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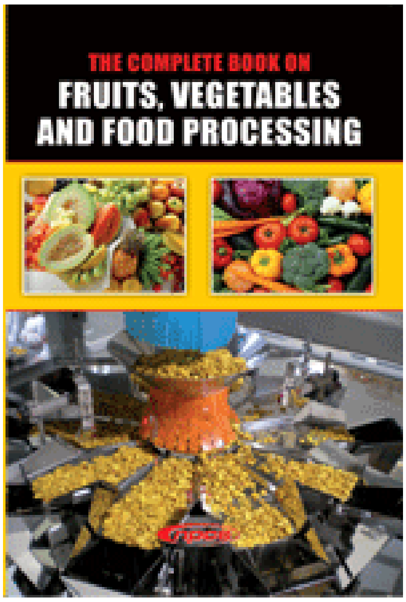
The Complete Book on Fruits, Vegetables and Food Processing



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Food processing is the transformation of raw ingredients into food, or of food into other forms. Food processing typically takes clean, harvested crops or butchered animal products and uses these to produce attractive, marketable and often long shelf-life food products. Benefits of food processing include toxin removal, preservation, easing marketing and distribution tasks, and increasing food consistency. In addition, it increases yearly availability of many foods, enables transportation of delicate perishable foods across long distances and makes many kinds of foods safe to eat by de-activating spoilage and pathogenic micro-organisms. Processed foods are usually less susceptible to early spoilage than fresh foods and are better suited for long distance transportation from the source to the consumer. The extremely varied modern diet is only truly possible on a wide scale because of food processing. Food Dehydration is a method of food preservation that works by removing water from the food, which inhibits the growth of microorganisms. The dehydration process has to check various parameters like heat-mass transfer, atmospheric pressure, equipments suitable for drying etc. to ensure suitable dehydration of food. Food processing techniques have to take measures on to maintain food safety and control risks and hazards associated with food processing.

The book includes dehydration process of Onion, roasting of coffee beans, development process of Guava squash, preparation of fried potato chips, processing of rice, butter and margaraine, canning of chilies Plums, processing and preservation of jack fruit, characteristics of sweetened dahi, cereal grains, instant chutneys from pudina and gongura, starch isolated from potato tubers, coating of cashew kernel baby bits, ripening changes in mango fruits, mechanical and thermal properties of maize, storage of basmati rice under carbon dioxide-rich atmosphere, effect of different varieties of soya bean on quality of paneer, analysis of menthol content in pan masala samples, preparation of dehydrated potato cubes, quality evaluation of raw dried mango slices khatai and mango powder amchur, packaging and storage of biscuits containing finger millet flour, storage effect on microbial safety of potato flour, processing and quality evaluation of ready-to-eat watermelon nectars etc. The book is highly recommended to new entrepreneurs, existing units who wants to get more information of processing of fruits and vegetables.

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Sample Chapter:

Cereal Grains; Legumes and Oilseeds

Cereals are plants which yield edible grains such as wheat, rye, rice, or corn. Cereal grains provide the world with a majority of its food calories and about half of its protein. These grains are consumed directly or in modified form as major items of diet (flour, starch, oil, bran, sugar syrups, and numerous additional ingredients used in the manufacture of other foods), and they are fed to livestock and thereby converted into meat, milk, and eggs.

On a worldwide basis, rice is probably the single most important human food, with wheat not far behind. Nearly all rice grown goes directly to human food. Similar amounts of corn and wheat are grown, but much of the corn is used for feeding livestock, whereas only a small portion of wheat is used in animal feed. Although wheat is produced in many temperate-zone countries, over 90% of the rice is grown in Asia, where most of it is consumed. Much of the world's corn is grown in the United States. In recent years annual world production of wheat, rice, and corn has been about 560, 530, and 470 million metric tons, respectively.

The principal cereal grains grown in the United States are corn, wheat, oats, sorghum, barley, rye, rice, and buckwheat. In the United States, corn is by far the largest cereal crop; in recent years corn production has averaged about 200 million metric tons, but most of it is used for animal feeding. Wheat-with an annual production of about 66 million metric tons-is the largest U.S. cereal crop used primarily for direct human food.

