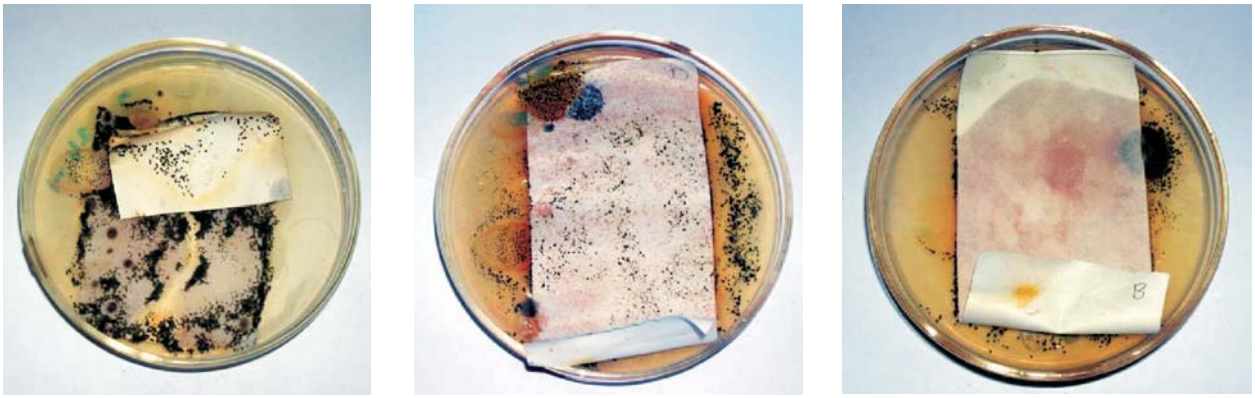
9. Post-harvest Management and Value-addition

Nanotechnology for antifungal paper: A technology has been developed to produce zinc-oxide nanoparticles using microbial approach. CIRCOT in collaboration with the Central Pulp and Paper Research Institute, Saharanpur, has carried out studies for coating paper with zinc oxide, both in bulk as well as in nano form. Nano zinc oxide imparted antifungal property to paper. Besides, nano zinc oxide-coated paper performed better compared to normal coating in brightness, whiteness, smoothness, print density and uniformity, picking velocity and oil absorbency.



Antifungal property of control (*left*), 100% bulk nano (*middle*) and 100% nano-ZnO coated paper (*right*)

Jute extractor: Manually operated and portable CRIJAF jute extractor has been developed. The machine has an output of about 25 kg dry fibres per hr.

Batch-type steam-blancher for fresh vegetables: This blancher of 100 kg/hr capacity is made of stainless steel. The unit has 7 nozzles to eject steam under pressure (2.5 to 3.0 kg/cm^2) on a layer of cut-vegetables from top as well as from bottom for uniform blanching. The blanched vegetables are dropped in a larger tank of stainless-steel filled with water for immediate cooling of processed products.

Multiplier onion peeler: This consists of an aluminum drum seated over a rotating disc. Inner surface of the aluminum drum and top surface of the disc are covered with corrugated rubber sheets, which aid in peeling process. Capacity of the peeler is 60 kg/hr; peeling efficiency is 92%; unpeeled and damaged onions are 6% and 2%. Peeling cost is about Rs 1.20/kg as compared to Rs 4.00/kg for manual peeling, and cost of machine is Rs 15,000.

Banana-comb cutter: Its serrated cutting blade is attached to handle with a 150-mm round pipe of diameter 12.5 mm. The handle is about 100-mm long which provides easy grip during cutting. The semi-circular blade is made of stainless steel sheet having 75-mm length and 25-mm width to suit banana-bunch stem

Banana-comb cutter facilitates cutting and separation of banana comb with minimum damage

geometry. The hand-tool facilitates cutting as well as separation of banana-comb in a single push with minimum damage.

***Aloe vera* gel (Fillet) extractor:** *Aloe vera* gel is used for preparing medicines and cosmetics. Considering the importance of a small machine for taking out gel from the *Aloe vera* leaves an *Aloe vera* gel (fillet) extractor was designed and developed by providing tolerance in between the crushing rollers, so that only the gel is just extracted and over-crushing of the leaves is avoided. The capacity of extractor is 60–80 kg leaves/hr and its cost is Rs 4,000.

