

Post-harvest Management and Value-addition

Value-added ready-to-cook product from mustard leaves: A mixture of dried ingredients, 'ready to reconstitute mustard *saag*' was developed. The dried ingredients on mixing with lukewarm/hot water yield the inherent taste and odour of staple ingredients. The taste and colour was observed to be acceptable on reconstitution. Ash content and crude fibre were observed to be 11.73% and 8.53% respectively.

Green chillies products precessing: One kg of green chillies yields about 130 g of green powder and 300 ml of puree. With an investment of about Rs 7 lakh, 200 kg of green chillies could be processed/day, thus deriving a value addition of almost 5 times the cost of green chillies, with ready market for such products. It is estimated that the pay-back period is as low as 1.9 years.

Pomegranate aril extractor: The machine is capable to process the whole pomegranate at a rate of approximately 30–35 fruits/min. with extraction capacity of 90–94% and about 2–4% damage. The technology has been transferred to M/s Padmatech Engineering Systems, Pune.

Development and quality evaluation of meat offals and vegetable waste incorporated pet food in extruded form: Value-added canine pet food samples utilizing byproducts of slaughterhouse were developed based on meat, meat, blood and bone and edible offals. This pet food incorporated 40% slaughterhouse offal (liver, blood, heart, kidney, chicken, pawn and MBM) and 50% fruits and vegetable residues, potato and *dal* residues and flours. Treatment with two natural preservatives, namely vitamin E (tocopherol) and C (ascorbic acid) was also adopted. Effect of storage on various qualities attributes of dog food samples including physico-chemical, microbiological, texture and quality were evaluated at 20 days intervals up to 120 days. The shelf-life of product is more than 6 months and found to be palatable to dogs.

Improved on-farm potato storage system: Potato storage system with tubular aeration reduced the storage losses compared to traditional pit storage in vogue in Karnataka. Accumulation of heat tended to be at the top in the traditional system, while it was lower and at the bottom in the improved system. Improved system recorded lower physiological loss of weight and total weight loss of tubers compared to the traditional system. At the end of storage of 1 tonne of potato for 3 months, PLW of 13.06% and 15.20% were recorded in bulk-stored potatoes of improved and traditional on-farm storage systems, respectively. Rotting damage in the bulk at the end of storage period was found to be 4.05% in the improved on-farm storage system compared to 6.85% in traditional on-farm storage system. The total sugar content of potato tubers was initially 295.89 mg/100 g fresh weight before storage, which increased to 402.67 mg and 423.98 mg/100 g in improved and traditional on-farm storage systems at the end of the storage, respectively.

Post harvest processing of *Aloe vera* leaves: A low-cost manually-operated *Aloe vera* extractor was developed. It consists of one pair of tapered roller swith varying clearance to accommodate leaves of differing thickness. The contra rotating rollers are operated with the help of a handle. It yields 10% higher quantity of juice as compared to manual extraction. It has a capacity of 12 kg gel/hr.

Hair care products from *Aloe vera*: *Aloe vera*, locally known as *guar patha*, has several medicinal properties, and is used as an ingredient in manufacture of a number of medicinal and cosmetic products. It is a xerophytic plant, well adapted to the arid environment of Rajasthan. Although the plant is locally used as a vegetable, its potential has not been fully exploited, perhaps due to the highly perishable nature of the aloe juice.

The CAZRI has developed two hair care products from the aloe juice, namely 'Aloe Shampoo' and 'Aloe Hair Cream'. These products have shelf-life of more than 10 months. Apart from conditioning effects, the developed Aloe shampoo makes the hair silky, shiny and dandruff-free. Aloe hair cream, which also contains olive oil, castor oil, mustard oil and aonla, prevents hair fall and makes the hair strong.

Post harvest processing of mahua flower and seed leaves: A power-operated mahua seed decorticator was developed. It has a throughput capacity of 60 kg/hr and operated with 90.5% decorticating efficiency and 94.5%, whole kernel recovery at 10.5% mc. The cost of decortication for 480 kg of seed in the decorticator was found to be Rs 180 as against the manual decortication cost of Rs 840.