Legumes are flowering plants having pods which contain beans or peas. Oilseeds are seeds which contain a high oil content and are widely grown as a source of oil. Both are considerably higher in protein than are cereal grains (Table 1). Legumes include the various peas and beans, most of which are low in fat, but a notable exception is the soybean. The term oilseed is applied to those seeds, including the soybean, which are processed for their oil. Other oilseeds include the peanut seed, cottonseed, sunflower seed, rapeseed, flaxseed, linseed, and sesame seed. The coconut also is an important oilseed. Cereal grains not only are comparatively low in protein but the proteins have deficiencies in certain essential amino acids, especially lysine. Legumes as well as many oilseeds are rich in lysine, though relatively poor in methionine.

Some oilseeds, such as the soybean, peanut, and coconut, are important foods in addition to being sources of oil. Oilseeds also yield great quantities of oilseed meals; for many years these were used principally to fatten livestock. Modern technology has

Table 1. Protein Content of Vegetable and Animal Products

Vegetable	**Protein (%)**	**Animal**	**Protein (%)**
Cereals	7-15	Whole milk	3.5
Legumes	20-25	Eggs	13
Oilseeds (defatted)	45-55	Meat (Red)	16-22
Concentrates (soy, cottonseed)	60-80	Fish	18-25
		Meat (poultry)	20-25
Isolates (soy, wheat)	90-95	Nonfat dry milk	36

made it possible to separate high quality proteins from these meals, and today, oilseed proteins in their many forms are used to improve the nutritional properties of cereal products, to extend the meat supply, and to generally increase available protein worldwide.

CEREAL GRAINS

General Composition and Structure

The major constituents of the principal cereal grains are listed in Table 2. These grains contain about 10-14% moisture, 58-72% carbohydrate, 8-13% protein, 2-5% fat, and 2-11% indigestible fiber. They also contain about 300-350 kcal/100 g of grain. Although these are typical values, compositions vary depending on varieties of the particular grain, geographical and weather conditions, and other factors.

A moisture content of 10-14% is typical of properly ripened and dried grains. When the moisture content of grains from the field is higher than this, they must be dried to this moisture range, otherwise they may mold and rot in storage before they are further processed. Some molds which grow on cereal grains containing excessive moisture produce toxic metabolites which can cause disease in humans and animals consuming the grain. Cereal grains contain about two-thirds carbohydrate, most of which is in the form of digestible starches and sugars. The operations of milling generally remove much of the indigestible fiber and fat from these grains when they are to be consumed for human food.

The nutritional quality of cereal proteins is not as high as that of most animal proteins. Table 3 lists the patterns of the essential amino acids lysine, methionine (plus cystine), threonine, and tryptophan of several cereals compared with whole egg and an FAO recommended standard mixture of these amino acids. Because the first limiting amino acid of these cereals is lysine, the ratio of the lysine concentration in a cereal grain protein to the concentration in whole egg, or the FAO standard mixture, can be used as an index of quality. This ratio times 100 gives the chemical score of a cereal, which can be improved by the addition of lysine. The lysine limitation also can be overcome by consuming cereals with other foods high in lysine.

There are a few important structural features that the cereal grains have in common and that form the basis for subsequent milling and other processing operations. All of the cereal grains are plant seeds and as such contain a large centrally located starchy endosperm, which also is rich in protein, protective outer layers such as hull and bran, and an embryo or germ usually located near the bottom of the seed.

For most food uses, processors remove the hulls, which are largely indigestible by man; the dark-colored bran; and the germ, which is high in oil, is enzymatically active, and under certain conditions would be likely to produce a rancid condition in the grain. Thus, the component of primary interest is the starchy, proteinaceous endosperm. Since the bran is rich in B vitamins and minerals, it is common practice to add these back to processed grains from which bran has been removed; this is known as enrichment.

