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Development of Health Foods from Oilseed Cakes

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Abstract

Four health foods were prepared using copra cake, sesame cake, dried mature coconut kernel without the testa, flattened rice flakes, sugar, coconut water solids, rice bran oil and sesame oil. The nutritional composition of raw materials and health foods were evaluated for various parameters such as moisture, ash, soluble and insoluble fiber (crude fiber), protein, carbohydrates, fats, fatty acid composition, oryzanol, lignans and minerals (sodium, potassium, calcium, iron and zinc). These health foods were also evaluated for sensory acceptance. The health foods had moisture content 2.2% to 3.9%, fat 2.0% to 35.0%, ash 2.1% to 6.2%, protein 9.2% to 12.2%, carbohydrates 42.85% to 83.7%, and crude fiber 2.95% to 6.4%. Among minerals, potassium content was in the range of 39-120.6 mg/100 g, sodium 9.95-49.6 mg/100 g, calcium 7.8-219.6 mg/100 g, iron 3.1-22.0 mg/100 g and zinc 1.9-6.4 mg/100 g. Fatty acid profile was designed to include medium chain, long chain saturated, monounsaturated and polyunsaturated fatty acids. Total phenolics content was in the range of 54.6-105.7 mg/100 g. A product with 0.6% oryzanol and 1% lignans was prepared to provide the hypocholesterolemic effect. These products were acceptable by sensory evaluation. Hence, it can be concluded that these products may be called health foods which provide health benefits to consumers.

Keywords: Coconut water solids, Copra cake; Health foods; Rice bran oil; Sesame oil; Sesame cake

Introduction

Oilseed cakes are the major byproducts obtained after oil extraction in the edible oil industries. Depending upon the extraction methods the percentage of oil in the cake varies. The oilseed cakes have been mainly used for feeding cattle and these oilseed cakes are rich in nutrients like proteins, carbohydrates, antioxidants, vitamins and minerals. These oilseed cakes can also be used for human consumption for proper processing and preparation of low-cost health foods [1,2]. Oilseed cakes are of two types, edible and non-edible grades. Edible cakes are those resulting from edible oil bearing seeds which are being used to meet a part of the nutritional requirements of either animal feed or for human consumption and those which cannot be used as feedstuff due to the presence of toxic compounds and other impurities are differentiated as non-edible [3].

Copra cake has been used for feeding cattle since it is rich in nutrients like protein, fat, nutraceuticals, fibers, vitamins and minerals. The copra cake can be processed and made edible for human consumption by giving certain treatments since it can be used as value-added products in food industries [2]. Coconut water solids may be prepared by drying the tender coconut water, which can be preserved for a longer time and is nutritionally rich in minerals especially sodium and potassium. Sesame cake can be used as a protein supplement in the food industries. Sesame cake also has lignans, a potential antioxidant against lipid oxidation [4]. The sesame oil has high amounts of lignans with health benefits like lowering the cholesterol level [5,6]. Rice bran oil is the only edible oil having an almost balanced ratio of saturated, mono unsaturated and poly unsaturated fatty acids (S:M:P ratio). Rice bran oil is stable especially during frying due to the presence of natural antioxidant called oryzanol which is heat stable antioxidant [7] and oryzanol can also be isolated from rice bran deodorized distillates and incorporated to other vegetable oils to increase the stability during frying [8]. Some oilseed cakes have antinutritional compounds such as tannins, phytates, trypsin inhibitors, pepsin inhibitors, hemaglutinin, etc., and these antinutritional compounds can reduce the bioavailability in our body but fortunately the concentration and activity of these compounds are less and can be inactivated by heat treatment to make palatable for human consumption [9].