Soybean dehuller: The modified dehuller is capable of dehulling various sizes of grains without grading. The modified soybean dehuller is provided with a tapered dehuller drum having variable clearance of 8.5 and 5.2 mm at grain inlet and outlet ends, respectively. The dehuller drum surface was knurled for creating coarse surface and ribbed spirally with 1 mm diameter wire to improve dehuller efficiency and capacity. Dehulling was carried out at drum peripheral speed of 4.13 m/s for mixed sizes of soybean grains having moisture content from 7 to 9.16% (wet basis). The machine capacity was found to be 144 kg/hr with 3.0% broken and 100% hulling efficiency. The output of the dehuller is 40% higher than the older machine and consequently has lower specific power consumption.

Production of alcoholic banana beverage: A fermented drink/beverage from over-ripe banana pulp and sorghum sprouts was produced. The alcohol content in the beverage was between 11 and 13% after 68 hr of fermentation produced in 5 litre capacity vessel. The final clarity observed was 3.6–4.5 NT units. The fermented drink was clarified to the extent of 95.6% as compared to 8.87 and 13.4% in unfermented controls of beverage with and without sorghum, respectively, when added as an ingredient to the fermenting medium. Changes in tannins, sugars and carbohydrates in beverage took place during fermentation of beverage. The average yield of beverage with sorghum and without sorghum was 53 and 42%, respectively. The beverage can be preserved with flavour for 3 months under refrigerated conditions.

Fruit grader: Fruit grader with 3 sorting channels having capacity of 50 kg/hr for guava/tomato was developed. The sorting channels are made of 4 endless rubber V-belts mounted on 4 sets of pulleys. The pulleys are spaced in such a



Expanding belt type fruit grader

way that the spacing between moving belts diverges from the feed end to delivery end, enabling the small fruits to fall down in appropriate collection tray placed below the moving belts. The top of belts has been dressed to form semi-circular cross section so that smaller fruits do not stay on the top of V-belt. The semi-circular top of the belt also prevents injury to the fruits. Idlers are provided to adjust tension of the belts. Commercial plastic containers are used for feeding hopper and collection trays to improve the quality of machine and to prevent damage to the fruits during the operation.

Continuous feed type seed removing and segmentation equipment for aonla: A pneumatic model of continuous feed type seed removal and segmentation unit having capacity of 12–15 kg/hr for aonla was developed. The cost of the equipment has been estimated as Rs 40,000 and the equipment is under commercialization.



Aonla suction unit

Discharge of cut sample of aonla

Stone remover from mango fruit: Mango stone remover from the fruit has been developed. It consists of a number of wooden reapers and nylon brushes mounted on a mild steel shaft and is placed inside a sieve having 12 mm diameter perforations. Provision of spraying water inside the pulper been made. Preliminary trials were conducted with Totapuri. Pulp recovery and pulping efficiency for Totapuri variety were 75 and 96%, respectively. Recovery of pulp by mechanical destoner was 20% higher than the manual method of peeling and pulping.

Value-added products from groundnut: GG11 and GG20 varieties of groundnut having white bold kernels and lower oil content were selected for peanut milk preparation. The cleaned and whole bold kernels were sand-roasted at different temperatures (110 and 120°C) and duration (5 and 10 min.), followed by removal of skin and the germs of kernels. The split kernels were soaked in NaHCO₃ solution of different concentrations (1.0 and 1.5%) and for different durations (5 and 10 min.). Treated kernels were then cooked with water (in ratio 1:5 and 1:6) and ground in the domestic grinder using hot water. The aqueous solution obtained after grinding was filtered to obtain white peanut milk. Based on the sensory evaluation results, GG20 was found to be the most suitable variety for obtaining milk of good colour and flavour.

System for live fish storage: System for the storage of live fish with aeration was designed, developed and tested for one year at Ludhiana. It consists of blower with pressure regulator, air filter, FRP tanks, diffuser stones, and distribution pipe assembly. 20 l of water is required to keep fish live for market purposes to store 5–8 kg of fish for a few days. The installed fish storage has a capacity of 350 kg. There was nil mortality ever after 24 hr of storage. Water temperature remained steady for 24 hr but pH increased from 6.7 to 8.6. The total dissolved solids (TDS) also increased with duration of storage from 0.44 to 0.800 mg/l and depend upon the variety of fish storage. The system costs Rs 30,000 for storage capacity of 200 kg and the cost of storage works out to Rs 1.50/kg for 24 hr, which helps to fetch almost 50% higher price as compared to iced/dead fish.