Besides indigestibility of hulls, bran color, and possible rancidity from the germ, a further reason for removing these components in many cases is to improve the functional properties of the endosperm in manufactured food use. For example, white bread made from wheat flour would have less acceptable color, flavor, and volume if the bran and germ were not removed before the flour was ground. However, there also are applications in which unmilied whole grain-containing hulls, bran, and germ-is used. Grain for animai feed is an example; sprouted barley,used for its malting effect in the brewing industry, is another example. Whole wheat bread, preferred by many, utilizes flour from which the bran and germ have not been removed during milling.

The processing and utilization of the major cereal grains are discussed in the following sections.

Wheat

As with all cereal grains, there are many varieties of wheat differing in yield, in resistance to weather, insects, and disease, and in composition. Wheats are classified into two types: hard and soft. In comparison with soft wheat, hard wheat is higher in protein, yields a stronger flour, which forms a more elastic dough, and is better for bread-making when a strong elastic dough is essential for high leavened volume. In contrast, soft wheat is lower in protein, yields a weaker flour, which forms weak doughs or batters, and is better for cake-making. Wherever wheat is used for human consumption, the majority of it is first converted to flour.

Conventional Milling

The miller receives the wheat, cleans it of foreign seeds and soil, soaks or conditions the wheat to about 17% moisture to give it optimum milling properties, and then proceeds with the milling.

Milling involves a progressive series of disintegrations followed by sievings. The disintegrations are made by rollers set progressively closer and closer together. The first rollers break open the bran and free the germ from the endosperm. The second and third rollers further pulverize the rather brittle endosperm and flatten out the more semiplastic germ. The flakes of bran and flattened germ are removed by the sieves under these first few sets of rollers. The pulverized endosperm is run through successive rollers set still closer together to grind it into finer and finer flour, which also is sifted under each set of rollers to remove the last traces of bran.

From such an operation several flour fractions having finer and finer endosperm particles are collected. These finer fractions also contain progressively lower and lower amounts of ground up contaminating germ or bran, some of which always gets through the earlier sieves. As a result, as the flour is progressively milled, it becomes whiter in color, better in bread-making quality, but lower in vitamin and mineral content. The starch and protein composition of flour-no matter how fine it is ground in the milling process-depends on the variety and kind of wheat that was ground. Thus, the protein-to-starch ratio of flour made from hard wheat will be greater than that of flour made from soft wheat. The kind of flour that is produced during conventional milling is largely dependent on the kind of wheat available.

Figure (2) is a diagram of two finely milled flours. The endosperm contains both protein (the dask matter) and starch granules (the white matter in this diagram). In addition to the large mixed endosperm agglomerates, there are smaller fragmented starch and protein particles. The fragmented starch and protein particles are too close in size to be further separated from one another by the sieves of the conventional milling operation. If they could be, it would be possible to separate any flour into fractions differing in protein and starch contents. Such a separation could yield both a hard and a soft flour from the same wheat. Further, a naturally hard wheat could be made to yield a soft flour plus a protein fraction, just as a naturally soft wheat could be made to yield a hard flour plus a starch fraction.

Turbomilling and Air Classification

Further processing can separate flour into higher protein or higher starch fractions in a process known as turbomilling. In turbomilling, flour from conventional milling is further reduced in particle size in special high-speed turbo grinders, which cause the endosperm agglomerates to abrade against each other in a high-speed air vortex.

Although the resulting protein and starch particles are too close in size to be separated by sieves, they do differ sufficiently in particle size, shape, and density to be separable in a stream of turbulent air. In this case, the slightly finer protein particles rise and the starch particles settle in the stream of air. The flour and air mixture is blown into a specially designed air classifier, which then may impose centrifugal force on the suspended particles, and two fractions of flour differing in protein and starch concentrations are recovered. Turbomilling, developed in the late 1950s, probably is the greatest milling advance of the past century since it gives us the ability to separate flour into fractions and then blend the fractions in any desired ratio. Thus turbomilling makes it feasible to custom-blend flours for bread-making, cake-making,cookie-making and many other specific applications.