Crushing rollers are designed so that only gel is extracted

Assessment of losses during storage of rice in warehouses in Andhra Pradesh: Storage losses depend on the initial moisture content of rice, month of stacking and storage period. Higher initial moisture content resulted in more losses. Storage losses were higher due to driage in low humidity and high temperate conditions. The study has shown that average losses in raw rice storage over 12 months would be about 1.25%.

Post-harvest sugarcane quality under mechanical and manual harvesting: Effects of mechanical and manual harvesting of sugarcane variety Co 86032 on loss during staling were studied at sugar factories located in Pune and Kolhapur districts of Maharahstra. Sugarcane was harvested manually and mechanically at farmers' fields and analyzed in the laboratory. A gradual rise in reducing sugars and losses in cane weight due to staling of cane was observed up to 72 hr after harvest. Losses in cane weight were more in mechanically harvested cane (16.25±0.4%) as compared to manually harvested cane (6.08±1.7%). Increase in reducing sugars was 0.61±0.08% in manually harvested cane compared to 1.66 ±0.13% in mechanically harvested cane after 72 hr. Delay in transport of harvested cane from field to factory is a major contributing factor to losses of recoverable sugar. It is recommended that during late crushing season, the cane should be crushed within 24 hr of mechanical harvesting.

Reduction in post-harvest sucrose loss: In March, pre-harvest foliar spray of $ZnSO_4$ (Zn^{++} at 0.1%) on CoSe 92423 sugarcane showed reduction in post-harvest sucrose losses. Sucrose percentage and purity of juice were higher after 8 days of staling in Zn-treated cane covered with trash as compared to untreated trash-covered control. Spraying benzalkonium chloride at 2.5–4.0 g/litre + sodium lauryl sulphate at 0.2–0.5 g/litre on harvested cane followed by covering with trash reduced sucrose losses. This improved sucrose recovery between 0.3 and 0.5 units.

Accelerated retting technology: The NIRJAFT accelerated retting technology yielded better quality of fibre by one or two grades, and the yield was also higher by 10–20% over the traditional one. The accelerated retting technology has also been adopted by the Jute Corporation of India. The Jute Corporation of India has also procured 100 manual ribboners and chemicals from the institute for demonstration of improved retting technology to farmers through their centres.

Mobile agro-processing unit for foodgrains and spices: A mobile agro-processing unit for foodgrains and spices has been developed for demonstration in production catchments. The unit consists of a grain cleaner, two burr mills for grinding foodgrains and spices, a popcorn machine and a 7.5 kVA diesel-generator for operating the machines. It is suitable for the primary processing in rural areas. With an investment of Rs 200,000 an entrepreneur can generate a net income of approximately Rs 47,000 annually.

Mobile agro-processing unit, suitable for rural areas

Community-level evaporatively cooled storage: This storage structure could achieve up to 20°C lower air temperature and relative humidity as high as 70–99%, depending upon the outside temperature and relative humidity. Its cost is Rs 1.5–1.8 lakh. Shelf-life of fruits and vegetables stored in this are as follows: Potato: two months in summer (May–June); tomato: 5–7 days and kinnow: about 35 days in February–March.Weight loss of 12.17% was observed in Kufri Pukhraj potato tubers and 9.03% in Kufri Chandramukhi after 60 days. Reducing sugar content was less than 250 mg/100 g fresh weight.

Enhancing shelf-life of mango: Shelf-life of Alphonso and Banganapalli mangoes could be extended by 5 weeks at 8°C in unripe hard green condition without any chilling injury by bulk packing (4 kg box) in 100-gauge D-955 or PP film with 0.0125% micro-perforations.

Papaya: The storage life of papaya Taiwan Red Lady could be extended by 2 weeks at room temperatures (27–33°C and 32–44% RH) and 4 weeks (18°C, 70–75% RH) by bulk MA packing with micro-perforated D955 or PE film.

Osmo-convective dehydration of pineapple slices: A method for preparation of pineapple candy from fresh peeled cored pinapple has been standardized. Pineapple slices were osmotically dehydrated at room temperature using sucrose syrup. It was followed by convective drying in a tray dryer. The sensory evaluation of the product has established its acceptability. The dehydrated product has 15.6% moisture content (weight basis), 1.85% acidity, 18.8% reducing sugar, 3.88 mg/100 g ascorbic acid and 115.71 µg/100 g α-carotene.

