapsulate active ingredients. One of the aims of this study was to evaluate the effect of process parameters *viz.* concentration of phospholipid (lecithin, phosphatidylcholine) at the rate of 0.1, 0.2, 0.3% (w/v), amplitude for sonication (40, 50, 60%) and sonication time (3, 5, 7 min) on size of nanoliposomes. There was an increase in liposome size with increase in concentration of phospholipids however there was decrease in size with increase in amplitude and duration of sonication. The main aim of the study was to compare the controlled release behaviour of pediocin loaded in delivery systems of different wall materials viz., nanoliposomes (lecithin, phosphatidylcholine); capsules of alginate and guar gum; hybrid capsules of alginate and guar gum incorporated with nanoliposomes.

When pediocin was added to the broth inoculated with *L. innocua* cells either free or encapsulated, there was two log reduction in growth as compared to control within first four hours of addition except phosphatidylcholine (PC) encapsulated pediocin where three log reduction was noticed. After 48 h, two log reduction with unencapsulated pediocin addition was observed. However, in case of pediocin encapsulated in lecithin and PC, there was a three log reduction. Among liposome encapsulated pediocin, lecithin encapsulated pediocin showed log reduction similar to that of unencapsulated pediocin till 24 h after which lecithin encapsulated pediocin inhibited growth by four log order as compared to three log reduction by unencapsulated pediocin. Pediocin encapsulated in PC liposomes have better log reduction than lecithin liposomes right from the beginning of the incubation period till 36 h after which log reduction trend was similar to that of lecithin liposome.

Release from alginate encapsulation: Alginate has been used for encapsulation of various antimicrobials. Inhibition by pediocin encapsulated in AG (alginate + guar gum) was of the same extent (2-4 log orders) as that of pediocin encapsulated in AL (alginate+lecithin) till eight hours of incubation (Fig. 4), after that log reduction was slightly better in case of AL. The slow release provided by AG or AL can be attributed to diffusional limitation to pediocin molecule due to tortuous path offered by AG matrix. In case of pediocin in APC, there was 3-5 log reduction as compared to control in growth of *L. innocua*. The hydrogel formed by the alginate guar gum cross linking have pores large enough for most of the proteins to escape and leaving only very high molecular weight enzymes and whole cells to be completely entrapped. Hybrid encapsulation of pediocin in PC liposome and then in alginate guar gum prevents leakage of pediocin from alginate guar gum matrix which gave a prolonged growth inhibition of *L. innocua*.

Encapsulated pediocin was found to be more effective in inhibiting bacterial growth than directly added pediocin. Hybrid capsules of alginate plus guar gum incorporated with pediocin loaded nanoliposomes of phosphatidylcholine were found to be the best delivery system for controlled release of pediocin.

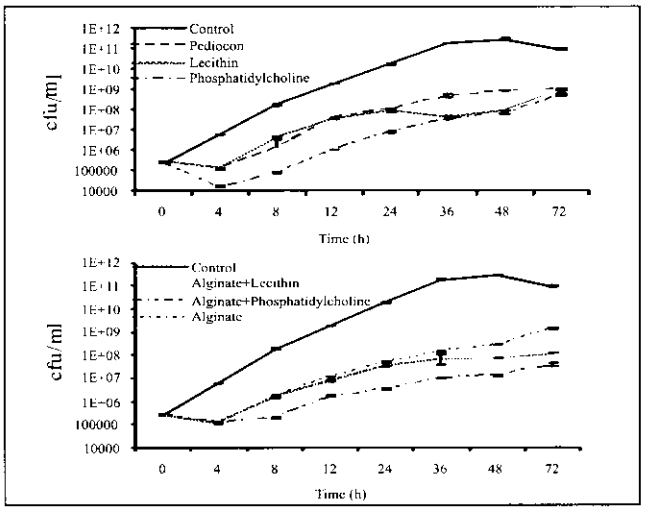


Fig. 4. Antibacterial activity of pediocin loaded in different delivery systems against *Listeria innocua*.

FOOD GRAINS AND OILSEEDS PROCESSING DIVISION

Development of nutritive functional flour and food products

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

Development of quick cooking wheat *dalia*

Quick cooking wheat *dalia* was prepared using sprouted wheat (cv. PBW550) to get the palatable quick cooking wheat *dalia*. Sprouting of wheat was carried out for 36 and 48 h, followed by drying to reduce the moisture content. Sprouted and dried wheat was then milled to get wheat grits i.e. *dalia*. Recovery of wheat *dalia* was 74.4 and 73.8%, respectively from wheat sprouted for 36 and 48 h as compared to 75.1% from unsprouted wheat ($p>0.05$). Sprouting and particle size affected the cooking quality of *dalia*. Cooking time of different *dalia* samples (3.2 to 7.38 min) was found reduced due to sprouting but sprouting did not affect the sensory characteristics. The mean overall sensory acceptability scores for *dalia* samples ranged from 7.69 to 7.98 with comparatively better acceptability for *dalia* prepared from 36 h sprouted wheat. Protein, fat, ash, crude fibre, calories, iron and calcium content in this *dalia* sample were 10.32%, 1.33%, 1.48%, 3.33%, 359 kcal, 1.18 and 44.67 mg/100g, respectively. Protein digestibility of *dalia* from sprouted wheat was better than unsprouted wheat. In view of good acceptability, lesser cooking and sprouting time, quick cooking wheat *dalia* may be prepared from 36 h sprouted wheat, which also stored well at room temperature for 3 months.

