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COCONUT PRODUCTS AND THEIR DIVERSIFICATION INDIAN EXPERIENCE

By

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INTRODUCTION

The primary processing of coconut products is a popular activity in the major coconut growing states of India. Traditionally, coconut is processed at the farm level for conversion into copra and for the extraction of coir fibre. This activity has promoted oil milling and coir processing which are, presently, the most popular coconut based industries in India. In some states, particularly in Kerala, toddy tapping and the production of toddy based alcoholic beverages, vinegar, jaggery etc. are also important activities with significant contribution to the annual income of the concerned states. Apart from the traditional utilisation of coconut palm products, product diversification and by-product utilisation have not received the required fillip in the past in the absence of appropriate R and D support. The importance of developing viable technologies for the efficient utilisation of all the products of the palm both at the primary and secondary stages, has received recognition only for a short period during the early sixties and, subsequently, during the eighties after the Coconut Development Board was established. The recent achievements made in the development of appropriate technologies which have proved to be technically and economically viable related to the production of milk/cream, edible flour, water based beverages and other miscellaneous food and non food products.

Coconut Milk.

The technology for the production and preservation of coconut milk has been perfected by the Regional Research Laboratory (RRL) at Trivandrum after passing through a number of trials. The pared kernels are utilised in the process which are first immersed in hot water for 10 minutes at 75 to 80 °C as a means of microbial control. The temperature is not allowed to exceed 80 °C as higher temperature was found to coagulate the protein which interfered with the extraction process. The kernels are then comminuted to the desired degree of fineness. Different comminution equipments were tried to select the most efficient one which would maximize the release of oil from the oil cells of the kernel tissue. In these trials the hammer mill (3 mm) and the Krauss-Maffei

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disintegrator with 3 mm perforation were found to be equally effective. The hammer mill was, however, suggested for commercial use considering its simple design and indigenous availability. Besides the efficiency of the comminution equipments, other essential requirements for achieving maximum yield of milk were found to be optimum maturity of nut and the moisture content of the original gratings. The optimum maturity of nut was found to be 11 to 12 months old. Similarly, the gratings shall have a moisture content of 40 to 45 percent for facilitating efficient extraction of milk. This implies that over matured nuts with less moisture content in the gratings may, perhaps, require sprinkling of water on the gratings to maintain the moisture level within the optimum range at the time of extraction.

For the extraction of milk, pressure is applied on the comminuted kernel with or without the addition of water. Addition of water has not been found essential for the extraction of milk. The extraction equipments tried for assessing comparative efficiency were simple dewatering screw press, batch type hydraulic press and Krauss-Maffei screw press. The screw press of Krauss-Maffei design was finally selected for its efficiency and continuous operation. The combination of hammer mill and Krauss-Maffei screw press have given 66 to 67 percent milk yield on the weight of wet kernel used. It was also found that the milk yield of 66 to 67 percent could be further improved to the level of 75 percent by introducing slight modifications in the screw design and application of back pressure. After the milk is extracted, it is passed through a vibratory seive of 150 microns inorder to ensure that the milk finally contained not more than 0.5 percent of the finely grated fibrous material derived from the pared kernel. The next step in the processing is pasteurization of the milk. The protein in the milk is highly heat susceptible at a temperature above 80 °C. Excess heating has been found to coagulate the protein which gets deposited on the surface of the pasteurization equipment preventing heat transfer. From the trials, the optimum temperature range for pasteurization was found to be 75 to 80 °C extending to 10 minutes. The use of a plate heat exchanger designed for medium viscocity products with slight modification was found to be more efficient than steam kettle for pasteurizing the milk within the desired temperature range and time limit. As an adjunct to heat treatment, various preservatives were tried inorder to enhance the shelflife of coconut milk at room temperature. While K M S was found to be effective, it was considered more appropriate to use the antibiotic nicine.

After pasteurization, stabilizers and emulsifiers are added to the milk for preventing the separation of the milk and for facilitating emulsion formation. From the trials with various stabilizers and emulsifiers, carboxymethyl cellulose (C M C) and guar gum were found to be good stabilizers. Among the emulsifiers tried, Tween-80 was found to be the best. Tween-80 at 0.1 and 0.2 percent levels was found to be satisfactory in the presence of 0.5 percent C M C. The pasteurized milk is passed through a colloid mill and pressure homogenizer. The colloid mill helps in the dispersal of the coagulam formed during the pasteurization and in the even distribution of the added stabilizers and emulsifiers. Pressure homogenization at 4,000 psi has been found to impart better stability to the furnished product. More number of passes and high pressure were found to destablize the emulsion and enhance the viscocity. The sequence and stage of additive addition, pressure and temperature were other important factors which affected the stability of the emulsion. Subsequent trials in pressure homogenization have, however, given better results when two stage homogenization was adopted. Stability studies of coconut milk using pressure homogenization technique are being continued to optimise the pressure and temperature requirements for the production of quality product. Hot filling and crown corking are presently followed for convenience. Other packing systems like flexible packing and canning will be employed at later stages. The analytical data of the coconut milk produced in India are shown in Table 1.