Osmo-air drying in vegetables: In vegetables, osmo-air drying has been standardized in bitter gourd and cauliflower. Bittergourd slices were dried after osmotic diffusion treatment at 10% NaCl solution at 60°C for 90 min followed by drying at 65°C for 4–5 hr and 3–4 hr at 60°C. The blanching treatment in cauliflower was standardized with hot water blanching at 100°C/

Osmo-air drying was standardized in bittergourd and cauliflower

3–5 min followed by dipping into 0.2% potassium metabisulphite solution for 10 min. Osmotic diffusion in cauliflower was carried out at 10% NaCl solution at 60°C for 6 hr. The cauliflower slices were dried at 60°C for 2–4 hr and at 55°C for 3–5 hr with final moisture content. Okra pieces were effectively blanched at 100°C for 30 sec in 0.1% MgO and dipping 1% sodium sulphite solution for 10 min. The blanched okra pieces were dried at 65°C for 4–5 hr and dried okra pieces were packed in LDPE pouches.

Ragi in biscuit-making: Cooking quality of both brown and white ragi was found comparable. Seed coat a byproduct of decorticated ragi is a good source of calcium, phosphorus, micronutrients, dietary fibre, and phytochemicals, and it can be used as an ingredient up to 25% in biscuit-making.

Extruded products from millets: Different snack foods could be developed using sorghum and legumes combinations using (collate type) low-cost, single-screw food extruder (costing about Rs 2.0 lakh). Raw materials were subjected to pearling/decortication and size reduction for product development through food extrusion system. The extruded products could be ground to produce instant porridge.

White sorghum extrudates

Red sorghum extrudate

Fortified Bengal gram *sattu*: Fortified Bengal gram *sattu* was prepared following standardized *sattu*-making process, and was fortified as per the FDA standard of wheat flour for thiamin, riboflavin, niacin, calcium and iron and was stored at 25, 35°C and room temperature in low density polyethylene and laminated aluminium foil (LAF) pouches. No significant changes were observed during 6 months of storage in alcoholic acidity of these samples at 25°C. Protein digestibility, calcium and iron content in fortified samples were 80.58%, 170.10 and 12.55 mg/100 g against control samples (80.6%, 69.5 and 10.2 mg/100 g).

Fermented food products using *okara* and defatted soymeal: Technology for preparing fermented traditional '*Dhokla*' and '*Idli*' by fortifying batter with *okara* or defatted soymeal has been developed. Fortification up to 20% of *okara* and up to 25% of defatted meal has been found acceptable to consumers. Fortified *idli* could be stored for 24 hr under ambient conditions, and for three days in refrigeration.

Tobacco oil: Solanesol derivatives have been synthesized and found promising in anti-diabetic activity. An expert system for diagnosis of nutrient deficiencies in flue-cured tobacco has been developed.Oil content in tobacco seed is 35–39%, which is free from nicotine, is better than groundnut, mustard and cotton seed oil and is at

par with sunflower oil in terms of fatty acid composition. The potential of tobacco as an oilseed crop has been established with possibility of producing 1,171 kg seed/ha with a recovery potential of 433 kg oil/ha from a chewing tobacco cultivar A 145 with modified agro-techniques in addition to cured leaf yield.

"Green" towels from organic cotton: Organic cotton sourced from Maharashtra was converted into yarn and subjected to bioscouring using "pectinase" enzyme. Bioscoured, bleached yarn was converted into towels in a commercial factory. The organically processed "green" towel compared well with normally (chemical) processed terry towel as well as a commercial product for its water-holding capacity.

Kenaf/mesta fibres for making reinforced PP composites: The PP/mesta fibre compound has been prepared using grafting of Maleic anhydride (MAH) on polypropylene (PP) by melt-mixing technique in the presence of Dicumyl peroxide (DCP) initiator, lubricant and antioxidant at 180°C for 5 min at 60 rpm in a rheocord. The chopped mesta fibres were added during melt-mixing. PP/mesta fibre composite sheets were prepared by compression moulding at 200±5°C and maximum load of 20 T compression. Fibre loading of 40 phr was optimized for making composites. Performance of mesta fibre-PP composites vis-à-vis glass fibre-PP composites was found comparable with respect to various physico-mechanical properties.