Uses of Wheat Flour and Granules

The uses of wheat flour in the baking industry include the making of breads, sweet doughs, cakes, biscuits, doughnuts, crackers, and the like. Wheat flour is also used in making breakfast cereals, gravies, soups, confections, and other articles. But a principal use of wheat flour, and coarser milled fractions of wheat, is in the preparation of alimentary pastes, such as macaroni, spaghetti, and other forms of noodles and pasta. Alimentary pastes like bakery doughs contain mostly milled wheat and water. The wheat, usually a hard durum wheat, is milled to yield coarse particles known as semolina, somewhat less coarse durum granulars. and finer durum flour. Alimentary pastes also may contain eggs, salt, and other minor ingredients. They differ from bakery doughs in that alimentary pastes are not leavened.

The unleavened dough is formed by mixing the ingredients in the ratio of about 100 parts of the wheat products to 30 parts of water. The dough then may be extruded in a thin sheet, which is cut into flat noodles and dried in an oven to about 12% moisture; or the unleavened dough may be extruded in dozens of other shapes depending on the choice of dies. This product also is oven-dried to about 12% moisture. Quick-cooking noodles, sometimes referred to as instant noodles, are made by steaming noodle dough and then frying it. Frying removes moisture and the noodles are not further oven-dried.

Rice

Rice is the staple food of billions of people worldwide. Whereas wheat for the most part is ground into flour, most of the world's rice is consumed as the intact grain, minus hull, bran, and germ. Therefore, the milling process must be designed not to disintegrate the endosperm core of the seed.

Milling

Rice milling begins with whole grains of rice being fed by machine between abrasive disks or moving rubber belts. These machines, known as shellers or hullers, do not crush the grains but instead rub the outer layer of hull from the underlying kernels. The hulls are separated from the kernels by jets of air, and the kernels, known as brown rice, move to another abrasive device called a rice-milling machine. Here, remaining inner layers of bran and germ are dislodged by the rubbing action of a ribbed rotor. The endosperms with bran and germ removed can now be further polished to a white, high glossy finish.

As in the case of wheat, the higher the degree of milling or polishing the lower are the remaining vitamin and mineral contents. This is particularly serious in the case of rice because entire populations depend on rice as the principal item of diet.

Enrichment

The two major ways to enrich rice differ from the simple admixture of vitamins and minerals in powder form that may be done in the case of flour. One method is to coat the polished rice with the enrichment mixture and then to further coat the grains with a waterproof edible film material. Upon hardening, the film material prevents the enrichment ingredients from dissolving away when the marketed rice is washed, as is common practice.

The second important method involves parboiling or steeping the whole rice grains in hot water before removal of hulls, bran, and germ in milling. Parboiling may be for about 10 h at 70°C, although several other time-temperature combinations can be used. This causes the B vitamins and minerals from the hulls, bran, and germ to leach into the endosperm. The rice is then dried, milled, and polished as before. Parboiled rice, processed for enrichment and other desirable changes in the rice kernels, has also been referred to as converted rice.

The principal nutrients used to enrich rice are thiamin, niacin, and iron; thiamin is particularly effective in reducing the incidence of beriberi where polished rice is a major item of diet. Legislation requires all rice sold in Puerto Rico to be enriched. Most of the rice sold in the United States is enriched. To be called enriched rice in the United States, the product must meet the standards indicated in Table 4.

Improved Varieties

Plant breeders are continuously at work improving the yields and properties of cereal grains. This includes considerations of soil types, weather conditions, response to fertilizer application, resis-tance to disease and insect attack, nutritional quality, storage stability, milling properties, cooking and processing characteristics, and other factors.

The development of a high-yielding strain of rice, designated IR-8, by the International Rice Research Institute in the Philippines, kindled hopes that the continued world shortage of this important food grain could be relieved. IR-8 has proven especially high yielding in the tropics. Consumer acceptability of this rice has not been universal, however, and other high-yield varieties with better milling and cooking characteristics have replaced much of the IR-8 in several countries. Meanwhile, it is of interest to note that the importance of rice as a dietary staple in some countries may be reduced as wheat becomes available in the form of bread and pasta. This tendency is now being seen in Japan and in parts of Indonesia.