Value-added products from low value and under-utilized marine and freshwater fishes of west coast: Fish sausage was developed using bulleye fish (*Priacanthus hamrur*), popularly known as disco fish and the recipe was standardized using potassium sorbate or Nisin as the preservative. Shelf-life studies of fish sausage as revealed after sensory evaluation showed that the sausage prepared using nisin (0.2%) could be stored up to 10 and 14 days under refrigerated (6±2°C) and ambient (28±2°C) conditions, whereas with potassium sorbate (0.2%), it was stored for 7 and 9 days, respectively.

Smoked fish was prepared using a low value fresh water fish, Tilapia (*Oreochromis mossambicus*), popularly known as *jilebi* fish. Brining of fish for 20 min. and smoking for 45 min. gave the product of highest acceptable score. The smoked fishes were packed in 200 µm polypropylene pouches using a vacuum packaging machine. The products packed with 50 and 100%

vacuum stored at ambient condition were acceptable up to 4 and 7 days and for 21 and 28 days under refrigerated condition.

Fish fingers were prepared using Pink perch (*Nemipterus japonicus*), a low value marine fish. The recipe was standardized by changing proportions of fish-meat: potato-starch along with spices and additives. The sizes of the fingers, battering medium and frying time were also optimized. After frying in the oil, the fish fingers were subjected to bio-chemical, microbial and organoleptic evaluation. The results revealed that fish fingers prepared with 70:30 proportion of fish meat : potato starch and battered with 25% Bengalgram slurry gave a product of highest acceptability for the finger size of 60 × 10 × 10 mm.

Portable FRP silos for hi-tech aquaculture: The FRP silo for fish culture/holding system, which is first of its kind in the country, was designed and fabricated at CIFA, Bhubaneswar. Experiments were conducted in the silos with IMC *Labeo rohita* with 3, 6 and 9 m³ water volumes and 0.8, 1.6 and 2.4 m water depths, respectively and stocking density of 3 kg/m³. Provision of pellet feed, water recycling through the biological filter and supplementary oxygen injection was made. Fish survival was higher in silos having water depth 0.9 m, followed by 1.8 m and 2.7 m. The silos with water depth 2.7 m have higher mortality due to lower dissolved oxygen concentration. The average survival was 94 and 88% for silos having water depths of 0.9 m and 1.8 m. The average fish growth was in the range of 478–523 g in 71 days during winters of 2007–08 and 442–466 g in 30 days in 2009 from average initial weight of 410 g.

Cotton bale manager software: A software called Cotton Bale Manager was developed to perform design and generation of bale identification tag and to interface this bale tag with the bale database management software. It was designed to generate a unique bar-coded customized label for each individual bale, integrated with bale information including the fibre properties. Each bale label includes information on the factory name, the press mark number, year of production, bar-coded bale ID and barcode.

Another software for managing a modern ginnery, namely GINERP was developed by CIRCOT in association with M/s SSPS, Hyderabad wherein bar-coding has been included as a bale management module. This software has already been commercialized.

Axial flow cotton pre-cleaner: A seed cotton pre-cleaner based on axial flow principle was designed and fabricated. This single cylinder axial flow pre-cleaner of 1,200 mm cylinder length has



CIRCOT axial flow cotton pre-cleaner

the capacity to clean 7–10 quintals of seed cotton/hr. For controlled feeding of seed cotton, a feeder assembly is also incorporated. The pre-cleaner is capable of removing effectively trash particles like leaves, bracts, *kawdi*, etc. and bring about significant improvement in the colour grade of cotton without any adverse impact on the fibre quality attributes. The cleaning efficiency of the machine was noted to be 25–30% and found to reduce the trash content in seed cotton by up to 1.5%.

Natural-synthetic composite geotextiles for protection of river-bank: Looking into the perennial problem and non-availability of indigenously produced geotextiles for specific use, a set of novel geotextile fabrics using jute/jute-coir blended yarn and polyolefin tape yarn were developed. The geotextile samples contain more than 60% (wt/wt) natural fibre. The production viability of the developed geotextiles was tested through continuous production of the geotextile fabrics using commercial-scale machines. The performance of the fabric samples was evaluated following ASTM standard test methods. The blended fabrics having much balanced property parameters are durable, more effective than both 100% natural and 100% synthetic fabrics and much cheaper than 100% imported synthetic geotextile fabrics. A successful field trial was conducted for protection of a part of the bank of Mayurakshi River (rainfed) at West Bengal using the developed geotextiles based on the principle of using geotextiles as reinforcing material for stable grass-turfing.