Development of non-dairy probiotic drink utilizing sprouted grains

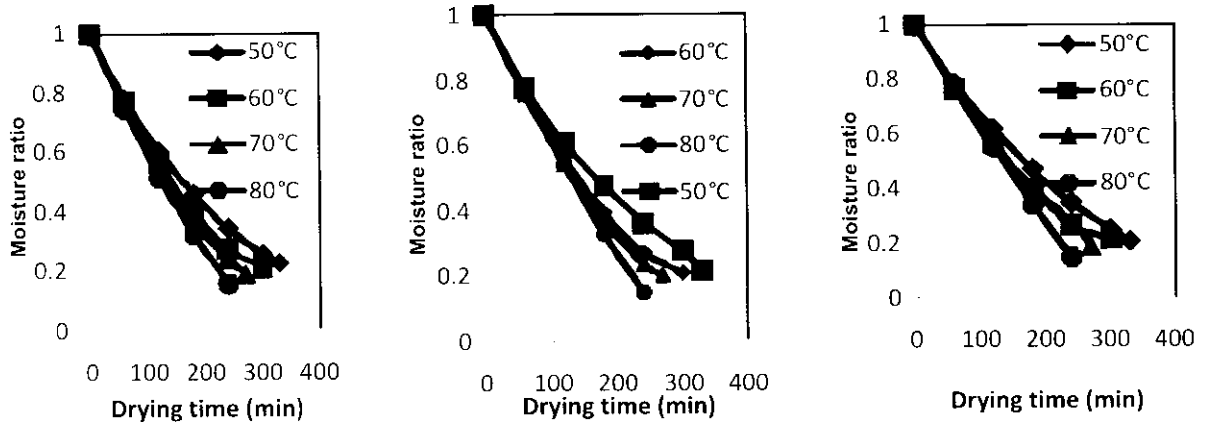
Four different non-dairy probiotic drinks (PD) were developed utilizing sprouted wheat, barley, pearl millet and green gram separately. Oat meal, stabilizer, sugar, *L. acidophilus*- NCDC14 (procured from NDRI, Karnal), soymilk and distilled water (liquid portion) were added in each treatment. Acidity and pH in different probiotic drink samples ranged from 0.45 to 1.02 % (in terms of lactic acid) and 4.11 to 4.49 with higher values for green gram based probiotic drink. Probiotic count ranged from 9.10 to 11.06, 10.36 to 11.17, 10.36 to 11.51 and 10.36 to 11.32 log cfu/ml in wheat, barley, pearl millet and green gram based probiotic drink samples, respectively, which increased with increasing level of these sprouted grain flours and soymilk. Sensory acceptability of all four probiotic drinks with soymilk increased up to 6 g each of wheat, barley and green gram, and 4 g pearl millet flour per 100 ml liquid portion. In view of sensory acceptability score more than seven and good probiotic count; wheat, barley and green gram at 6 g while pearl millet at 4 g level with 100 ml of liquid portion i.e. soymilk and distilled water, may be considered for development of non dairy probiotic drink. Total solids and *in vitro* protein digestibility in standardized wheat, barley, pearl millet and green gram based probiotic drink samples (Table 4) varied between 19.88 to 22.03% and 68.91 to 71.98%, respectively.

Mathematical modelling of drying kinetics of sprouted wheat

Drying kinetics of 24, 36 and 48 h sprouted wheat (cv. PBW550) in single layer in a tray dryer were studied at 50, 60, 70 and 80°C (Fig. 21). Drying of sprouted wheat occurred in falling rate period. In order to select a suitable drying curve, six thin layer drying models were fitted to the experimental moisture ratio data. The performance of these models were investigated by comparing five statistical parameters; the square of the coefficient of determination, standard error, reduced chi-square error, mean bias error and root mean square error. Among the mathematical models investigated, Wang and Singh model best described the drying behaviour of sprouted wheat with high correlation coefficient values for 60, 70 and 80 °C drying temperature whereas logarithmic model fitted for sprouted wheat at 50 °C. The effective moisture diffusivity of sprouted wheat increased as the drying air temperature increased. The moisture diffusivity in 24, 36 and 48 h sprouted wheat were found to

Nutrients	Wheat based PD*	Barley based PD*	Pearl millet based PD*	Green gram based PD*
Moisture, %	77.77	77.97	80.12	77.74
Total solids, %	22.23	22.03	19.88	22.26
Protein, %	2.51	2.42	2.21	2.72
Invitro Protein digestibility, %	71.14	70.54	71.98	68.91
Fat, %	0.38	0.30	0.46	0.25
Total minerals, %	0.37	0.33	0.39	0.48
Crude fibre, %	0.426	0.466	0.261	0.436
Carbohydrates, %	18.55	18.67	16.41	18.37
Calories, kcal/ 100ml	87.67	86.20	79.44	86.65
Iron, mg/ 100ml	1.80	1.70	1.40	1.60
Calcium, mg/ 100ml	47.1	38.9	38.6	36.5
Colour quality				
L value	65.39	58.82	66.13	63.85
a value	4.48	5.74	2.79	3.20
b value	21.77	20.34	19.14	22.82
h°	78.36	74.23	81.71	82.02
Chroma	22.22	21.13	19.35	23.05

*Standardized PD samples with soymilk



(a) 24 h (b) 36 h (c) 48 h

increase from 1.79 x 10^{-9} to 2.58 x 10^{-9} $m^2 s^{-1}$, 1.921x10 to 2.781x10^{-9} $m^2 s^{-1}$ and 1.858x10^{-9} to 2.561x10 $m^2 s^{-1}$ respectively, when the drying temperature increased from 50°C to 80°C. The relationship between the temperature and the effective moisture diffusivity was described adequately by means of Arrhenius-type equation. The activation energy for 24, 36 and 48 h sprouted wheat was found to be 11.357, 11.428 and 9.427 kJ g^{-1} mol^{-1}, respectively.