Rice Products

Rice can be made quick-cooking or almost instant in terms of preparation time. This is done by precooking to gelatinize the starch, and then drying under conditions that will give the rice an expanded internal structure for quick absorption of water during subsequent preparation. Many patents exist.

Rice is also the basis of several prepared foods and dried mixes. Typically, these products contain quick-cooking rice and other ingredients such as spices, noodle products, and starch-based sauces.

Rice may be ground into flour and as such is used by people allergic to wheat flour. Rice is a source of starch. It is the grain that is used in preparing the Japanese fermented alcoholic beverage sake. Rice hulls, bran, and germ also are used as animal feed.

Effect of Processing on Mancozeb Residues in Apple

Ethylene bis-dithiocarbamates (EBDC) are used to control various fungal diseases of fruits and vegetables. Apple is vulnerable to the attack of fungal pathogens causing diseases, such as scab *(Venturia inaequalis)* and leaf fall. Six sprays of mancozeb as a protectant fungicide has been recommended for the control of these diseases. In actual practice, mancozeb is being used extensively by apple growers. There is no prescribed MRL's for mancozeb on processed products of apple. It was therefore, important to gather information on this aspect following recommended practices for apple cultivation. Hence, the present studies were undertaken to determine the level of mancozeb residues in raw apple fruit and its processed products, following treatment of Dithane M-45.

Materials and Methods

Fruits and pesticides : Dithane M-45 containing 75% active ingredient of mancozeb (a mixture of 2.5% zinc and 20% manganese) was sprayed in a block of ‘Golden Delicious' cultivar of apple located at the R.F.R.S., Mashobra, Dist. Shimla (7200 f.a.m.s.l.). Concentrations of 0.25% and 0.5%, each replicated four times having 3 plants in each replication were sprayed to run-off by power sprayer. Two sprays were given close to harvest with 10-12 litres spray suspension/tree at an interval of 20 days. Identical portions of trees were maintained as controls and were sprayed with water.

Sampling/harvesting of fruits : After 4 h of second mancozeb spray, about 60 kg fruits were collected for residue analysis at a height of 1.5-2.0 m above ground and from the inside and outside regions of each tree. The samples collected from each tree were kept in labelled field crates.

Fruit processing : Fruits from all the replicates were combined into a composite sample of two to three field crates per treatment for simple decontamination and processing studies. Apples were kept at ambient temperature and processed within 24 h of treatment. On the first day of harvesting, 1/3 portions of fruits from each composite lot of treatment were stored in boxes at ambient temperature for further analysis. The remaining fruits of each treatment were used for processing.

Sampling : For residue analysis in raw fruits, four apples were drawn randomly from each treatment alongwith the control. Each analysis was carried out in triplicate. Washing was done in cold, flowing tap water for 5 min, then drained for 2-4 min. Pulp samples were obtained by removing the peel (1mm thickness). The residues in whole and peeled fruit samples were determined simultaneously at different time intervals over a period of 20 days. For residue estimation, apples were chopped and 100 g representative sample drawn randomly from a mixed lot was used for further analysis.

Processed products : For processing, the fruits of each treatment were first washed in cold water, flowing tap water and then drained. Washed apples were cored, peeled and sliced manually with stainless steel knives. The fruit pieces were steamed for 5-6 min. The cooked slices were pulped in a tomato pulper with a 1.5 mm screen, as done commercially. The apple pulp was mixed with sugar (1:1) in a container and the whole mass was continuously cooked to the desired consistency (TSS 68 °Brix). The hot apple jam was filled in hot water-sterilized well-labelled wide-mouthed bottles and stored for further analysis. For juice preparation, washed apples of each treatment were grated in a stainless steel grater, followed by pressing in a cloth and rack press. Juice was collected in plastic containers. Half of the juice of each treatment was filled hot in hot-water sterilized glass bottles of 200 ml capacity, crown corked, pasteurized in boiling water for 15-20 min and immediately cooled. These were labelled and later used for residue analysis. The remaining juice was supplemented with sugar to 24°Brix, DAHP at 0.1% and KMS at 100 ppm and stored in big jars for inoculation with *Saccharomyces cerevisiae* at 5% of 24 h active culture to make wine as per the standard method. The fermentation was conducted at a temperature of 22 ±1ºC. It took about 10 days for the completion of fermentation. It was allowed to mature further for another 5-6 months. During this period, the wines were siphoned, clarified and finally, bottled for residue analysis. The remaining portion after pressing the grated apple, was apple pomace. It was used for residue analysis as such.