Coffee from vilayati babool pods:Vilayati babool (*Prosopis juliflora*), an alien species, introduced in India in 1877 from Mexico. The species has now spread in entire arid and semi-arid parts of India except frost-prone areas and mountainous regions.

It profusely produces pods (15–30 kg/tree) and in general stray animals browse the fallen pods. At the CAZRI, Jodhpur, efforts were made to utilize pod flour for coffee, biscuits and syrup (sugary concentrate). In one cup of boiled water add ¼ tea spoon *Prosopis* coffee powder and enjoy the coffee without *caffeine*. The taste of *Prosopis* coffee is similar to original powder of coffee (*Coffea arabica*).

***Salvadora oleoides* fruits (peelu) for value-added products:** Peelu squash and peelu jam from the juicy pulp of fruits can successfully be prepared for use in off-season. Dried peelu fruits have also been prepared. Seeds (the squash and jam preparation residue) can be utilized cost effectively for extraction of inedible fat for soap industry and in candle making.

Jute-synthetic geotextiles in rural road construction: New woven fabric has been developed using jute and polyolefin fibres suitable for application in soil reinforcement and stabilization. Use of synthetic material enhances durability of fabric as geotextiles compared to 100% jute; with advantages of lightness, high productivity and low cost. An extensive field trial was conducted using geotextiles for separation and reinforcement function in construction of a low-medium traffic volume rural road, Deocha–Saranda village road, Birbhum district, West Bengal. After six months of full monsoon, physical observation of the road showed that the portion where fabric was underlaid had even surface without any significant mark of subsidence or canalization causing ruts, depression etc. And cracks were found on the top and no patch marks were seen. The marks of ruts and cuts were found and ruptures were seen in places with vibration sensations on road without using synthetic fabric.

Jute fibreglass reinforced shellac sheets: Jute fibreglass reinforced sheets were prepared using jute fabric and fibre glass mats using shellac-filled sheet moulding compound. The sheets were smooth and aesthetically appealing. These sheets can be used for partition wall (in place of plywood and particle board), for door and window panels, as these are resistant to water and termite attack. The sheets possess good mechanical properties. Technologies for jute fibreglass reinforced sheets and jute fibre glass plywood composite have been transferred to an entrepreneur for commercial production.

Mango products: Preparation of carbonated beverages and osmotic dehydrated slices from Totapuri and fruit-bar of pulp from Arka Anmol have been standardized. Fruits of Pulihora showed highest antioxidant capacity (80.73 mg/100 g), followed by Ratna (78.33 mg/100 g). Arka Puneet possess highest flavonoid content (12.69 mg/100 g).

Guava cider: A sweet, fermented nutritious and highly refreshing cider, having strong guava

Jute polyester blended fabric

The blended yarn has been produced using polyester (hollow) of 6 denier, 110 mm and raw jute of TD-3 grade in conventional jute-spinning system. Attempts have been made for developing winter fabric in handloom using jute-blended yarn and commercial cotton yarn alternately as weft and commercial cotton yarn of 5.9 tex (100s Ne) as warp for developing jacket fabric. Alternate use of cotton and jute-blended yarn in weft direction improves fabric appearance and other physical properties. Fabric is 7.5% lighter in weight compared to commercial acrylic, and 15% lighter than cotton-jacket fabrics. The fabric thickness of the jute based fabric was also lower compared to commercial acrylic fabric and cotton jacket fabric by 19 and 47%. Thermal insulation of the jacket is much superior compared to commercial jacket fabrics.

flavour could be prepared. The cider prepared from guava Lalit scored high for colour, clarity, aroma, taste and astringency, free from acetic acid, sugar and impression. This mildly fermented beverage has 13° Brix TSS, 3.0% alcohol, 0.45% acidity and 32.8 mg/100 ml ascorbic acid. The cider can be stored up to one year under ambient conditions and its taste improves with aging.

Sweet, nutritious and refreshing guava cider

Banana beverages: To increase nutritional quality and appeal of banana juice, it was blended with other fruit juices. Banana and tomato juice in a 1: 1 ratio has received the best organoleptic score (6.14) and has a shelf-life of 5 months.