Characterization, fortification, cooking and quality evaluation of soft rice

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

Quality of soft rice genotypes for selected physico-chemical and nutritional parameters

Soft rice genotypes, received from Directorate of Rice Research, Hyderabad were studied for selected physical, biochemical parameters (Table 5a&b) and cooking characteristics at initial moisture content ranging from 8.7 to 10.2% (w.b.). Length, breadth and thickness of studied 28 soft rice genotypes were found in the range of 5.06 to 6.83 mm, 1.65 to 2.78 mm and 1.48 to 1.85 mm, respectively. Geometric mean diameter (GMD), surface area, sphericity and unit volume of *Vasumathi* were found to be minimum while *Lahi Chokua* genotype showed the maximum breadth, thickness, GMD, surface area and unit volume amongst the studied varieties. Thousand grain weight was found maximum in *Boga Chokua* and *Lahi Chokua* genotypes. Bulk density was found minimum in *Boga Chokua, Kagori Chokura* and *Vasumathi* genotypes of soft rice. Hardness force for studied soft rice genotypes ranged from 59.24 to 125.02 N with minimum hardness for *Hampori Chokua* and maximum for *Lahi Chokua* genotypes. The instrumental colour quality i.e. L, a and b values for whole milled soft rice genotypes ranged from 60.77 to 84.46, 0.92 to 6.19 and 7.23 to 13.10, respectively. The hue values were minimum (52.73) for *Kagori Chokura* and maximum (82.79) for *Chokura Bora* genotype. *Sungal Bora* genotype exhibited minimum peak and final viscosity i.e. 2500 cP and 1664.33 cP, respectively amongst the 28 genotypes, which were evaluated during the study. Amylose content in studied 28 genotypes of soft rice varied between 3.56 to 27.35% with minimum in *Sungal Bora, Ranga Bora* and *Chokura Bora*. Cooking time of different genotypes varied between 9.7 to 14.6 min with minimum for *Boka Chokua* and maximum for *Dadhora Bora*. *Sungal Bora* genotype of soft rice with minimum peak and final viscosity and lowest amylose content showed a possibility of utilization in making instant type of products.

Table 5a: Proximate composition of selected soft rice genotypes (received from DRR, Hyderabad)

S. No.	Soft rice genotypes	Moisture, %	Protein, %	Fat, %	Total minerals, %	Amylose, %
1	*Agnoni Bora*	9.55	8.31	0.69	0.44	5.67
2	*Boga Chokua*	10.17	7.61	0.59	0.68	16.26
3	*Bogali Bora*	9.35	7.56	0.50	0.42	5.12
4	*Boka Chokua*	9.12	8.28	0.71	0.56	12.03
5	*Bongari Bora*	8.94	8.44	0.76	0.66	27.07
6	*Bora-1*	9.00	8.55	1.05	0.75	10.80
7	*CH5*	9.33	8.35	0.88	0.59	11.85
8	*Chokura Bora*	9.48	8.18	1.07	0.46	3.69
9	*Dadhora Bora*	9.46	8.26	0.97	0.50	3.88
10	*Ham Chokua*	8.95	7.71	0.55	0.52	12.79
11	*Hampori Chokua*	9.19	8.36	0.89	0.58	13.83
12	*Haru Chokua*	9.31	8.22	1.03	0.65	14.38
13	*Kagori Chokura*	8.72	8.24	0.79	0.73	26.11
14	*Kasturi*	9.06	8.04	0.57	0.47	13.98
15	*Kalampaki Bora*	9.67	8.28	1.05	0.63	4.44
16	*Kola Boka Chokura*	9.45	8.51	0.66	0.65	12.19

from 30.57 to 16.91) while the loss in yellowness was very less in enzyme treated (decreased from 29.13 to 24.73) fruits maintained under low temperature. The firmness of the strawberry decreased with the advancement of storage period. The firmness of ambient storage reduced drastically and control samples were lost within one day of storage due to fungal attacks and tissue liquefication. The fruits treated with enzyme retained acceptable firmness by 2nd day of storage, athough tissue liquefication in these samples too made them unfit for consumption on 3rd day. Low temperature storage reduced this loss in fruit firmness. Fruit firmness of cold stored untreated (control) sample was found to be 0.872 N at 6th day, while the corresponding value for enzyme treated samples was 0.987 N and it reached at the stage of control sample on 10th day (0.881 N) of storage (Fig. 46). Thus, the enzyme assisted calcium chloride treatment was found to extend shelf-life by more than 4 days compared to control. Results were more or less same for fresh-cut strawberries.

Effect of storage on microbial spoilage of enzyme treated strawberry

No *Salmonella*, *Staphylococcus* and coliforms were present in fresh as well stored strawberry (whole as well as fresh-cut) samples during both storage conditions and period. Total plate count increased for control samples ($33x10^3$ cfu/g) while it was low for treated samples ($15x10^3$ cfu/g) on 2nd day of storage, under ambient conditions. Similarly, total plate count observed was less for treated strawberry ($11x10^3$ cfu/g) compared to control ($34x10^3$ cfu/g) under low temperature storage. In case of fresh-cut strawberries, total plate count increased for control samples ($53.33x10^3$ cfu/g) while it was low for treated samples ($27.33x10^3$ cfu/g) at 2nd day of storage, under ambient conditions. Similarly, less total plate count was observed for treated strawberry fresh-cuts ($16x10^3$ cfu/g) compared to control ($24x10^3$ cfu/g) under low temperature storage. This may be due to firmer cell wall and less spoilage because of treatment effect.

Changes in biochemical composition of enzymatic treated strawberry during storage

The total antioxidant capacity (TAC) is an indicator of the capacity of total antioxidants to counter oxidative stress mediated by biotic and abiotic factors. Overall TAC decreased during storage at both conditions of storage (Fig. 47). At ambient storage, the decrease in TAC was more for control samples (from initial value of 3578.82 to 2204.65 nmols of ascorbic acid equivalents per g) while the corresponding decrease for treated samples was found to be in the range of 3578.82 to 2565.41 nmols of ascorbic acid equivalents per g of fruit. At low temperature storage, the TAC protected the control samples up to 6th day, but the treated samples survived up to 10th day of storage though the respective decrease in TAC from initial value (3578.82 nmols of ascorbic acid equivalents per g) was 1297.42 and 1367.83 in control & treated samples, respectively (Fig. 47).