Table 1. Analytical data of coconut milk*

Characteristic/composition	Appearance/Value
Colour	White
Texture	Smooth
Flavour	Coconut
Appearance	Homogeneous
Consistency	Creamy
Fat globules	Uniform
Total Solids	37 percent
Solids non-fat (S N F)	12 percent
Fat	26 percent
Protein	4.5 percent
Sugars	5.5 percent
Minerals	1.8 percent
Added gums	0.4 percent

* Arumughan, C. et al; 1987

Edible Flour

Partially defatted edible coconut gratings is an excellent product which can find use in the preparation of household foods, bakery and confectionary articles and also in the nutrition feeding programme in schools. The method developed by the Regional Research Laboratory at Trivandrum involves disintegration of pared kernel, rapid drying or desiccation of the kernel gratings and hydraulic pressing for extraction of oil. The pared meat is first cut into pieces followed by fresh water washing. The washed pieces are soaked in hot water at 80 °C for 10 to 15 minutes to reduce the microbial load and also to inactivate enzymes. The water is then completely drained and the kernel pieces are comminuted into fine gratings using a pin mill. The wet gratings are dried using a flow type drier at a temperature range of 60 to 70 °C until the final moisture content is reduced to around three percent. The dried gratings are charged into a perforated S.S. cage and pressure is applied from the top using a down stroke hydraulic press till the desired level of oil has been expelled. The oil is stored for 10 to 12 hours and filtered using a filter press in the presence of 0.1 % super cell as filter aid. The partially defatted gratings are removed and powdered using a cake breaker. The powder is further dried in an electrical drier to a moisture content of about two to three percent. The fat content of the final flour is adjusted to 40 to 45 percent. The shelf life of the product stored in sealed aluminum foil pouches is 4 to 6 months at ambient temperature and more than one year under refrigerated conditions. The by-product of the process is paring, constituting about 12 to 15 percent of the weight of the fresh meat used for processing. It has an oil content of 60 percent on dry weight basis of which about 90 percent could be recovered as commercial grade coconut oil.

The process has been standardised to produce products of different oil contents tailored to specific end uses. Because of the low content of fat and higher percentages of proteins, sugars and minerals, the flour has been found to possess better water holding and thickening properties. The oil recovered from the dried gratings being of superior quality could command premium price for special applications in both edible and inedible sectors.

Consumer acceptability studies have shown that the flour derived after removing up to 60 percent of the oil from the dried gratings was suitable for household culinary uses. The composition of a typical partially defatted coconut flour is given in Table 2.

Table 2. Composition of coconut flour and desiccated coconut* (In Percentage)

Constituent	Coconut flour	Desiccated coconut
Moisture	3.83	1.70
Fat	41.43	70.05
Protein	17.32	8.30
Crude fibre	7.00	4.65
Ash	3.26	1.62
Total carbohydrates by difference	27.16	13.69

* Satyavati Krishnankutty, 1987.

Coconut Water Beverage

The process developed for the formulation of non-carbonated beverage from coconut water of mature nuts involves collection of water, upgradation and pasteurization, filtration and bottling. The coconut water is usually collected from copra processing units and immediately filtered through a clean cheese cloth. Quality of the final product depends on the collection of water from good unspoiled nuts under hygienic conditions. Initial filtration at the collection centres reduces the bacterial load in the water. On arrival at the processing site the P H of the water is adjusted to 4.5 or less and the total soluble solids content to 8 to 10 percent, inorder to upgrade the flavour of ripe coconut water to the level of tender coconut water. The acidulent used to adjust the P H is citric acid plus 0.1 to 0.15 percent sodium citrate. The addition of sodium citrate has been found useful in minimising the biting taste that may develop with the addition of citric acid to the required level. In some formulations the use of 0.01 to 0.05 percent sodium chloride was found useful in improving the taste. The formulation is immediately pasteurized and the temperature maintained at around 94 °C for about 25 to 30 minutes. The protein in the coconut water starts coagulating at 70 °C and at this stage super cell is added to aid sedimentation by co-precipitation. Rigorous agitation of the formulation is avoided to prevent disintegration of the protein coagulum into fine particles. Excessive heat treatment is also avoided as it imparts a cooked flavour to the finished product which would be very unwelcome.

During pasteurization, precipitation of protein etc. occurs and, hence, filtration has been found essential to obtain a clear product free from turbidity. Centrifugation was tried but in that process seepage of unfiltered water containing super cell and protein particles and temperature drop to 90 °C because of excessive aeration were the problems encountered with. Consequently, the filtration is now done under vacuum. The filtered product is filled in sterilized returnable bottles and crown corked under sterile conditions. The final temperature of the processed coconut water in the bottle after filling ranged from 72 to 75 °C. The pasteurization and other hygenic measures adopted during the processing have been found adequate to maintain a good microbiological standard for the product. Bottled coconut water incubated at 37 and 55 °C has not developed any turbidity or gass formation. The bottles could be stored at ambient condition for three months without spoilage. Test marketing of the product done at different cities in south India has revealed encouraging consumer response with an acceptability range of 80.9 percent to 95.5 percent.