Oilseed cakes have been used for feed application for cattle. However, oilseed cakes have never been prepared as food for human consumption due to the presence of antinutritional factors in them. Therefore, the present study aimed to utilize oil seed cakes (copra and sesame) by giving certain heat treatments and coconut water solids as a natural source of minerals and nutrients for the preparation of health foods for human consumption in food industries. With this background and using published research findings, two cakes and two vegetable oils having cholesterol lowering properties viz., rice bran oil and sesame oil were selected for incorporation. Also, to find a use for the new product developed, tender coconut water solids as a natural mineral supplement, food ingredients included improving texture, sensory attributes were also added to get the experimental design was framed in such a way that the raw materials used are safe for human consumption.

Materials and Methods

Collection of raw materials

Copra cake was collected from M/s Nirmal Coconut oil industries Pvt. Ltd., Cochin, sesame cake was collected from a local ghani mill, dried mature coconut kernel powder was collected from M/s Elite Food Industries, Mysore. Sugar, rice bran oil, sesame oil and flattened rice flakes were purchased from the local super market. Coconut water solid was prepared by drying the tender coconut water in the pilot plant using the process developed at the institute (CFTRI Process). Standard gallic acid, hydroxybenzoic acid, chlorogenic acid, vanillic acid, syringic

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acid, coumaric acid, caffeic acid, ferulic acid cholesterol, FAME mix and cinnamic acid were procured from Sigma Chemicals Co., St. Louis, USA. All chemicals, solvents, and reagents were of analytical grade.

Oilseed cake treatment

The raw copra cake and sesame cakes were mixed with distilled water (1:4 w/v) and cooked in such a way to get a cooked solid residue and a liquid extract which are separated by decantation of the liquid extract followed by freeze drying ('ScanVac' FREEZE DRIER model: Cool Safe 55-9 Pro with Drying Chamber, Denmark) at −55°C to get two products from each. Cooked solid residues of copra cake and sesame cakes were used as ingredients for the preparation of health foods [2].

Health food preparation

Different health foods (HF1, HF2, HF3, and HF4) were prepared by using the ingredients such as copra cake, sesame cake, mature coconut kernel, flattened rice flakes, sugar, coconut water solids, rice bran oil (RBO) and sesame oil (SESO). The health food HF1 was prepared by blending of mature coconut powder and copra cake along with sugar. HF2 was prepared by blending of a mature coconut, copra cake and sesame cake along with sugar. HF3 was prepared by mixing copra cake, rice flake, and tender coconut water solids along with sugar. HF4 was formulated by using copra cake, sesame cake, rice flake, sugar, rice bran oil, and sesame oil in specific combination (Table 1). Before the formulation of the health foods all the ingredients except TCWS, RBO and SESO were ground into fine powder. The ground ingredients mixed along with other raw materials in a mixer grinder to obtain a uniform distribution of ingredients in health foods. The prepared health foods were transferred to pet jars and kept at 4°C till the time of further analysis.

Proximate composition of health foods

Moisture content: The samples were ground to a fine powder; 10 g of the ground samples were taken in aluminum moisture cups and placed in an oven at 100 ± 1°C for 2 h or till a constant weight was obtained. The moisture content was expressed on a dry basis (Method No. Ac 2-41 1997) [10].

Fat content: The analysis was carried out by AOCS Official Butt-tube Method Ac 3-44 [10]. The samples of raw rice bran, oil cakes, their cooked residues, and extracts were ground to a fine powder, dried in an oven at 100 ± 1°C, packed in 26 mm × 60 mm thimbles and extracted with hexane in Soxhlet apparatus. The extracts were desolventizing by vacuum flash evaporation (Rotavapor RE 121A, Buchi, Switzerland) at controlled temperature and were subjected to various analyses.

Protein content (AOAC Official Method 950.48): The micro-Kjeldahl method was used to determine total proteins using 1 g sample. Sample nitrogen content was calculated using the formula [11]. The method described by the AOAC Official Method 950.02 [11] was used for crude fiber determination.