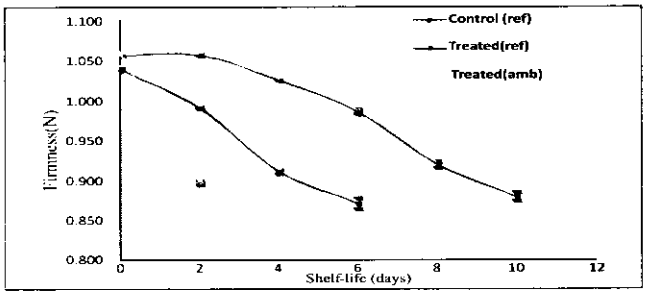


Fig. 46. Changes in fruit firmness of whole strawberry during storage under ambient (25 °C and 60% RH) and refrigerated (7 °C and 80% RH) conditions.

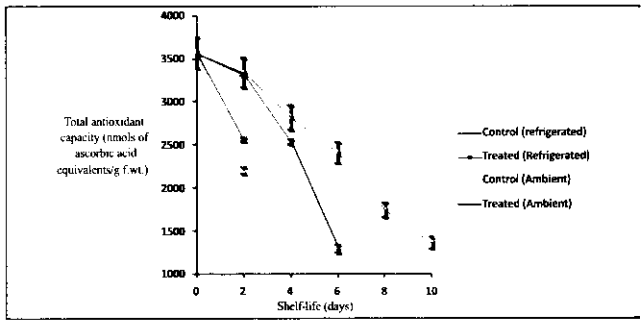


Fig. 47. Total antioxidant capacity of whole strawberry during storage under ambient (25 °C and 60% RH) and refrigerated (7 °C and 80% RH) condition

Ferric reducing antioxidant power (FRAP), an important part of TAC, however, showed a differential response during storage (Fig. 48). At low temperature storage, the TAC protected the control samples up to 4th day, but the treated samples survived up to 8th day of storage though the respective increase in TAC from initial value (3570.44 nmols of ascorbic acid equivalents per g samples) was 4183.95 in control and 4727.06 in treated samples (Fig. 49). Ferric reducing antioxidant power (FRAP) also corroborated with TAC pattern for strawberry fresh-cuts during storage (Fig. 50). The increase in TAC and FRAP may be attributed to increase in phenolic content due to wounding (probably some stress genes being activated to counter wound stress) and desiccation stress due to moisture loss.

The actvity of PPO increased continuously during storage at both conditions. The PPO activity increased from an initial value of 56.78 nmols of purpurogallin produced/min/g fruit to 216.28 in control fruits and 190.97 in treated fruits at ambient storage conditions. Whereas, the corresponding values for control and treatment were 252.43 and

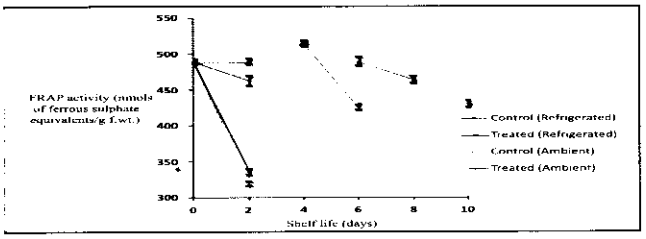


Fig. 48. Ferric reducing antioxidant power of whole strawberry during storage under ambient (25 °C and 60% RH) and refrigerated (7 °C and 80% RH) condition

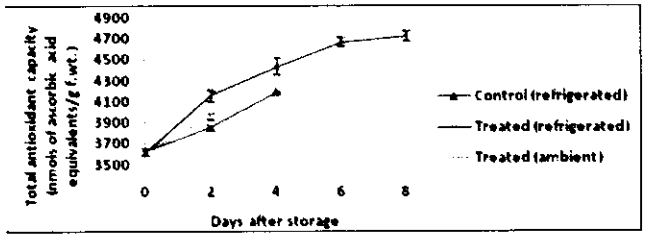


Fig. 49. Total antioxidant capacity of strawberry fresh-cuts during storage under ambient (25 °C and 60% RH) and refrigerated (7 °C and 80% RH) condition

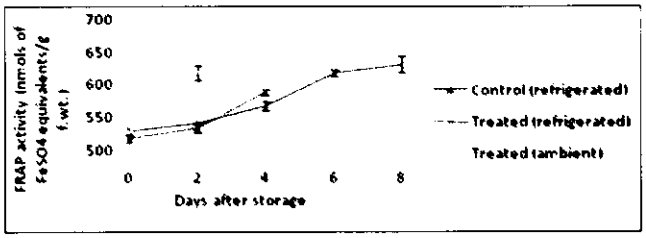


Fig. 50. Ferric reducing antioxidant power of strawberry fresh-cuts during storage under ambient (25 °C and 60% RH) and refrigerated (7 °C and 80% RH) condition

251.05 nmols of purpurogallin produced/min/g fruit, respectively at low temperature storage. Lipxygenase (LOX) enzyme causes oxidative degradation of unsaturated fatty acids to conjugated dienes. The LOX activity also showed the similar trend with the storage period. During ambient storage, the LOX activity changed from a minimum value of 145.97 to 672.81 and 531.40 nmols while the LOX activity increased from a minimum value of 145.97 to 556.49 and 517.72 nmols of conjugated dienes produced/min/g fruit, respectively, for control and treated strawberry samples during low temperature storage. A similar increasing trend was followed by PPO and LOX enzymes in case of strawberry fresh-cuts.

The optimized treatment (pectin methyl esterase concentration of 300 units applied for 30 min with 1.25% $CaCl_2$) enhanced the shelf-life to 10 days in case of whole strawberry and 6 days in case of fresh-cut strawberry when stored at low temperature (7±2 °C and 80±5% RH).