Residue analysis : The samples of raw fruits/processed products in each of the treatments were mixed and a sub-sample of 100 g was drawn for analysis of mancozeb, based on evolution of carbon disulfide (CS.,), resulting from acid hydrolysis and measuring spectrophotometrically.The level of residues in the samples was expressed as mg of carbon disulfide per kg raw fruit/product. The half-life in whole fruits was calculated as per the method of Hoskins.

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Use of Sorbitol for the Preparation of Plum Seasoned Squash

Sorbitol is polyols or polyhydric alcohols or dextrose alcohols which is extensively used for the replacement of refined carbohydrates as food sweeteners and additives. In USA and Europe 1.44 thousand MT of sorbitol is used by the food and confectionery industry. Polyglycerol sweeteners have been approved for food use because their hydrolysis products are glycerol and fatty acids, which are metabolized normally in the body. Sorbitol (70 % solution) is the only polyhydric alcohol available in India. It is generally recognized as safe (GRAS) for use in special dietary foods, breath mints, cough syrup, chewing gums, tooth pastes and pharmaceutical industries. It is 0.5 to 0.6 times sweeter than sucrose depending upon the concentration and temperature. It has emulsifying, stabilizing, humectancy and thickening properties. It has resistance to thermal and nonenzymatic browning. Its negative heat of solution results in characteristics cooling effect in the mouth.

Sweet fruit products prepared by the use of sorbitol are beneficial to the diabetic and obese subjects. Sorbitol is neither absorbed in the intestine through an active transport mechanism like dextrose nor fermented by the buccal micro-flora. Moreover, it is neither acidogenic nor cariogenic. Sorbitol can replace glucose and sucrose in the diets of diabetics as it does not increase blood glucose level. Keeping this in view, attempts have been made to develop low calorie seasoned plum squash using sorbitol for the benefit of masses, in general, ailing and health conscious people in particular.

Ripe fruits of cv. ‘Santa Rosa' plum were procured from the Research Orchard of the University of Horticulture and Forestry, Nauni Solan. Fruits were sorted, graded and washed thoroughly with water and pulp was prepared by hot break method. Extracted pulp was preserved in jerry cans (20 litre capacity) using 1000 ppm SO2 derived from KMS and sealed tightly.

Spices and herbs : Spices and herbs were purchased from local market. Cardamom, cumin and black pepper were dried in an oven at 60°C for 24 h and ground in the Super Mixer Grinder Mx-1155. Black salt was broken into small pieces by hammer and finally ground in the pestle and mortar. Fresh ginger was washed thoroughly, peeled manually and passed through Screw type juice extractor to extract juice. Fresh mint leaves were washed, crushed in a blender and squeezed through muslin cloth to get extract.

Sorbitol : Sorbitol was purchased from M/S Devinder Cottage Industries, Chandigarh.

Preparation : Seasoned squashes were prepared from fresh as well as preserved pulp using recipe standardized by Sharma mentioned in Table 1. Preserved pulp was heated to 97 ± 0.5°C for 10 min (till

whole of the S02 vaporized from the pulp). The sweetness intensity of sorbitol worked out to be 0.5 times *vis-a-vis* sucrose by dilution method. Low calorie seasoned squashes were prepared by replacing sugar sweetness with equi-sweetness of sorbitol at different proportions (Table 2). Pre-determined quantities of spices (Table 1) were boiled in 100 ml of water, strained through muslin cloth and added to the mixture of pulp and sugar/ sorbitol. Finally, mint and ginger extracts were added along with citric acid at 0.5% and sodium benzoate at 0.06% (dissolved in 30 ml water) in the seasoned squash and mixed throughly. The product was hot filled (85° C) in pre-cleaned sterilized glass bottles of 700 ml capacity, crown corked, labeled and analyzed on the day of preparation and after 30, 90 and 180 days of storage.
Chemical analysis : Total soluble solids (TSS) were measured by refractometer (Erma). Titratable acidity (TA), reducing sugars, total sugars (as invert sugars) and ascorbic acid were estimated as per procedures described by Ranganna. Energy value was calculated by taking into account the amount of sugars, sorbitol, crude protein and fat contents present in the seasoned squash. The content of each nutrient was multiplied by a conversion factor.