Dietary fiber content: The estimation of dietary fiber in the samples was done according to the enzymatic-gravimetric method [12]. Briefly, 1 g of ground sample was suspended in 25 ml of 0.1 M phosphate buffer (pH 6), then 0.1 ml of Thermo amylase was added and the mixture was kept in a boiling water bath for 15 min to digest starches. The crucible was kept in an oven (105°C) until the weight became constant and its final weight was determined. The sample-containing crucible was then incinerated at 550°C for 5 h and its weight was determined. To obtain soluble dietary fiber, the volume of the filtrate was adjusted to 100 ml and the soluble fiber was precipitated by adding 4 volumes of warm (60°C) ethanol. The precipitate was filtered through a crucible containing celite, dried at 105°C and the weight of the crucible was determined. The sample-containing crucible was then incinerated at 550°C for 5 h and its weight was determined. Blanks were prepared as above but without the sample.

Ash content: A known weight of the sample was initially charred on a tared silica crucible and placed in a muffle furnace at 550°C for 6 h till the charred material became white. The dish was allowed to cool to room temperature in desiccators and reweighed. The difference in weight was taken as total ash content [11].

Mineral content: Iron, zinc, sodium, potassium and calcium content of raw materials and health foods were analyzed by atomic absorption spectroscopy (AAS) [13].

Total phenolic content (TPC): The phenolics extraction from the samples was carried out according to [14]. The phenolics were extracted from samples using 80% methanol. For CK, 1.0 g of sample was mixed with 5.0 mL of 80% methanol, heated for 5 min on a water bath and vortexed for 2 minutes (twice). The samples were centrifuged at 2500 rpm for 10 minutes at room temperature. The methanol-water layer was collected in another tube and this step was repeated for four times. The extracts pooled and made up to 20 mL with 80% methanol. For CW, it was used in aliquots directly. The TPC was determined using the Folin–Ciocalteu reagent. Different aliquots were mixed with 0.20 mL of Folin–Ciocalteu reagent and were kept for 3 minutes. About 1.0 mL of 15% Na_2CO_3 solution was added and made up to 7 mL with distilled water. The tubes were incubated for 45 minutes and centrifuged at 2000 rpm for 10 minutes at room temperature. The absorbance was determined at 765 nm using a UV-Visible spectrophotometer (Shimadzu corporation, Kyoto, Japan, model UV–1601). The TPC (mg/100) was calculated using gallic acid as a standard compound [15].

Extraction of crude fat and its composition in health foods: The four different health foods were subjected to fat extraction and further this fat was analyzed for various parameters such as fatty acid profile, oryzanol, and lignans content.

Fatty acid composition: Fatty acid methyl esters (FAME) of the oil samples were prepared by transesterification, according to AOCS Method No: Ce 1-62, 1998 [10]. FAMEs were analyzed on a Fisons 8000 series gas chromatograph (Fisons Co., Italy), equipped with a flame ionization detector (FID) and a fused silica capillary column (100 m

Health Foods	Raw materials (%)							
	Sugar	Mature Coconut	Copra Cake	Sesame Cake	Rice flakes	Coconut water solid	Rice bran Oil	Sesame Oil
HF1	40	50	10	-	-	-	-	-
HF2	40	45	7.5	7.5	-	-	-	-
HF3	20	-	20	-	40	20	-	-
HF4	40	15	7.5	7.5	10	-	15	5

Table 1: Composition of health foods.

× 0.25 mm i.d.), coated with 0.20 ml SP2560 (Supelco Inc., Bellefonte, PA) as the stationary phase. The oven temperature was programmed from 140°C to 240°C at 4°C/min with an initial hold at 140°C for 5 min. The injector and FID were at 260°C. A reference standard FAME mix (Supelco Inc.) was analyzed under the same operating conditions to determine the peak identity. The FAMEs were expressed as relative area percentage.