Litchi wine: The technology for wine-making from litchi fruits by yeast fermentation method has been standardized with 6.5% alcohol recovery.

Aonla products: Aonla jelly has been prepared using aonla juice, pulp and other ingredients like mango pulp, papaya pulp sugar and pectin. Prepared aonla jelly has 72 mg/100 g vitamin C (ascorbic acid), 0.8% acidity (as citric acid), 0.3% total ash (mineral), 68% total soluble solids, 47% sugar (sucrose), and 2,552 gross calorific value.

Aonla leather has been processed by slow heating of aonla, mango and papaya pulps. At the time of heating prepared sugar syrup (50 ºB) was added. This mixture was heated slowly till it reached 35 TSS ºB. Potassium meta-bisulphite as preservative was added for increasing shelf-life. The product has 81 mg/100 g vitamin C (ascorbic acid), 1.3% acidity (as citric acid), 0.5% total ash (mineral), 80% total soluble solids, 27% sugar (sucrose), and 3,019 gross calorific value.

Aonla powder has been obtained using foam-mat drying. This drying of aonla pulp using foaming agent TCP: 1% with 5% egg albumin at 5 min foaming time and 60°C drying temperature gave the best results by retaining good colour, appearance and nutritional values of aonla powder. Nutritional quality of foam mat dried aonla powder was superior as compared to simple aonla powder. Nutritional value of foam mat dried powder is higher, vitamin C (135 mg/100 g) is higher than simple dried powder (96.5 mg/100 g) and the acidity was low (1.07%) and total soluble solids (8.5 ºB) were higher than sample power (TSS 6ºB).

Soft-type aonla toffee has been prepared by using shreds (10.4%), glucose, sugar and colouring


Aonla jelly prepared from aonla juice, pulp and other ingredients, contains vitamin C, citric acid, minerals, total soluble solids and sucrose

flowering agents. This toffee had higher acceptability and retained vitamin C. For making soft toffee, fat was used for softening as compared to hard toffee.

Processing and preservation of drumstick: They were without any fungal attack after on year of storage. Drumstick pulp was separated by steam blanching and gravy was prepared with onion and tomato, masala powder (3 different combinations as available commercially) and other spices used for cooking.

Jackfruit srikhand: Jackfruit srikhand from jackfruit bulbs has been developed and process was standardized.

Drying of onion in forced ventilated greenhouse type dryer: Thermal efficiency of greenhouse dryer is 21%. With dryer, onion slices could be dried from 86% to 5.8% moisture content (wb) in about 16 sunshine hr. Dehydration as well as rehydration ratios are 11.5:1 and 1:4.9. The dried samples can be stored safely for 6 months after 0.5% Potassium meta-bisulphate treatment.

Process for potato flour: Potato flour has been prepared by mechanical dewatering of potato-meal. The process requires 75% less energy compared to conventional drying.

Extraction of aromatic oil from patchouli: Its essential oil yield varied from 1.9 to 2.0%. And during storage, alcohol content of oil increased gradually. The refractive index values for oil samples distilled from shade-dried patchouli herbage, stored in different packaging materials for ageing, varied between 1.504 and 1.506, but refractive index values of distilled essential oils were insignificant with respect to packaging material used and the ageing period.

Banana-peel pickle: In banana-chip industry, for every tonne of fruits, 300– 400 kg banana

peels are generated. Peel pickle has an organoleptic score of 6.8 with a shelf-life of 8 months.

Natural resins and gums

Lac production technologies for Gujarat: On the basis of lac cultivation trials conducted at various places in Gujarat on the newly identified lac host, *Prosopis juliflora* (a serious weed available in abundance in Gujarat and neighbouring states), a pakage of practices for winter *kusmi* lac production (*aghani*) on this host has been developed. Utilizing summer broodlac produced on *kusum*, a good harvest of *kusmi* sticklac crop to the tune of 1.2 tonnes of sticklac can be made in a plantation of this host with 1,000 plants/ha. An annual profit of Rs 0.1 million/ha will be generated from plant-biomass and lac. Sale of lac produce as broodlac would lead to much higher returns (up to Rs 0.25 million).