A total shower (till laying of geotextiles) during monsoon as recorded nearly 140 cm and then at the end of full monsoon period, even after release

of stored water from Tilpara barrage @ 125,000 cusec (plus additional 40,000 cusec from local catchments due to a spell of spear-headed shower for continuously 3 days during the same period), no change (deformation), and zero erosion of the part of the river-bank under trial was observed. While, on the rest of the part (where geotextile was not used), signs of major soil erosion including rain-cuts (no. of rain-cut – 64/100 m length of river-bank) were clearly visible. It was also observed that Durba grass has been grown extensively in the more or less same extent on the geotextiles of all the combinations.

Knitted warm garments from jute-based spun-wrapped yarn

Jute (100%) and jute-polyester (75:25) blended core and textured polyester multifilament cover spun-wrapped yarns were developed using existing jute spinning machines. The spun-wrapped yarns so produced show a reduction in hairiness up to 86.1%, improvement in specific work of rupture up to 9.8% and specific flexural rigidity up to 23.6% over ordinary jute or jute-polyester blended yarn. The knitted swatch produced out of these spun-wrapped yarn using 7-gauge and 9-gauge needle in both single jersey and double jersey knitting machines showed very good dimensional stability even after 3 washing. The 2-ply and 3-ply yarn produced from single spun-wrapped yarn can be easily used in knitting machines and also in hand-knitting for the production of sweaters. The thermal insulation value of the sweaters



Machine knit sweaters

produced from spun-wrapped yarn is comparable with thermal insulation value of sweaters made from 100% acrylic and 100% wool.

Chemical-free hand made paper from date-palm fibre: The total domestic demand for paper in India is 7.2 million tonnes, whereas production is only 6.7 million tonnes. At present gap between consumption and production is 0.5 million tonnes. The paper industry has turned to fast growing wood species, alternative non-wood fibres like datepalm leaf fibre for paper production by mechanical pulping process is felt necessary. The process is economic and eco-friendly. NIRJAFT

has developed the new technology on development of pulp and paper by mechanical pulping process (chemical free) from datepalm leaf and different products, viz file-cover, carry bag, writing pad etc. The technology can be transferred to rural sectors at low capital investment.

Jute: Jute is normally retted in ditches/ponds/channels under muddy/repeatedly charged water which often reduces colour and luster of the fibres and also incurs sizeable cost in carrying the material from the field to the retting spot. *In-situ* retting in polyethylene sheet lined micro pond was successfully done with less water (groundwater, 1:1, v/v) to get good quality fibre and the technique will be of immense help to jute farmers under drought condition.

Computerized system for analyzing jute yarn linear density: Under Windows XP operating system, GUI (graphical user interface)-based software was developed that captures data required for evaluation of yarn linear density from digital balance. It has the flexibility in capturing data from a wide range of balances with maximum capacity of 10 kg and readability range from 0.1 to 0.0000001. A module has been incorporated to the software that determines the linear density of yarn under 10 textile unit systems, including Jute, Tex (SI), Denier, Dtex, Ctex, Metric, Cotton (British), Worsted, Woolen (Skein) and linen with jute being the default system. Four options were provided for selection of units of length (viz yards, meter, cm and inch). Flexibility of changing the number, size and unit of cut length has been provided. A special computing facility for jute yarn was provided to obtain quality ratio, twist and/or twist factor and moisture adjusted results. A special module has been integrated to determine the minimum number of tests required to obtain the linear density within prefixed error level.

Blanket from jute and polyester hollow fibre: Jute and polyester fibres were blended and converted to yarn. From tensile tests the 80:20 jute/hollow polyester blended yarn was found to have more uniform trends in case of breaking tenacity, breaking strain and energy at break. The yarns were woven into blanket on handloom, trimmed and borders covered and stitched with satin cloth. It was observed that with the increase of hollow polyester in the blend fabric weight (FW) and TD increased, while blanket fabric thickness (BFT) decreased. Thermal insulation value (TIV) of the developed jute-hollow polyester blended raised blankets are higher than commercial woolen, but lower than that of commercial acrylic blankets. The dermal toxicity and comfort test of the developed blankets samples proved these to be non-allergenic to the sample population. Thus the jute-polyester fibre blended blanket provides

a novel alternative use of jute, which is also quite economic to commercially available all wool or all synthetic blankets.