Processing technology has been standardised for the preservation of tender coconut water also obtained from seven to eight months old tender coconuts. Canned water has a good shelf life at ambient temperature and is microbiologically safe for over nine months. Bottled tender coconut water after upgradation also keeps well at ambient temperature. In the processing with tender coconut water the precipitation during pasteurization is very less and it has been found possible to obtain a clear product even without filtration. The composition of mature coconut water and tender coconut water in their natural state is given in Table 3.

Table 3. Composition of mature coconut water and tender coconut water.*

Characteristic	Mature coconut water	Tender coconut water
Total soluble solids (T S S)° Brix	4.00 - 5.00	5.50 - 6.20
Titrable acidity (as % citric acid)	0.05 - 0.90	0.10 - 0.13
P H	5.10 - 5.80	4.60 - 5.10
Reducing sugars %	0.60 - 0.82	2.22 - 2.85
Total sugars %	1.90 - 2.70	3.50 - 4.25

* Satyavati Krishnankutty, 1987.

In order to overcome the problem of long distance transport of coconut water in bulk either in the natural or processed state, technology is being standardised for the concentration of coconut water by reverse osmosis. This method is tried for facilitating the easy availability of coconut water as a natural drink after dilution to the desired strength or as a base for reconstitution into beverages. The Defence Research Laboratory at Mysore has produced concentrated coconut water by reverse osmosis and work is still being continued to standardise the technology for the production of a product possessing good organoleptic quality and storage stability.

Other Edible Products

The soft kernel of seven to eight months old tender coconut and the haustorium from germinating nuts have been successfully canned in syrup by the R R L at Trivandrum. In the case of tender nuts the optimum maturity was found to be less than eight months for extracting the kernel of desired consistency. The kernel of six months old nut was in a fluid stage whereas the kernel of nine months old nut was hard and more prone to rancidity. The tender kernel of seven to eight months old nut is cut into stripes of about 6 cm length and 2 cm width. The kernel stripes are put into cans, covered with hot syrup, exhausted to can centre temperature of 80 °C, sealed and processed. The product has a shelf life of four to six months at ambient temperature and has been found to be microbiologically safe even after one year. With the use of strong syrup and additives, the haustorium could be successfully canned. The product was found to have a shelf life of four to six months and was microbiologically safe for one year.

Miscellaneous products

Apart from promoting diversified uses of coconut kernel, coconut water etc. studies were conducted for the economic utilisation of other palm products particularly the leaves, shell, wood, coir pith etc. The R R L has standardised a low cost technology for extending the longevity of coconut leaf thatch from the normal one year period to four years. The technology consists of antifungal treatment by dipping the plaited coconut leaves in copper sulphate solution followed by a water repellent treatment with cashewnut shell liquid before thatching. Fire retardant for short term and long term uses of coconut leaf thatch and coir and its products has also been developed. The laboratory could establish the feasibility of using coconut pith and shell and their chars as reductants for iron ore and ilmenite and also coconut shell based fuels for low melting alloys and metals.

The Regional Engineering College (R E C) at Calicut has developed a viable technology for using coconut shell either as a structural material or filler material in building construction. The use of coconut shell cellular blocks made up of concrete masonry units in which coconut shells were incorporated was found to result in as much as 30 percent saving in material without loss in strength. Both load bearing and non-load-bearing partition walls could be constructed using shells. Vault shaped dwelling nuts using coconut shell core sandwich panels were also constructed and demonstrated at different locations. The trials on the destructive distillation of coconut shells were carried out in India in as long back as late forties. The process has yielded 30 percent char, 46 percent volatiles comprising pyroligneous acid and tar, 20 percent gas and 4 percent losses. The use of coconut shell for the manufacture of activated carbon is covered by the Indian Patent No: 109082.

Coconut wood has been successfully put to use for the making of solid wood wall panels and parquet flooring. It was observed that the use of carbide-tipped saws and cutters could overcome the less desirable working properties of coconut wood. Carving and fairly intricate turning was also found possible on coconut wood. Another use identified was in the making of tool handles and beautiful curio articles. It was found that coconut wood has very good strength and elasticity and its resilience helps to absorb impact strocks in hammers, tool handles, axes etc. In constructions where sawn wood in unfinished form is used, coconut wood has been found to be the most suitable material cost wise.

A process for the production of a variety of light weight, high strength bricks using coir pith has been standardised. This is done by the partial replacement of clay with the pith. Coconut pith briquettes are now produced on commercial scale in some states in the country. Coconut pith briquettes have a calorific value ranging from 3200 k cals per kg to 4000 k cals per kg as against 3700 k cals to 6000 k cals per kg of coal. However, the ash content is only seven percent maximum as against 34 percent of coal. Coir pith inoculated with Pleurotus sajor caju, edible mushroom, after enriching the medium with the addition of urea has yielded excellent compost which could be used in place of farm yard manure and farm compost for manuring field crops.

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