Oryzanol content: Oryzanol content was determined by spectrophotometric method using UV–vis spectrophotometer (model-UV-1601, Shimadzu, Kyoto, Japan) by measuring the optical density at 314 nm of the oil taken in hexane followed by calculation using the extinction coefficient of 358.9 and expressed as g/100 g of oil and reported as milligram/ 100 g of oil [16].

Lignans content: The oil samples (0.01 g), in triplicate, were dissolved in 10 ml of hexane + chloroform mixture (7:3, v/v) and the absorbance at 288 nm was determined [17]. The lignans content was calculated by using the formula:

$$\% \text{ Lignans (as sesamin)} = [(A/W) \times (100/230.1)] \quad (1)$$

Where,

A is the absorbance of the sample

W is the weight of the sample in gram/100 ml

230.1, E1% 1 cm for sesamin

Sensory attributes: Sensory evaluations of health foods were carried out by 20 untrained taste panelists. They were instructed to taste the samples and to rinse their mouth after each sample taste. They were requested to express their feelings about the samples by scoring the following attributes: appearance, texture, taste, aroma and overall acceptability. Sensory scores were based on a nine-point hedonic scale, where 1 dislikes extremely and 9 are like extremely [18].

Statistical Analysis

The experiment was carried out in quadruplicate. All the quality parameters were analyzed in quadruplicate and the data obtained for each parameter were expressed as a mean ± standard deviation. One-way ANOVA was used to calculate the significant difference in the oils and residues [19].

Results and Discussion

The raw materials used for the preparation of health foods (HF) were dried mature coconut, copra cake, sesame cake, sugar, rice flakes, coconut water solid, rice bran oil (RBO) and sesame oil (SESO) depicted in Table 1. All these raw materials were made into a fine powder before mixing them uniformly in a 10 kg capacity mixer. Four health food products were prepared by standardizing the composition for each product for different health benefits. Cooked residues of copra and sesame cakes were little bitter in taste so sugar was added up to 40% to mask the bitterness in the product. HF1 was based on the utilization of copra cake (10%) and dried matured coconut (50%), these two are rich in protein, fiber, fat, and minerals. HF2 was based on the utilization of copra cake and sesame cake (15%), sesame cake is rich in antioxidant lignans and minerals especially calcium. HF3 was based on copra cake (20%) and coconut water solid (20%), coconut water solid is very rich in minerals especially sodium and potassium. Finally, HF4 was based on the copra, sesame cake, rice bran oil and sesame oil. All the four health foods are sweet in taste and can be eaten as such or can be mixed with water or milk for use as an energy/nutritional/health drink.

The health foods developed were subjected to storage studies. The above health foods were stored for 3 months and analyzed at every 15 days up to 3 months' period for the product's shelf-life characteristics. Table 2 depicts the storage studies of health foods such as moisture, fat, oryzanol and lignans contents. The moisture content of health foods was in the range of 1.75% to 2.0%. Fat content was in the range of 2.0% to 34.9%. Fat content was almost constant during the storage studies this was due to the presence of potent antioxidants oryzanol and lignans. The antioxidants, oryzanol (0.6% to 0.58%) and lignans (0.98% to 1.0%) were stable during the storage studies as they are heat stable antioxidants [5,7] and they may also give synergistic effect for the stability of enhanced shelf-life. The antioxidant oryzanol is a heat-stable compound and it does not degrade even at higher temperatures. Many studies shown the health benefits of oryzanol such as hypocholesterolemic activity [20,21], protective role in lipid peroxidation [22], safety assessment of oryzanol indicates no genotoxic or carcinogenic activity [23], utilization of oryzanol concentrate and purified oryzanol as natural antioxidant for stability and can be used as functional foods [8, 24]. Lignans are natural antioxidants present in sesame oil. Lignans have health benefits, including antioxidant activity [25], anticarcinogenic [26], blood pressure-lowering [27] and serum lipid-lowering [28].