Modified flush door shutter solid core type: Jute stick particle boards, bonded with phenol formaldehyde (PF) resin, were developed first in laboratory and then manufactured in an industry (viz Corst Compostie, Baharampur, Murshidabad, West Bengal) on commercial trial basis in a study jointly conducted by NIRJAFT, Kolkata and IPIRTI, Kolkata. Solid core type flush doors were prepared by assembling the jute stick particle board and resin impregnated non-woven jute felt in a wooden frame. The boards were found to be boiling water resistant and having medium density with good mechanical properties. Modified flush door shutters thus made in conformity with IS: 2202 (Part-I), 1999. This is an environment-friendly technology, which can save wood by replacing it with jute in manufacturing of flush doors.

Suitable lac insect-host plant combinations: Screening of 5 kusmi lac insect stocks, viz. kusmi crimson early, kusmi yellow, kusmi crimson late and 2 productive breeds, namely Kulajanga and Nawadih was carried out to identify the most suitable lac insect-host plant combination for sustained lac production. Lac encrustation did not detach from the stem thus ensuring quantity and quality of the broodlac produced. The mean (2 years) sticklac yield/m was 72.5 g in case of kusmi early stock compared to other stocks (55.2 – 58.4 g/m). The mean (2 years) sticklac yield/m was 96.8 g in case of kusmi late stock compared to other stocks (44.6–79.9 g/m).

Lac-based formulation (fresh coat) technology for fruit coating application at commercial plants: A lac-based formulation was developed for fruit coating applications on apple and citrus fruits like kinnow and orange. The formulation yielded good results in respect of gloss and firmness to kinnow. To evaluate and assess the performance of fresh coat on kinnow fruit at commercial level, about 40 litres of the formulation was tried at 7 kinnow waxing and grading plants at Abohar (Punjab). Approximately 83 tonnes of kinnow fruits were coated with the above formulation. There are 17 kinnow waxing and grading plants at Abohar



Kinnow coating in industry



Lac-coated kinnow

in Punjab, and they use commercial formulations such as NU Coat Flo, Citrashine, Stay fresh 451 and Stayfresh high shine for coating kinnow fruits. Chemical fungicides are added to control post harvest diseases in stored kinnow fruits. Application of fresh coat produced better results in respect of gloss, spread area and firmness to the fruits as compared to commercial wax. Other advantages of lac-based formulation over the available commercial ones observed are: it is natural, non-toxic and composition of lac-based formulation is well specified, no fungicide addition is required since lac has inherent property of antifungal properties, lac-based formulation does not produce any obnoxious smell during waxing operation, it is water-based and thus making the plant more versatile.

Aleuritic acid (technical grade) in pilot plant:

Aleuritic acid is isolated from seedlac by saponification and several separation and filtration steps. There is a continuous growing demand of aleuritic acid in the field of perfumery and pharmaceuticals due to it being an excellent starting material for the synthesis of civetone, ambrettolide, isoambrettolide etc., which have musk like fragrance. A pilot plant of aleuritic acid was installed for providing training and demonstration and can produce 2 kg of technical grade aleuritic acid/batch from seedlac. Aleuritic acid (technical grade) was successfully produced in the plant with a yield of approximately 19% of the weight of fresh seedlac. The melting point and acid value of aleuritic acid was found to be 93–94°C and 178.6, respectively and its purity was around 96.5% (based on acid value).

Mango: At IIHR, Bangalore, carbonated beverages were prepared from mango, passion fruit and custard-apple. Fortification of beverage was done in mango with *aonla* antioxidants. Addition of ascorbic acid at 1,500–2,000 ppm during extraction of pulp from custard-apple, packaging the pulp in polyethylene bags and storage under frozen conditions at –18°C was found useful to prevent browning during frozen storage.

Storage life of mango could be extended to 5 weeks by MA-packing in micro-perforated D-955 film and storing at 8°C. Exposing mature fruits of sapota (Cricket Ball) to 500 ppb 1-MCP for 18 hr delayed ripening-rate and extended shelf-life to 12 days at RT (22–30°C).