Standardization of pectin methyl esterase treatment for enhancing shelf-life of pomegranate arils

The experiment was performed as per the matrix of RSM (Central composite rotatable design) for all the combinations in case of pomegranate arils. The arils were treated with different concentrations (50-300 units) of enzyme (PME), treatment time (5-30 min) and calcium chloride concentrations (0.5-2.0%). The enzyme was applied at 35±2 °C in 0.05 M acetate buffer (pH 4.0). It was deduced from the study that 249.33 units of enzyme (PME) applied for

24.93 min with 1.70% $CaCl_2$ was found optimum for pomegranate arils.

A value chain on commercial exploitation of underutilized fruits of tribal zone of Rajasthan (NAIP Sub-Project)

R. K. Vishawakarma, Ramesh Kumar and V. E. Nambi

The various physico-chemical properties of the *Jamun* fruit were determined in order to assess the composition of cultivated and wild *jamun* fruit (Fig. 51). Average mass of fruit was found to be 8.34 and 6.31 g for cultivated and wild *jamun*, respectively (Table 11).

Fruit volume varied from 6.66 to 5.12 cc in cultivated and wild type fruit. The cultivated type comprises of 7.5% peel, 57.4% pulp and 35.1% seed content while wild type was having 6.12% peel, 47.10% pulp and 46.78% seed content. The percentage of seed coat and kernel of cultivated *jamun* seed was found to be 8.4 and 91.6, respectively. Total soluble solid, acidity, vitamin C and total sugar varied from 13.83 to 11.68°Brix, 1.32 to 1.56%, 19.13 to 25.41 mg/100g and 12.52 to 8.25 % in cultivated and wild *jamun*, respectively. The moisture content of fruit was recorded to be 85.6% and that of seed was found to be 40.18%. The wild type was more acidic and hence cannot be utilized for table purpose. On the other hand, cultivated *jamun* was found to be less acidic and can be used for product development. Also it was less susceptible to browning due to its low tannin content as compared to the wild type.

Effect of egg albumin (0, 5, 10, 15, and 20 %) was determined in order to assess the foaming efficiency of *jamun* pulp for foam mat drying. The results indicated that foaming efficiency increased with the increase in concentration of egg albumin and whipping time (Table 12). However, maximum foaming expansion was observed when whipping was performed for three minutes. The whipping of *jamun* pulp with egg albumen rarify the pulp and density of foam was reduced to 0.65 g per cc with 15% egg albumin as against 1.02 g per cc for unfoamed pulp. Both foam volume and foam expansion increased while foam density decreased with the increase in the concentration of foaming agent up to 15% and then there was increase in foam density with a corresponding decrease in foam expansion. This seems due to saturation in solubility of foaming agent in pulp under given set of experimental conditions. Addition of 10 or 20% egg albumin resulted in slightly higher foam density (0.78 and 0.73g per cc, respectively) as compared to 15% concentration but it was quite suitable for foam mat drying. Foaming with 5% egg albumin resulted in foam density of 0.97g per cc and was least suitable for foam drying.

Drying kinetics of *jamun* pulp was studied using tray dryer. Drying of the pulp was done at three temperatures *viz.* 50, 60 and 70°C and ten commonly used models were evaluated for fitting the drying kinetics data. The time required to dry the *jamun* pulp from initial moisture content to near equilibrium moisture content was 18.5, 17, 13.5 h at 50, 60 and 70°C, respectively. The drying rate decreased with time; however, the rate was not equal for equal increase in temperature. The pulp exhibited the characteristic exponential drying behaviour whereby an initial high rate of drying was followed by slower rate of drying in later stages at all temperatures. The drying rate ceases as drying time elapsed and

Table 11: Physico-chemical composition of *jamun* fruit

Parameter	Cultivated	Wild
Fruit weight (g)	8.34	6.31
Fruit volume (ml)	6.66	5.12
Specific gravity	1.25	1.23
Peel content (%)	7.50	6.12
Pulp content (%)	57.36	47.10
Seed content (%)	35.14	46.78
Kernel (%)	91.67	88.32
Seed coat (%)	8.33	11.68
Fruit moisture content (%)	85.61	89.89
Seed moisture content (%)	40.18	43.33
Juice (%)	64.86	55.20
TSS (°Brix)	13.83	11.08
Acidity (%)	1.32	1.56
Vitamin C (mg/100g)	19.13	25.41
Total sugar (%)	12.52	8.25
Tannins	278.62	412.43

attained equilibrium moisture content for a particular drying temperature. The effect of drying time in decreasing of moisture content is shown in Fig. 52.

Drying took place at constant rate initially followed by fall in the drying rate. Two falling rate periods were observed. The first falling rate period initiated at moisture contents of about 2.0 kg/kg dry matter. The second falling rate period started at the moisture content of about 0.48 kg/kg dry matter. It corresponded to the moisture content of the inflexion point where the high drying rate was transformed into very low drying rate and finally attained equilibrium moisture.

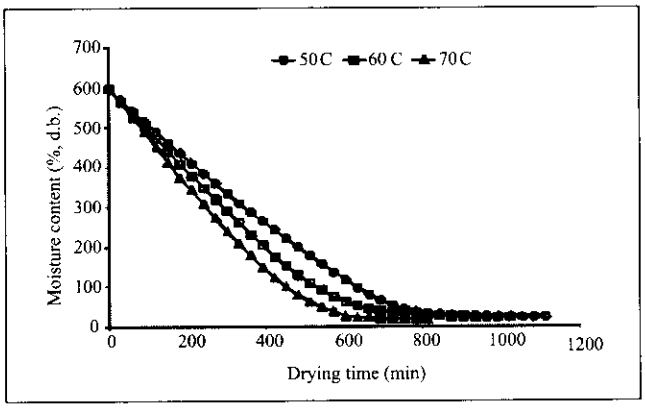


Fig. 52. Change in moisture content of *jamun* pulp with drying time

Table 12: Characteristics of *jamun* pulp as affected by different foaming concentration