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Coating of Cashew Kernel Baby Bits

Commercial processing of cashew nuts involves number of steps like, roasting, shelling, peeling and packing. Cashew processing results in recovery of kernels of different grades such as wholes, splits, bits etc. Value addition in cashew is one of the emerging areas. Earlier, attempts have been made for coating of cashew kernels with salt and preparation of burfi. Cashew kernel wholes fetch maximum price while cashew kernel baby bits (CKBB), the lowest grade kernels obtained during processing of cashew nuts, fetch less. About 0.5 to 1% of CKBB are obtained during commercial processing. These are sold at Rs. 120 to 140/kg in the local market. The present investigation has been undertaken to develop value added products without introducing external oil by coating CKBB with cane sugar, honey, salt and cashew apple juice.

Materials and Methods

Cashew kernel baby bits (CKBB) and almond were purchased from M/s Achal Industries, Mangalore. Cane sugar, honey, iodised salt, groundnut and permitted colours were purchased from the local market. All the other chemicals used were of analytical reagent grade. Cardamom capsules were procured from Cardamom Research Centre, Indian Institute of Spices Research, Appangala, Kodagu and essential oil was recovered by hydro distillation and used for coating studies. The samples were thoroughly washed with distilled water to remove adhering testa particles and dried at 70°C for 6 h. These were defatted with n-hexane at ambient temperature (27°C to 30°C) over a period of 48 to 72 h with frequent ‘changing of solvent and dried at 70°C for 6 h.

Coating of CKBB with cane sugar, honey and salt was carried out at different temperatures and concentrations for 5 min and were dried at 70°C for 3 to 4 h. Ratio of CKBB to the coating solution was 1:2 (5 g/10 ml). Similarly, coating of CKBB with clarified whole cashew apple juice, aroma stripped cashew apple juice and aroma distillate was carried out. Freshly harvested and washed cashew apples were squeezed and the recovered juice was boiled for 15-min in presence of 0.05% gelatin and allowed to settle. Aroma from the clarified juice was recovered by steam distillation.

Coated baby bits (1 g) (BB) were extracted with distilled water at 10°C for 12 h and sugar was estimated for assessing the extent of coating. Similarly extent af coating of salt was assessed by measuring the conductivity of the extract. Esters in the extract of cashew apple juice coated baby bits were estimated using ethyl acetate as standard.

Coated CKBB were assessed by a panel of judges using a 9-point Hedonic scale for colour, flavour, texture and taste. Mean cumulative scores for these characters were calculated for comparison of different coated CKBB.

Results and Discussion

Cashew kernel baby bits (CKBB) were coated with cane sugar, honey and iodised salt at temperatures varying between 60 and 100°C at different concentrations for 5 min (Fig. 1 to 3). In the case of honey, coating at concentrations beyond 70% could not be tried as the solution became very viscous. Per cent coating of cane sugar increased with increased temperature and concentration. Coating beyond 70% concentration did not differ much. Optimum temperature for coating of BB with cane sugar, honey and iodised salt was 100°C. Optimum concentration for coating of BB with cane sugar and honey was 70%. Similarly, optimum concentration for coating of baby bits with salt was 5%.

CKBB, almond and ground nut (after removing the testa) were defatted and were coated with cane sugar and honey at 70% concentration at 100°C for 5 min (Table 1). Defatting of kernels enhances the extent of coating of honey and cane sugar.

Coating of whole and defatted CKBB at different temperatures with cane sugar and honey was compared. Enhanced coating of defatted CKBB was noticed at all the temperatures (Table 2).