At CISH, Lucknow, hot water treatment at 52 ± 1°C combined with Prochloraz (0.1%) for 10 min. was found effective for managing the post-harvest anthracnose up to 8 days at ambient conditions and up to only 3 weeks at low temperature (12 ± 1°C) storage of fruits.

Litchi: At NRC on Litchi, Muzaffarpur, technique for preparation of litchi nuts was

Shellac-based dental plates

The base plates are plastic compositions comprising shellac, fillers and colouring matter. The base plates can be easily softened over a flame and modeled to the desired shape. Upon cooling, the base plate retains its shape to form a strong and dimensionally stable intermediate base for the prosthesis. The plates were molded and tested through a firm in Delhi and 23 like heat stability, colour stability, solubility, resistance to climate changes, strength, softening, mould ability etc. were carried out and found to be highly satisfactory.

standardized. It was found that fruits treated with KMS (0.1%), followed by citric acid (2%) and dried alternatively in sun-oven-sun for different periods gave quality litchi nuts.

Sapota: Mature sapota fruits (Cricket Ball) exposed to 50 ppm ethylene gas (liberated from ethrel solution) for 18 hr could be ripen uniformly in 5 days at RT (21–26°C) compared to 8 days in non-treated fruits.

Papaya: Papaya fruits (Taiwan Red Lady) exposed to 50 ppm ethylene gas in the ripening chamber for 18 hr could be ripen, with uniform colour and firmness, in 4 days at RT (26–32°C) and 7 days at 20°C at IIHR, Bengaluru.

Citrus: At NRC Citrus, Nagpur, for dried juice powder of citrus fruits, fresh fruits of 4 citrus species, namely *Citrus medica* L (Citron), *C. aurantifolia* (acid lime), *C. reticulata* Blanco (Nagpur mandarin) and *C. sinensis* (Mosambi) as well as juice blend of pummelo and citron fruits were utilized to manufacture the value-added products by mixing the encapsulating agents in filtered extracted juice, followed by homogenization. The spray dried juice powder recovery was of 13.51, 11.17, 10.49, 9.52 and 9.60%, respectively, in Citron, acid lime, blended juice (high acidic) as well as Nagpur mandarin and Mosambi juice (low acidic), showing higher powder recovery in high acidic fruits than low acidic fruits. The flavour, colour, aroma and TSS content of juice powder (rehydrated) were similar to natural juices in all citrus cultivars. However, vitamin C content of fresh juice reduced in juice powder. The powder particle size was recorded to vary from 0.33 to 0.77 micron in all citrus cultivars. The colour (a/b ratio) of Nagpur mandarin juice of fine powder was found to be slightly higher than that of juice, while trend was reverse in Mosambi juice. However, not much changes were observed for acidity and limonin content both in fresh juice and powder of all citrus species. Production cost of citron juice powder was cheaper (Rs 175/kg) than that of remaining citrus species.

juice powder. Thus, powder of citrus species manufactured were of free flowing and good for different juice beverage preparation, ensuring the viability of processing industry in the country.

Black pepper: Black pepper samples stored with a moisture content of 10% under controlled atmosphere (90% nitrogen + 10% oxygen) for 480 days did not show significant variation in essential oil, oleoresin and piperine contents compared to the control.

Turmeric: Turmeric samples stored with a moisture content of 10% under controlled atmosphere (90% nitrogen + 10% oxygen) for 480 days showed minimal variation in essential oil and no variation in oleoresin and curcumin contents compared to the control. Processing with or without boiling or different drying methods did not lead to variation in oil, oleoresin and curcumin contents.

Ginger: Comparison of essential oil constituents of fresh and dry ginger rhizomes indicated that fresh rhizomes contained higher level of monoterpenes, namely, *Z*-citral and *E*-citral, whereas dry rhizomes were predominated by zingiberene, farnesene and sesquiphellandrene.

Cinnamon: The GC-MS analysis of chemical constituents of essential oils in leaves of *Cinnamomum sulphuratum*, *C. glaucescens*, *C. glanduliferum*, *C. macrocarpum* and *C. perrottetti* revealed that major chemical constituents in these oils were β -phellandrene, α -phellandrene, camphor, *t*-caryophyllene and *germacrene-D*, respectively.