Foaming agent (%)	Wt. of non - foamed pulp (g)	Vol. of non - foamed pulp (cm^3)	Bulk density of non - foamed pulp (g /cm^3)	Foam volume (cm^3)	Foam expansion (%)	Foam density (%)
0 EA	203	200	1.02	-	-	-
5 EA	214	210	1.02	220	5	0.97
10 EA	225	220	1.02	290	29	0.78
15 EA	235	230	1.02	360	57	0.65
20 EA	249	240	1.03	340	41	0.73

TRANSFER OF TECHNOLOGY DIVISION

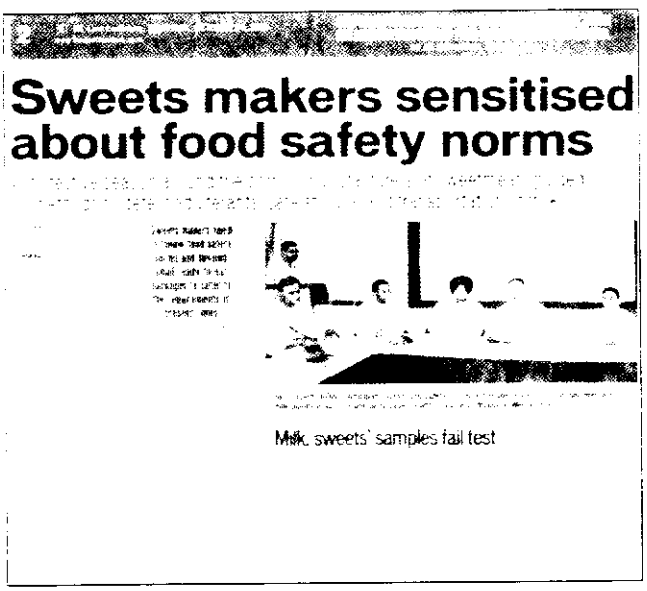
Mobilizing mass media support for sharing agro-information (NAIP Project)

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

The year 2012-13 witnessed production of two documentary films on successful technologies/ success stories emerging out of the northern region of the country. More than 100 news-clippings in leading regional and national dailies were publised. A **you tube** channel on video films developed under the NAIP Mass Media Project has been started for wider dissemination of information. Besides, these films were exhibited during different farmers' fairs across north India to motivate farmers and entrepreneurs. Achievements at a glance may be seen in Table 19.

Coverage in print media

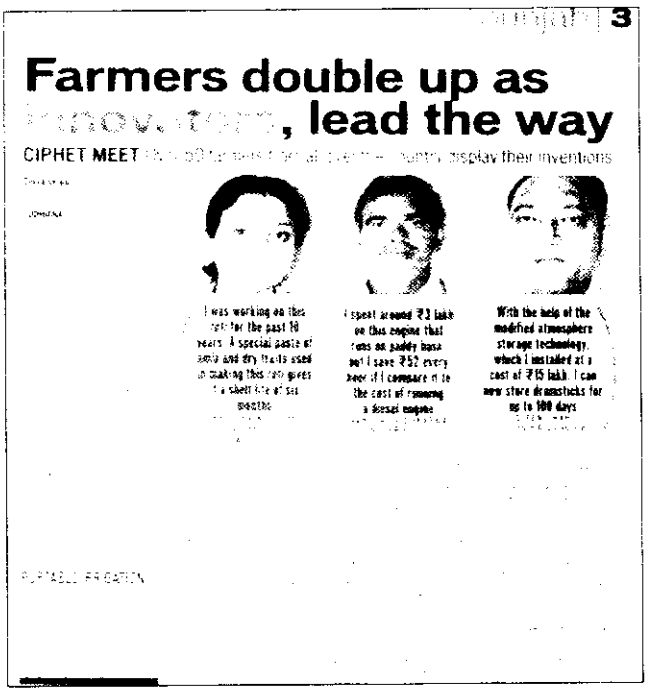
As many as 106 news-items were published during this period, which included the success stories of innovative farmers, transfer of technology events, training programmes, institute activities, visits of the important personalities and new technologies etc. Coverage appeared in leading regional and national dailies and generated considerable impact.


Sweets makers sensitised about food safety norms

Milk, sweets' samples fail test

Radio programmes

All India Radio station (AIR) Jalandhar covered the national farm innovators meet organised at the


Farmers double up as [illegible], lead the way

CIPHET MEET

Central Institute of Post-Harvest Engineering and Technology, Ludhiana. The programme was broadcasted through a powerful 300 kW transmitter on medium wave frequency at 873 kHz and covered whole state of Punjab. The programmes were also available in parts of Haryana, Himanchal Pradesh, Uttarakhand, J&K and Rajasthan.

Video films

Visual medium is an effective form of communication and under the mass media project, three films have been produced based on successful technologies/entrepreneurs. In this financial year, a film on success story of the NAIP project on saffron in Kashmir was prepared and uploaded on You Tube. Another film on success story of CPRI varieties of potato and practices is in the final stages of editing. These films were sent to KVKs across the county and demonstrated on important events/ exhibitions/ visits for creating awareness and motivating farmers/entrepreneurs to replicate successful models.

Television programmes

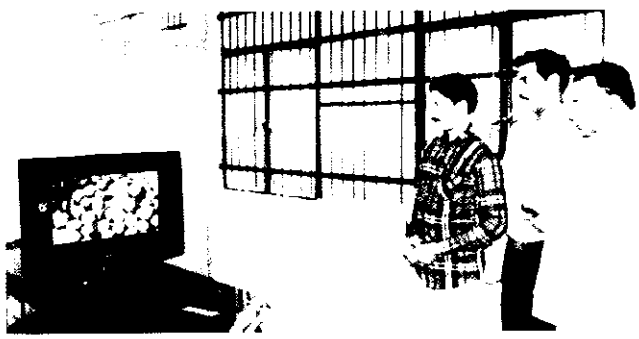
Five television programmes on CIPHET

technologies and events were broadcasted on leading channels including Zee News, PTC News, Fastway etc. The coverage included technologies like potato enriched cattle feed, exhibition and farm innovators meet organized at CIPHET.