Since limited resource in the form of *kusum* plant for production summer broodlac (*jethwi*) is available in Gujarat, alternative host was needed for cultivation of summer broodlac on plantation scale. *Flemingia semialata*, a quick-growing bushy host plant, is normally recommended for winter *kusumi* lac production under rainfed condition. Earlier experiment at the Institute has shown summer sustainability of lac crop on this plant under irrigation. Therefore, field trials were undertaken in Gujarat for summer *kusmi* broodlac production on *F. semialata*. The crop matured during the first week of July and 90 kg broodlac was obtained with the use of 9 kg broodlac, which is equivalent to 3–6 tonnes/ha.

Lac insect-host plant relationship: *Kusmi* and *rangeeni* strains of Indian lac insect, *Kerria lacca* were evaluated on five host plants [*Acacia auriculiformis* (*akashmani*), *Albizia lucida* (*galwang*), *Butea monosperma* (*palas*), *Schleichera oleosa* (*kusum*) and *Ziziphus mauritiana* (*ber*)] for productivity-linked parameters. Host-suitability index was calculated for all the five hosts for both seasons.

Acacia auriculiformis was least suitable and *Butea monosperma* most suitable host during summer (*baisakhi*) crop for *rangeeni* strain. Differences in relative suitability of host plants were very high. Host suitability in order of lac yield was: *Acacia auriculiformis*<*Albizia lucida*<*Flemingia semialata*<*Butea monosperma.* Host-plant suitability changed with season. Maximum yield of lac was obtained on *Ziziphus mauritiana* and least on *Albizia lucida* during rainy-season crop than summer crop. Host-suitability index in order of lac yield was: *Albizia lucida* < *Acacia auriculiformis*<*Flemingia semialata*< *Butea monosperma*< *Ziziphus mauritiana.*

For *kusmi* strain host plants were more suited to lac insects in winter than summer season crop. Inter-host plant variability was also lesser. Host-suitability index in order of lac yield was: *Flemingia semialata*< *Acacia auriculiformis*< *Albizia lucida*< *Ziziphus mauritiana*< *Schleichera oleosa.* And during summer season (*jethwi*) crop, *Flemingia semialata* was the lowest yielder of lac and *Schleichera oleosa* the best yielder. Variability observed in host-suitability index among the different hosts was very high in this season. Host-suitability index in order of lac yield was: *Flemingia semialata*< *Acacia auriculiformis*< *Ziziphus mauritiana*< *Albizia lucida*< *Schleichera oleosa.*

Resin-dye content of lac when grown on different hosts showed significant differences and other industrial parameters, viz. life, flow, m.p. of lac, did not differ significantly when lac insects are grown on different hostplants for one generation. An endosymbiont *Wollbachia* sp. was found associated with lac insect for the first time.

Detection of adulteration of ghee: A rapid colour-based test has been developed to detect adulteration of ghee with vegetable oils/fats. The test gave appearance of orange-brownish colour/ tint in ghee samples adulterated with vegetable oils/fats. Adulteration to the tune of 5–7% could be detected with the newly developed test. Efficiency of the method remained unaffected as the result of storage of ghee for test period of 12 months.

Detection of adulteration of milk: The colour-based test for this is simple and reproducible. It can detect detergent up to 12.5 mg/100 ml milk. The result can be obtained in 5–10 minutes.

Goat milk products for additional income generation

In arid Rajasthan, the higher number of goats reared indicate its role as a saviour of drought-prone rural economy and human livelihood. The goat milk produced is organic in nature and is mostly obtained from the animals browsing on local bushes and tree fodder. Besides, its limited home use in the tea making and/or infant feeding in rural areas it has not been considered for making any value-added products. Goatee odour from the milk could successfully be removed to make the value-added products. The goat milk products like paneer, kulfi and paneer whey drink are now popular for additional income generation and livelihood security in the region. The benefit:cost ratio of kulfee and paneer is 1:1.69 to 1.70.

Continuous *chhana*-ball forming system: A prototype for continuous *chhana*-ball forming system has been developed. This system is an integrated device consisting of a kneading unit and a ball-making unit working in perfect synchrony to convert *chhana* mass into smooth balls of uniform size. The same unit can produce *chhana* balls of different desirable diameters from 15 mm to 25 mm. It does not involve any contact of human hand during the process. The system is easy to operate, saves labour and gives smooth hygienic balls required for preparation of high quality rasogolla.The prototype has a capacity of preparing 3,000 rasogolla balls from 18 kg *chhana*/ hr. It can be scaled up to any desired capacity as per the production plan of the company. It can save up to 80% on labour cost.