Tuber crops: Production of cassava-cereal flour extrudates was perfected. Extrudates were prepared from cassava blended with corn flour, *maida*, wheat flour and finger-millet and nutrition facts determined and extrudates were also made from *Amorphophallus* flour and blends of cassava with cotton seed cake. High protein and dietary fibre enriched pasta were prepared from cassava-*maida* blends and their nutritional, functional and textural properties were studied. The protein content could be enhanced to 11–12% with whey protein concentrate, defatted soy flour and prawn paste. Starch-based adhesive for special bonding applications was upscaled to 5 kg level and is ready for transfer. The solid adhesive was tested on various surfaces by M/s Swarup Industries, Ernakulam, Kerala. In simultaneous saccharification and fermentation processes for bio-ethanol production from sweet potato starch at 40–50°C, 2 thermo-tolerant putative *Saccharomyces cerevisiae* strains (T1 and T3) were isolated which is necessary to mediate the process at high temperature.

Patent filed on aloin: A process patent (No. 1261/MUM/2008) has been filed by DMAPR at Indian Patent Office, Mumbai, for preparation of pure

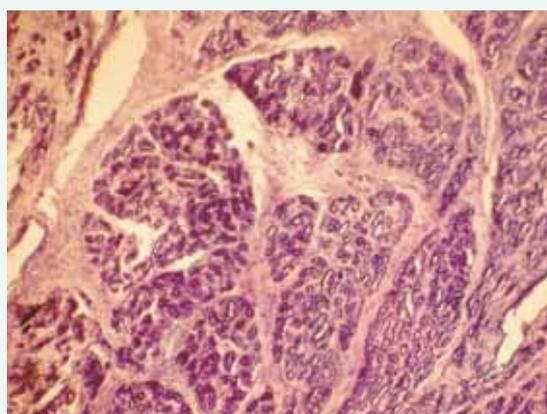
Cow ghee confers protection against mammary gland carcinogenesis

Health benefits of cow ghee were validated. Cow ghee decreases initiation and progression of mammary and gastro intestinal tract cancer in rats. The tumour latency period was greater in rats fed on cow ghee (27 weeks) than on soybean oil diet (23 weeks). The tumor incidence and tumour volume and tumour weight were considerably higher in animals on soybean oil (65.4%) than on cow ghee diet (26.6%). No adenocarcinoma was observed in cow ghee group, while 8% of tumours in soybean oil group were adenocarcinoma.



Rat fed with soybean oil diet showing large tumour

Rat fed with cow ghee diet showing small tumour



Mammary fibroadenoma tumour showing high amount of fibrous tissue

aloin from aloe (*Aloe barbadensis*) through extraction and purification. Aloin (aloin A) is the major active principle in aloe. It is a pharmaceutically important compound and utilized for production of various drug intermediary compounds. The new method is easy to perform and can be used for extraction of aloin of high quality from fresh, sun-dried, oven-dried or freeze-dried leaf exudates. The method is also quicker, efficient (recovery up to 90%) and cost-effective (most of the solvent used can be recovered for reuse). Aloin purity of more than 90–95% can be achieved by this method, hence, suitable for industrial purposes.

Mithun milk proteins

Per cent contribution of different casein fractions in mithun milk was studied. It revealed that β -casein was the highest (71.97%), followed by κ -casein (16.27). The per cent contribution of α -casein (α s1-casein and α s2-casein) was the lowest.

Distribution of casein fractions in whole casein of mithun milk

Casein fractions	Per cent contribution
α -casein	11.18 \pm 0.47
(i) α s1-casein	4.32 \pm 0.21
(ii) α s2-casein	7.45 \pm 0.37
κ -casein	16.27 \pm 0.99
β -casein	71.97 \pm 0.41%

Mithun leather

Mithun leather showed more properties of acceptance than cattle leather considering the following users' aspects apart from their superior physical and chemical properties to cattle leather.

1. Hide processed with intact hair has been a stuff of excellence having good usability as exotic outer cover for sofa.
2. Bag leather produced with mithun hide is very good as compared with conventional leathers produced from cow hides. It is soft and having much better body and roundness.
3. Shoe upper leather is also better not the least comparable with wares made from conventional cow hides.
4. Garment leather is also exclusively soft and can be an optimal substitute for the conventional leathers.