Table 3 depicts the data for the moisture, fat, protein, carbohydrates, ash, crude fiber, oryzanol, and lignans. Carbohydrate content was calculated by difference. The moisture content was ranged from 2.2% to 3.9%. Estimation of lipids is an important factor for nutritional evaluation of any food products. The fat content of health foods ranged from 2.0% to 35.0%. HF1, HF2, and HF4 health foods were oil based foods and HF3 was mainly of coconut water solid and copra cake based product, the fat content was only 2.0% in it. The fat content of the oils

Parameters (%)	Health Foods	Storage period at 38°C/90% RH (days)						
		0	15	30	45	60	75	90
Moisture	HF1	2.0 ± 0.01	1.84 ± 0.08	1.84 ± 0.01	1.77 ± 0.01	1.76 ± 0.02	1.76 ± 0.08	1.75 ± 0.01
	HF2	2.0 ± 0.05	1.98 ± 0.01	1.98 ± 0.05	1.97 ± 0.01	1.97 ± 0.02	1.95 ± 0.01	1.91 ± 0.06
	HF3	2.1 ± 0.01	2.1 ± 0.01	2.1 ± 0.01	2.1 ± 0.02	1.99 ± 0.01	1.99 ± 0.02	1.99 ± 0.05
	HF4	2.3 ± 0.02	2.3 ± 0.01	2.3 ± 0.04	2.3 ± 0.01	2.3 ± 0.01	2.3 ± 0.1	2.3 ± 0.01
Fat	HF1	34.9 ± 0.01	34.9 ± 0.06	34.9 ± 0.04	34.9 ± 0.1	34.8 ± 0.01	34.8 ± 0.02	34.8 ± 0.02
	HF2	32.7 ± 0.01	32.7 ± 0.04	32.7 ± 0.02	32.7 ± 0.05	32.7 ± 0.05	32.7 ± 0.01	32.7 ± 0.01
	HF3	2.0 ± 0.05	2.0 ± 0.05	2.0 ± 0.01	2.0 ± 0.08	2.0 ± 0.02	2.0 ± 0.02	2.0 ± 0.1
	HF4	30.2 ± 0.01	30.1 ± 0.01	30.1 ± 0.02	30.1 ± 0.05	30.1 ± 0.01	30.1 ± 0.05	30.1 ± 0.02
Oryzanol	HF4	0.6 ± 0.02	0.6 ± 0.08	0.6 ± 0.08	0.6 ± 0.01	0.59 ± 0.02	0.59 ± 0.01	0.58 ± 0.01
Lignans	HF4	1.0 ± 0.01	1.0 ± 0.01	1.0 ± 0.01	1.0 ± 0.02	0.98 ± 0.01	0.98 ± 0.05	0.98 ± 0.08
Values are average of triplicate determinations.								

Table 2: Storage stability of health foods.

Proximate Composition	HF1	HF2	HF3	HF4
Moisture (%)	2.3 ± 0.1	2.4 ± 0.2	2.2 ± 0.5	3.9 ± 0.2
Fat (%)	35.0 ± 0.08	32.7 ± 0.1	2.0 ± 0.1	30.1 ± 0.08
Protein (%)	11.3 ± 0.4	10.7 ± 0.5	9.2 ± 0.2	12.2 ± 0.4
CHO (%)	42.8 ± 0.08	47.0 ± 0.05	83.7 ± 0.01	50.5 ± 0.2
Ash (%)	2.1 ± 0.3	2.7 ± 0.05	3.3 ± 0.01	6.2 ± 0.02
Crude fiber (%)	6.4 ± 0.05	4.5 ± 0.02	2.9 ± 0.2	3.3 ± 0.4
Oryzanol (mg/100 g)	-	-	-	600 ± 0.1
Lignans (mg/100 g)	-	-	-	1000 ± 0.1
TPC (mg/100 g)	65.52 ± 0.1	54.65 ± 0.2	105.7 ± 0.5	89.64 ± 0.2
Values are average of triplicate determinations.				