Continuous *chhana* ball making machine—it does not involve any contact of human hand during process

Milk: A substantial rise in phagocytic activity of macrophages was observed in probiotic *dahi* group on 2, 5 or 8 days of supplementation and it was found highest on the fifth day. Activities of β-glucuronidase and ß galactosidase enzymes were highest in probiotic *dahi*, group followed by normal *dahi* and milk groups. The augmentation in activities of these enzymes was highest after 2 days of dietary treatment.

Consumer response to dairy products: A consumer response study was conducted for evaluating a newly developed ready-to-reconstitute *basundi mix* (RTR-BM). The average consumer response on RTR-BM was between 'very good' and 'excellent'. A sizeable number of consumers (79%) rated product as 'very good' or better, indicating a high acceptability of the new RTR-BM. Most of the respondents (97%) expressed their willingness to buy this product as and when it would be available in the market.

A new shelf stable product formulation, ready-to reconstitute rasmalai mix, was also subjected to consumer-response study. Their opinion was also sought for willingness to purchase new formulation. More than 80% of the consumers rated product as very good or even better, the average consumer ranking for the product was more than 4.0 on 9.5 point scale. The respondents were segregated according to age and sex to evaluate demographic pattern of their responses. More than 90% of the respondents expressed their willingness to buy this product if produced commercially.

Multi-nutrient feed block: boon for livestock and self employment for farmers

The multi-nutrient feed block (MNFB) and nutrient mixture are prepared by using locally available ingredients, viz. molasses, urea, guar *churi*, salts, mineral mixture, dolomite, wheat bran, pearl millet husk, neem leaves and guar gum. Feeding of block/moisture to the livestock meet their requirement for balance feed by supplying fat, mineral and salts. To popularize this technology farmers' training programmes through KVK were organized. One of the trainees Shri Dada Ram Patel, resident of Kharda Ki Dhani village established his own unit for commercial production of MNFB with initial investment of Rs 9,800 and his product became popular in the area. Shri Patel has registered his enterprise and earning monthly income of around Rs 6,000 successfully by self employment.

Meat products: Designer **pork sausages** with low salt and fat, with high fibre, and shelf-life of 35 days in vacuum packaged in multi-layered nylon pouches, were developed. The processes for designer **chicken patties** with better consumer acceptability and **chevon and mutton sandwich spread**, well-acceptable variety products, were developed. Calcium chloride proved to be most effective in improving tenderness and other sensory attributes of mutton curry. Capsicum addition in mutton and chicken formulations improved flavour and acceptability of the products.

Designer pork sausages with low salt and fat with high fibre and shelf-life

Post-harvest cooling of fish: Cooling of Indian major carp catla (*Catla catla*) and rohu (*Labeo rohita*) fish under ice has been studied. Exponential and logarithmic models adequately represented cooling behaviour of catla and rohu. Average surface heat transfer coefficient of catla ranged

Technology of flavoured milk transferred for commercialization

from 11.68 to 34.41 W/m/C for weight range of 1.378 to 0.195 kg, respectively and that of rohu ranged from 19.84 to 33.01W/m/C for the weight range of 1.165 to 0.215 kg. Thermal diffusivity ranged from 6.6012 to 3.2475 × 10^{-8} m^2/sec and from 6.6481 to 5.4267 × 10^{-8} m^2/sec for catla and rohu. Thermal diffusivity decreases with increase in weight of fish. The study has indicated that for each 10°C reduction of fish temperature, approximately 0.110 kg ice/kg fish is required to lower temperature up to 0°C.

Fish products: New fish products developed include coated trout fillets, cutlet from filleting waste; cured product from freshwater fish; canning of trout; prawn soup powder; smoked fish products; tuna biriyani; ready-to-serve mahaseer (*Tor khudree*) curry in mughlai and Punjabi style. ❑

Technologies assessed and transferred

Probiotic dahi

- Continuous *chhana* ball forming system
- Probiotic dahi
- Gulabjamun mix
- Hansa test serum (HTS) to detect admixing of buffalo milk in cow milk
- Technologies of urea treatment of paddy straw,preparation of balanced concentrate mixture
- Technology of flavoured milk for commercial use