Orchid: Twelve hybrids of *Cymbidium* and 4 species of orchids were evaluated for their vase-life. Out of 4 stages, 75% opened flowers recorded highest vase-life with 8 HQS (200 ppm) *Cymbidium* hybrid Red Princess. In *Dendrobium* Hyb. Thongchai Gold, that opened flower contains 29%, half opened flower 28.25% and buds 16.17% of reducing sugars.

Microbial assay for detection of β -lactam group: A real time microbial assay was developed. A comparison of the intensity of the test reaction with that of a control was taken as criteria to determine whether the sample is positive or negative (Patent Regd. #IPR/4.14.1/08073). The assay can detect specifically β -lactam groups in spiked milk within 15–20 min. at regulatory codex limits with negligible sensitivity towards non β -lactam groups. The presence of inhibitors other than antibiotic residues in milk did not interfere with the working principle of microbial assays. The microbial assay-I (Rs 45/test) and assay-II (Rs 20.54/test) are cost effective. Both microbial assays can find immense application in dairy industry as "on Farm" milk screening test for β -lactam group.

Goat products: Processing, techniques for manufacture of value-added products from spent goat meat were developed. Recipes, viz pickles, sausages, cubes, *shami kebabs*, *samosas*, patties, roll slices, cutlets, croquettes, meat balls, warm and serve meat curries and chevonetles were developed and standardized. The quality attributes of value-added meat products and their shelf-life were evaluated. Processing techniques for preparation of paneer, using different coagulants were developed and standardized.

Yak milk paneer: Standardized processing technologies for the preparation of yak milk paneer, low fat paneer, *churpi*, *churkam*, enrobed paneer

fingers, dahi, ghee, vegetable extended paneer and whey beverage were developed.

Products from camel milk: In pursuits of transforming camel into a milch animal there had been continuous efforts in terms of selling camel milk as health drink and value-added camel milk products like flavoured milk, tea, coffee and *kulfi*. *Gulab-jamun*, a new value-added product, was developed from camel milk.

Electrical stunning effect on fillet quality: Electrical stunning had no adverse effect on the quality characteristics of marinated fillets with added advantage of addressing poultry welfare concern during dressing of chickens. Likewise, chill-aged (5°C; 24 hr) deboning of fillets offered no real advantage in terms of yield, quality and storage stability of marinated fillets, except for relatively lower shear value over those deboned 4 hr post-mortem. The products remain microbiologically safe and acceptable up to 9 and 60 days of refrigerated (5 \pm 1°C) and frozen (18°C) storage, respectively.

Functional chicken scroll: Chicken scrolls processed with larger size (8 \pm 1 cm) breast/drumsticks meat portions, marinated for 16 hr and oven-cooked were significantly superior. Optimization of suitable level of oat flour and sprouted moong suggested that 20% supplementary levels of either item as natural source of beta glucan/tocopherols rendered good quality product. Similarly, incorporation of 10% *jawar* (white millet/sorghum) or 20% *bajra* (black millet) yielded better quality chicken scrolls. Use of 10% sprouted Bengalgram (another natural source of tocopherols) was also suitable for preparing this product. Sprouted moong was more cost-effective than sprouted Bengalgram for preparing chicken scroll.

Chicken nuggets: An economic formulation containing about 60% chicken meat for preparing

chicken nuggets at pilot scale was optimized for efficient utilization of culled layers and meat-type parent stock. Chicken nuggets can be safely stored for 4, 20 and 75 days under ambient (25°C), refrigeration (4°C) and frozen (-18°C) conditions, respectively. The retail price of chicken nuggets can be Rs 127/kg with a marketing cost of 20% and gross profit of 25%. The processor can earn Rs 2,780/day with an initial investment of about Rs 6 lakh.

Value-added egg product: Process of preparing egg quiches was standardized. Egg quiches prepared with 70% liquid whole egg and 15%

chicken meat sausage, among other ingredients, were most acceptable and had a refrigerated shelf-life of 10 days in vacuum and 8 days in aerobic packaging with acceptable sensory and satisfactory microbiological quality. The cost of formulating 1 kg of cooked egg quiches was estimated as Rs 104.7 and that of one egg quiche weighing about 80 g was Rs 8.4.

Hides and wool: Value-added caps were prepared from yak hair by mixing 50% and 25% levels each of sheep wool and angora rabbit wool fibres.

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