Table 3: Proximate composition of health foods.

Health Foods	Dietary fiber (%)		Total dietary fiber (%)
	Soluble	Insoluble	
HF1	4.1 ± 0.01	28.2 ± 0.02	32.3 ± 0.06
HF2	2.8 ± 0.06	33.5 ± 0.02	36.3 ± 0.05
HF3	3.6 ± 0.08	52.2 ± 0.06	55.8 ± 0.01
HF4	3.2 ± 0.09	48.0 ± 0.08	51.2 ± 0.02
Values are average of triplicate determinations.			

Table 4: Dietary fiber content of health foods.

Health Foods											
	C8:0	C10:0	C12:0	C14:0	C16:0	C18:0	C18:1	C18:2	SFA	MUFA	PUFA
HF1	9.2 ± 0.2	6.3 ± 0.5	44.0 ± 0.5	21.9 ± 0.1	10.1 ± 0.1	1.4 ± 0.1	5.4 ± 0.5	1.7 ± 0.1	92.9 ± 0.6	5.4 ± 0.4	1.7 ± 04
HF2	8.8 ± 0.5	6.1 ± 0.1	41.6 ± 0.4	21.7 ± 0.8	10.0 ± 0.5	1.8 ± 0.4	7.2 ± 0.2	2.8 ± 0.5	90.0 ± 0.2	7.2 ± 0.6	2.8 ± 0.5
HF3	9.1 ± 0.08	6.4 ± 0.8	44.2 ± 0.2	21.8 ± 0.4	9.9 ± 0.5	1.4 ± 0.6	5.3 ± 0.5	1.9 ± 0.8	92.8 ± 0.8	5.3 ± 0.4	1.9 ± 0.6
HF4	3.0 ± 0.1	2.1 ± 0.1	14.9 ± 0.8	12.6 ± 0.6	12.4 ± 0.1	1.5 ± 0.2	27.8 ± 0.1	25.7 ± 0.4	46.5 ± 0.5	27.8 ± 0.5	25.7 ± 0.8
Values are average of triplicate determinations.											

Table 5: Fatty acid composition of health foods.

and cakes depends on the oil extraction method [29]. Oilseed cake is an excellent by-product source of protein for the preparation of health foods in food industries. The protein content of health foods varied from 9.2% to 12.2%. The maximum protein content was observed in the HF4. The ash content varied from 2.1% to 6.2%. There was a wide variation in the ash content of health foods. HF1 had the lowest and HF4 showed the highest ash content. The health foods were also analyzed for crude fiber and the crude fiber was in the range of 2.9% to 6.4%. The HF4 was incorporated with both rice bran and sesame oils to enrich the nutritional value to the product. The rice bran oil is having the antioxidant called oryzanol, a highly stable antioxidant to give stability to the oil. The oryzanol content in HF4 was having 600 mg/100 g of the product. The sesame oil is rich in antioxidant like lignans, the lignans in HF4 had 1000 mg/100 g of the product. The total phenolic contents were also analyzed in the health foods. The oilseed cakes are rich in phenolics especially copra cake, kernel, testa [30,31] and health benefits of phenolics includes antioxidant and anticancer [31,32]. The total phenolic contents were in the range of 54.65-105.7 mg/100 g, the highest phenolic content was found to be in HF3 (105.7 mg/100 g) and lowest was in HF2 (54.7 mg/100 g).

Health foods were analyzed for the total dietary fiber (soluble and insoluble) and are presented in the Table 4. Dietary fibers are best known for its ability to prevent or relieve constipation. The total dietary fibers were ranged from 32.35 to 55.8% and these values were agreed well with those reported for the total dietary fiber of copra and sesame cakes [2]. The soluble and insoluble fibers were ranged from 2.8-4.1 and 28.2-52.2 respectively. The insoluble dietary fiber contents were more compared soluble dietary fiber in all health foods.

