Value added products from coconut

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Introduction

India is one of the third largest coconut growing nation in the world. In order to develop the products from coconut and to improve the economy of this sector, Coconut Development Board is extending financial assistance for research projects to Central Food Technological Research Institutes (CPCRI) for developing technologies.With the financial support of Coconut Development Board, CFTRI has developed the processes for production of coconut milk products, coconut dietary fiber and virgin coconut oil.

There is an ever-increasing scope for producing diversified products from the by-products of coconut industry. Such products will ensure better prize for the farmer, better products to consumer and more effective cost of production to the industry

Introduction and adoption of modern technologies in coconut processing sector to provide technical impetus for transformation of traditional coconut dependent rural economy into a vibrant commercially viable economy, development of technologies/process for consumer based products from by-products in coconut processing in order to increase the consumption of coconut and exploitation of by-products in coconut processing for production of value-added, shelf-stable, convenient products are the major objectives of the research and development works.

The R&D works done at CFTRI on various products like mature coconut-water concentrate (i.e. coconut honey), tender coconut beverage (i.e. coconut lassi), coconut whey protein from aqueous extract after the recovery of coconut milk, coconut spread based on mature coconut-water concentrate and dietary fiber, coconut soufflé and coconut chutney are initiated and presented in the following sections.

Tender coconut beverage (Coconut lassi)

Coconut beverage is produced mixing the solid white meat and liquid coconut water endosperm from tender coconut. The product is having refreshing and fresh taste of coconut, good shelf life, characteristic coconut flavour and natural electrolytes. There are numerous health benefits of tender coconut water as it is a natural source of minerals, vitamins, complex carbohydrates, amino acids and other nutrients. The natural carbohydrate content is 4-5%, which makes tender coconut water suitable for sports persons.

A homogenized mixture of liquid and solid endosperm of tender coconut forms a beverage. Once it is exposed to air, the mixture rapidly loses most of its organoleptic and nutritional characteristics, and begins to ferment. Since the pH of the mixture was less acidic, hence the product needs to be bottled and sterilized.

The tender coconut water and thin solid endosperm from the tender coconut are together homogenized and the mixture is formulated. The formulated beverage is filtered with cheesecloth, heated and filled in pre-sterilized glass bottles. The bottles are subjected to hot water to expel the air present in the headspace. Further, the bottles are sealed and autoclaved (Raghavendra et al., 2009). The product, with no preservative added during the process, was found to have characteristic taste and aroma of tender coconut. The novelty of the present invention lies in the way of selecting the processing steps, conditions/ parameters and components to obtain a value added product, which is not hitherto available, without loosing the characteristic flavour of tender coconut. The world market for sports beverages is about $1,000 million.

Ratio of tender coconut endosperm to tender coconut water was maintained in order to get very highly acceptable product having characteristic

flavour of tender coconut. The time and temperature of processing was also found to have direct bearing on the quality of the product. The product was having nutritional qualities of both tender coconut water and the solid coconut endosperm as well as taste and aroma of tender coconut water and endosperm was rendered intact. The product was made without altering the pH and without the addition of chemical preservatives.

The product has shown a shelf-life of more than six months when packed in pre-sterilized glass bottles and kept at ambient storage conditions. The physico-chemical and microbial analysis of tender coconut beverage is shown in Table 1. Sensory quality studies of the product were conducted by using Quantitative Descriptive Analysis (QDA) where the attributes were quantified on 15 cm structured scale. The samples were evaluated against fresh sample by trained panel. The attributes considered were whiteness, consistency, coconut like, milky, coconut oil like, fermented, sweet and overall quality. The product prepared was well received by the panel with a high score of 12.1.

Table 1: Physico-chemical and microbial analysis of tender coconut beverage

Parameter	
Moisture, % by weight	82.9
Total ash, % by weight	0.52
Total soluble solids	13°Brix
pH	5.6
Titratable acidity (g/100g)	0.50
Fat, % by weight	0.90
Protein, % by weight	0.50
Crude fiber, % by weight	Below detection limit of 0.2
Carbohydrate (by difference), % by weight	13.74
Calorific value (kCal/100g)	65
Aerobic mesophilic spore formers	Absent
Aerobic thermophilic spore formers	Absent
Anaerobic mesophilic spore formers	Absent
Anaerobic thermophilic spore formers	Absent
Fermentation test	Negative

Mature coconut water concentrate (Coconut honey)

Mature coconut water is procured from desiccated coconut industry filtered and centrifuged to remove suspended solids and fats. Mature coconut water is passed through cationic, anionic and mixed bed resins to remove saltiness caused by the minerals in the final product. The mature coconut water is then subjected to thin film evaporator to achieve the desired concentration. Further sugar is added to increase the concentration level.