CIPHET has started a You Tube channel under the name of **ciphetmedia** for dissemination of films and making them available throughout the world. All video films produced under the NAIP and CIPHET are available by typing ciphetmedia on you tube. Among the film produced are the success story of Dharamvir Kamboj, who invented multi-purpose processing machine which is getting attension of maximum number of visitors.

A meet was organized on backdrop of the farm innovations on October 31, 2012 to provide an interactive farm-media interface. The event helped in generating many success stories, while programme was also broadcasted by All India Radio and various television channels.

A video films produced under the NAIP mass media project was showcased during the exhibitions/events for motivating farmers and entrepreneurs to replicate the similar models of success. The films have been showcased during national farm innovators meet at CIPHET, India International Trade Fair (IITF), Pragati Maidan, New Delhi and Kisan melas at Punjab Agricultural University, Ludhiana.



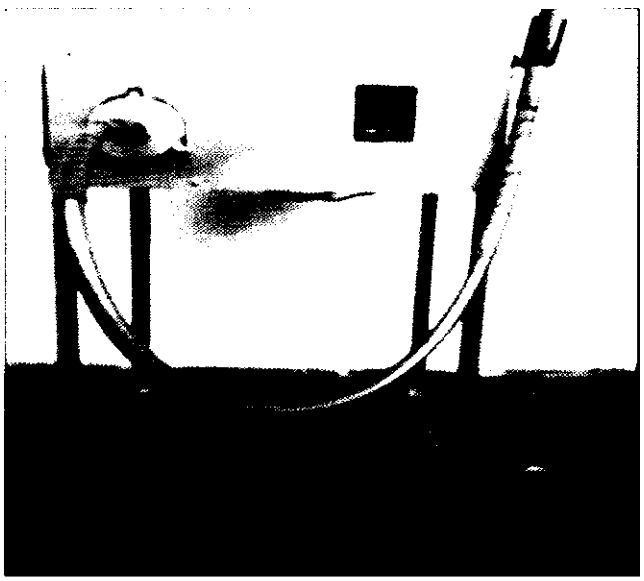
Refinement and evaluation of fish descaling machine and entrepreneurship development (Collaborative research project of CIPHET and GADVASU)

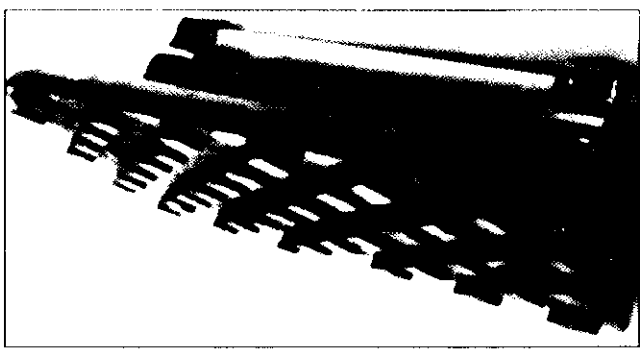
Fish descaling machine was developed (Fig. 62) and performance evaluation was carried out. The combination of optimum speed and most suited descaling head were used for performance evaluation of descaling machine. Speed of 2800 rpm and the diamond shaped descaling head was best

Activities	Achievements
News clippings	106 news-clippings were published in leading regional and national dailies
Radio programmes	Coverage of national farm innovators meet
TV programmes	Five news-reports and programmes on Zee Punjabi, PTC, Fastway etc
Video films	• Saffron revolution in paradise, a success story of NAIP Project on saffron cultivation in Kashmir • Success story of CPRI varieties of potatoes (final stages of production)
Media meet	A channel has been started under name of ciphetmedia for disseminating video films produced under the NAIP mass media project

suited for the catla species (Table 20). Speed of 2800 rpm and the 26 slots descaling head were found best suited for the silver carp species. The descaling was carried out for an hour. The results are tabulated below:

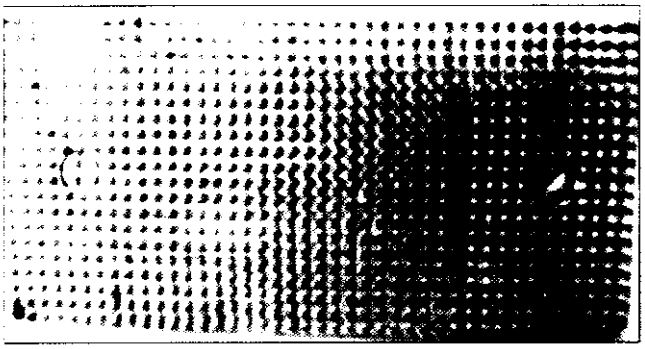
Performance	Fish species	
	Catla	Silver Carp
Capacity (time in second for avg. 500 g fish)	38	40
Efficiency (%)	99	99.5
Damage (%)	Nil	
Energy required (kwh)	0.25	0.24

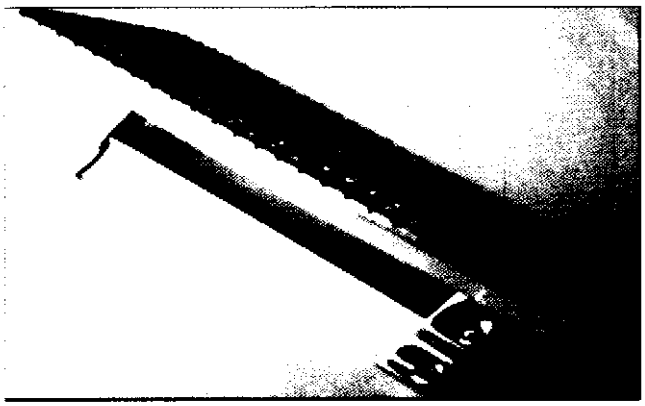




Fish descaling hand tools were designed. Considerations were given to higher descaling capacity to reduce drudgery, maximum descaling efficiency, injury free operation and low cost of tool. It consists of descaling plate, top plate, and handle (Fig. 63, 64 and 65).