Membrane concentration of mature coconut water is also attempted using reverse osmosis using cellulose acetate membrane (membrane area 0.9 m2, pressure 20-40 bar). Further, concentration of coconut water is achieved by thin film evaporator. Since the salt concentration in the concentrate is high, it was not possible to consume mature coconut water concentrate as such and hence diversified products from this concentrate is made. Keeping this in view the mature coconut water concentrate was mixed with various ratios of sugar concentrate and sensory tested for its acceptance.

Mature coconut water concentrate is formulated with sugar solution in increasing proportions, and referred as A, B, C, D and E, respectively. The samples are analyzed sensory using a panel consisting 10 members. The mean scores were plotted in the web plot against different attributes. The sample D and E containing higher proportion of sugar content attained the highest score for overall quality as compared to other samples.

Coconut spread from mature coconut water concentrate

Coconut spread is one of the several important aspects of value addition to the by-products (concentrate from mature coconut water and dietary fiber) generated in the coconut processing industries, besides solving an environmental problem vide the disposal of these by-products. This exotic spread can find extensive utilization in sandwiches, chapatti, dosa or similar breakfast foods to make them more appealing and appetizing. Coconut spread is prepared by partial replacement of sugar with concentrate from mature coconut water along with addition of other ingredients

such as citric acid, pectin and benzoic acid followed by thermal treatment. Addition of coconut dietary fiber, which can be evenly suspended in the spread, provides a characteristic coconut flavor, texture and taste. The high osmotic pressure in the product creates unfavorable conditions for the growth and reproduction of most species of microorganisms like yeast, mold and bacteria responsible for spoilage of food.

The process involved filtration with the help of a muslin cloth of mature coconut water followed by concentration in thin film type of evaporator. The ingredients, sugar, water, pectin solution, xanthan solution, citric acid blended and the mixture is boiled till a moderately viscous and thick mass of desired concentration is achieved. At that time, the concentrated mature coconut water is added to the boiling mixture at the end of processing to the above mixture. Finally, dietary fiber obtained from coconut was added to the above mixture. The dietary fiber was obtained by dehydrating spent grating after extraction of coconut milk, solvent extraction of fat and finally ground to reduce particle size. The spread mixture is added with class II preservative, filled into pre-sterilized glass bottles, capped, cooled and stored at room temperature. The product is characteristic flavour of coconut and is having an expected shelf life of more than six months.

Microbiological analysis indicated the yeast and mould count is zero, whereas mesophilic aerobes count is less. Sensory studies are done with the help of Quantitative Descriptive Analysis (QDA) where the attributes were quantified on 15 cm structured scale. The samples are evaluated against fresh sample by trained panel. The product prepared is well received by the panel and scored high score of 12.0. Sensory studies indicated that the node of taste of coconut was very well noticeable in the product. Further, sensory acceptability of the product was quite high. Spreadability of the product was excellent that was supported by the back extrusion measurements.

The level of replacement of mature coconut water concentrate with sugar was optimized to get very highly acceptable product having characteristic taste and flavor of coconut.

Similarly, the addition of mature coconut water concentrate at an appropriate stage during processing allowing the mature coconut water concentrate to be heated for minimal duration (2-3 minutes), so that the flavour components of mature coconut water remain intact in the final product.

The process provides the value-addition to the by-products, which are currently disposed to environment. In this process only a part of sugar was replaced with concentrated mature coconut water, which resulted in a product having characteristic flavour and taste of coconut. Process is easy to scale up. The product contains dietary fibre from coconut, which has added health benefits. Production of coconut spreads without any artificial flavouring agents has niche market to cater the consumers who prefer least chemical additives.

Coconut soufflé

Coconut soufflé is a light fluffy baked dish.Coconut soufflé is made with butter, egg yolk and white mixed with corn flour, milk, sugar and coconut water. Coconut soufflé can be prepared by two methods such as baking or refrigeration. Production of baked soufflé involve cooking of ingredients like butter, corn flour and milk over hot water until the batter becomes thick and smooth and then stiffly beaten egg yolk is added along with sugar to the batter. The mixture was thoroughly mixed along with egg white and coconut milk and then it is baked. In another approach, coconut soufflé was prepared by mixing the ingredients (cream sugar, egg white and corn flour) with boiled milk and then cooked until the mixture became thick. Sodium alginate, coconut extract, tender coconut water and stiffly beaten egg white were added to this mixture and then it was poured in a mould and refrigerated. Further efforts are in progress to produce ready mix for coconut soufflé.

Coconut chutney from spent coconut gratings

Coconut chutney is a culinary specialty and food adjunct /accompaniment, served along with south Indian dishes. It may be served either as thick coarse paste/slurry/dried. The spent coconut gratings after the extraction of coconut milk is used to make coconut chutney. The ingredients like Bengal gram, green chilly, coriander, ginger, pudina, tamarind, garlic, salt and water are made into paste and then mixed with coconut gratings in required proportions and then the chutney is seasoned and then packed. The dry coconut chutney powder is then sent for sensory and microbiological analysis. Sensory attributes like yellowish brown, fibrous, spicy, coconut like, fresh,

pungency and overall quality are measured in 15 cm web scale. The coconut chutney powder was well received by the panel and scored a high score of 10.0. The pH and moisture content of the ready chutney were 4.5 and 6.2%. The TBA value, which is an indicator of rancidity is found to be low (0.42 mal/kg). Attempts are under progress to produce dried coconut chutney powder with increased shelf life.

Coconut whey proteins

Coconut whey protein is a byproduct of virgin coconut oil industry. The technology for virgin coconut oil was earlier developed at CFTRI. In order to provide value-addition to the protein obtained, the following approaches are adopted.

Membrane processing of coconut whey proteins

Ultrafiltration in combination with spray drying was explored as a method for the production of coconut whey protein powder. The coconut whey was centrifuged to remove fat and then it was subjected to ultrafilteration using membranes of MWCO of 5, 10, 30 and 50 kDa. The retentate and permeate were collected. It was found that MWCO of 5 kDa gave maximum retention of proteins in the retentate (96%). The ultrafiltration was performed in the pressure range of 2 to 10 bar, the separation process occurring across a membrane, which discriminates solute molecules on the basis of their sizes. The retentate collected was then spray dried to get coconut protein powder.

Differential partitioning studies of coconut whey proteins using aqueous two-phase extraction

In aqueous two-phase extraction (ATPE), the purification of most of the proteins is mainly due to the differential partitioning of the target protein to one phase and the contaminant proteins to the other phase. The phase system is dependent upon many factors such as type of aqueous two-phase system, phase forming salt, molecular weight of the phase forming polymer, pH of the system and phase volume ratio.

Selection of type of aqueous two-phase system

In order to know the suitable type of phase (polymer-polymer or polymer-salt), both polymer-polymer and polymer-salt phase systems were prepared using coconut whey. The results indicated that the protein yield was higher in polymer-salt system as compared to that of polymer-polymer system. After selecting the type of phase system (polymer-salt), the next most important step was the selection of type of phase forming salt.

Selection of phase forming salt

In order to identify the suitable salt for the yield of coconut whey protein ATPE experiments were carried out by adding predetermined weighed quantity of different molecular weight PEG and different phase forming salts (ammonium sulphate, magnesium sulphate, sodium sulphate and potassium phosphate) to a given quantity of coconut whey making the total weight of the system 100% on w/w basis. Out of these salts potassium salt has resulted the maximum yield of protein in the bottom phase.

Selection of polymer molecular weight

In order to identify the suitable molecular weight of phase forming polymer for the yield of coconut whey protein, ATPE experiments were carried out by adding predetermined weighed quantity of different molecular weight PEG. The PEG of MW 1000, 4000 and 6000 resulted in protein yield of 82, 92 and 98%, respectively. Hence PEG 6000 was found to be most suitable.

Effect of different tie line length

The effect of tie line length (TLL) was studied on the partition of proteins in the PEG 6000/potassium phosphate phase system. Increase in the yield of protein was increased with an increase in %TLL; a maximum yield of 96% was obtained at a particular high value of TLL. Very high values of TLL resulted in decrease in the yield of proteins.

There are number of areas in coconut research which have not been explored in India. There is a need to further think about the development of diversified products from coconut such as diary whiteners, coconut paneer, nata-de-coco etc. Of course, the coconut research may take vibrant trend with the advent of latest technologies like membrane processing and other techniques. These things are only possible when regulatory and governing agencies come forward to sponsor further research projects in this potential field. It would be very encouraging if the private industries come closer to R&D institutions and work together for development of state of the art technologies and can finance part of the research.

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