The performance of the developed hand tools were evaluated for its capacity, efficiency, and injuries inflicted and compared if with that of traditional hand tool (Table 21). The experimentation was carried out with the average 500 g fish and the 10 kg fishes for each type of hand tool. The comparative evaluation revealed that diamond shaped hand tool was best suited for descaling of catla species because of larger size of





scales and corresponding wider spacing of 10 mm. The lowest descaling capacity was found for traditional hand tool which required almost 120 s for descaling of average 500 g fish. In case of the silver carp species, the capacity of descaling was higher with a triangular shaped hand tool, which has a removal capacity of 116.57 scales per second followed by slanting cut descaling hand tool (Table 22). The reasons for higher capacity of the triangular shaped hand tool are its smaller depth and spacing of 2 mm.

The fish processing table was designed with ergonomic considerations with height of 935 mm lead to the comfort of worker, with no undesirable bending of back as observed in case of the fish processing in drooping posture.

The length and width of the table were decided on the basis of the workspace envelop, which leads to sleek design of table accommodating all the components within reach of the person without the undesirable movement while processing the fishes (Fig. 66). The different processing steps necessary for the hygienic processing of fishes were included in the form of components fitted on the fish processing table. The components were arranged from left to right in such a way that there is unidirectional flow of the processing. This unit includes sink on the left

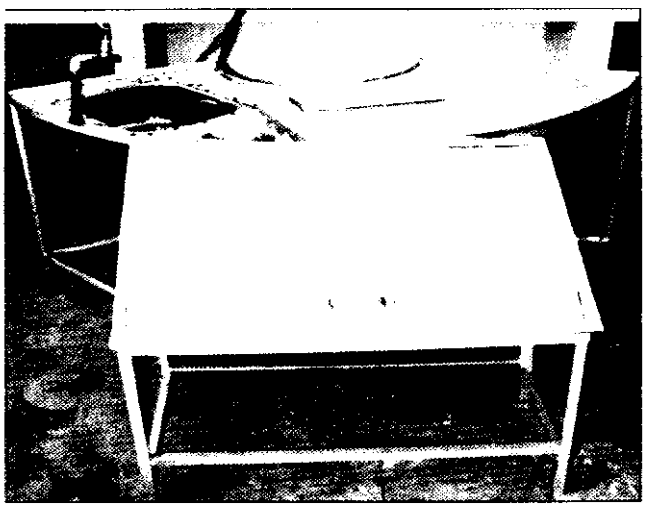


Table [illegible] Comparison of traditional and triangular shape descaling hand tool

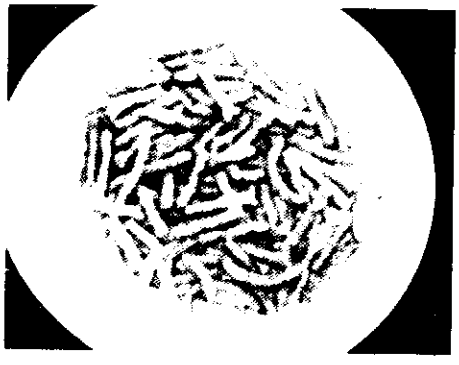
Type of descaling plate	Diamond shaped	Slanting cut	Triangular shaped	Traditional hand tool
Weight (g)	384	262	392	200-250
Size (mm)	135x60	135x60	135x60	Non standard
Depth of the teeth / nails ails	5	3	2	20

AICRP on Post-Harvest Technology

Food Grains Sector

Continuous mass flow technique was introduced in the hot air puffing system, developed with a provision for re-utilization of hot air. It was observed that the commercially available triangular shaped wheat based fryums could be puffed at 250 °C temperature in the developed machine. Byproducts as broken *dal* powder (from *dal* mills) and flour of rice brokens (from rice mills) could be used in 2:8 proportion with required water to prepare fryums using commercial fryum making machines. The cylinder shaped fryums prepared from *dal* powder (from *dal* mills) and flour of rice brokens (from rice mills) having L/D ratio of 1.25 could be puffed well in the continuous hot air puffing system at the rate of 6 kg/h. This hot air puffed oil free RTE snack has about 9 months shelf life at 30 °C and about 5 months shelf life at 40 °C when packed in 135 g metalysed polyester.

Study was conducted on cold and hot extruded products with different treatments of small millets namely foxtail, *kodo*, little, proso and barnyard. Good quality ready-to-eat value-added products like extrudates (Fig. 69) and pasta were developed and recipes were standardized.



Papads from small millets flours (barnyard, foxtail, kodo, little and proso millets) blended with selected leafy vegetables (curry leaves, moringa, *methi* and shepu) were prepared. The recipe for making *papads* incorporating selected leafy vegetables has been standardized. Results sensory evaluation indicated that millet *papads* blended with *shepu* are the most preferred, followed by curry leaves, moringa and methi. Among the small millets, barnyard millet is the most suited for making *papads*. Interestingly, incorporation of leafy vegetables did not affected appearance, texture and flavor of *papads*.

Various proportions of moringa leaf powder have been evaluated to optimize the desired composition based on sensory qualities. Rice flour-moringa leaf powder (RF-MLP) formulations at different moisture content have been tried for acceptable quality extruded product with desired physical and functional properties. The developed products were displayed and distributed in the Golden Jubilee Exhibition of OUAT and well accepted by the people.

Small scale oil dewaxing/refining unit (capacity 30 kg/batch @ 8 h) has been developed (Fig. 70) for minimal refining of sunflower oil. The unit consists of one open conical tank for degumming neutralization, one closed tank for vacuum drying/bleaching, one filter for filtration of oil, and a cooler for dewaxing. The oil tanks and filter are connected with pipelines and pump for circulation of oil to different units.