Table 5 depicts that fatty acid composition of health foods. Fatty acid composition is one of the key factors for nutritional evaluation of any foods [33]. HF1 was having coconut oil and its fatty acid composition was mainly the presence of lauric acid (C12: 0 44.0%) and myristic acid (C14: 0 21.9%). HF2 was having both coconut and sesame oil and there was a slight variation in the fatty acid profile compared to HF1. This was due to the presence of sesame oil in the sesame cake of HF2. HF3 health food was based on coconut oil and its fatty acid profile was almost similar to HF1. The HF4 was incorporated with rice bran and sesame oil and its fatty acid composition was well balanced with S:M:P ratio compared to other commercial individual edible oils (Saturated: Mono unsaturated : polyunsaturated fatty acids) i.e., saturated fatty acid was 46.5%, mono unsaturated fatty acid was 27.8 and it had 25.7% of poly unsaturated fatty acids.

Mineral composition is one of the nutritional factors for any foods. Potassium, sodium, calcium, iron and zinc were analyzed from these health foods and provided in Table 6. There was a wide variation in the mineral contents of health foods. The lowest mineral content was found to be zinc in HF3 (1.9 mg/100 g) and highest was found to be calcium in HF2 (219.6 mg/100 g) this was due to the incorporation of sesame cake in the HF2. The RDA for minerals such as potassium, sodium, calcium, iron and zinc for adult men and women are mentioned [34]. The health foods of potassium and sodium content were in the range of 39.0-120.6 mg/100 g (RDA for adult men and women is 4.7 g/day) and 9.9-49.6 mg/100 g (RDA for adult men and women is 1.1-3.3 g/day). Potassium and sodium are essential to maintaining the body's electrolyte balance. The content of calcium was in the range of 7.8-219.6 mg/100 g (RDA for adult men and women is 1000 mg/day). The iron content was in the range of 3.1-22.0 mg/100 g (RDA for adult men and women are 8 mg/day and 18 mg/day). The mineral iron is a very important nutrient

Health Foods	Mineral Composition mg/100 g				
	Iron	Zinc	Sodium	Potassium	Calcium
HF 1	13.1 ± 0.05	3.2 ± 0.1	49.6 ± 0.06	120.6 ± 0.01	95.6 ± 0.1
HF 2	22.0 ± 0.01	6.4 ± 0.05	43.5 ± 005	118.3 ± 0.04	219.6 ± 0.05
HF 3	3.1 ± 0.08	1.9 ± 0.01	16.0 ± 0.01	90.0 ± 0.01	7.8 ± 0.06
HF 4	5.1 ± 0.02	2.3 ± 0.01	9.9 ± 0.12	39.0 ± 0.02	16.2 ± 0.01
Values reported are mean ± SD (n=6).					

Table 6: Mineral composition of health foods.

Health Foods	Appearance	Texture	Taste	Aroma	Overall Acceptability
HF 1	7.3 ± 0.01	6.6 ± 0.05	7.5 ± 0.1	6.8 ± 0.02	7.0
HF 2	7.8 ± 0.02	6.6 ± 0.06	7.5 ± 0.02	7.2 ± 0.05	7.2
HF 3	8.3 ± 0.02	8.2 ± 0.1	8.5 ± 0.01	8.2 ± 0.04	8.3
HF 4	7.5 ± 0.05	7.4 ± 0.01	7.4 ± 0.02	7.0 ± 0.01	7.3
Values reported are mean ± SD (n=6).					

Table 7: Sensory scores of health foods.

because iron deficiency is the most common nutritional disorder and the health foods meet the RDA for adult men and women. The zinc content was in the range of 1.9-6.4 mg/100g (RDA for adult men and women are 11 mg/day and 9 mg/day). The health foods have good sources of minerals, health benefits, and sufficient intakes meet the RDA for adult men and women.

Sensory evaluation of health foods is shown in Table 7. The quality parameters such as appearance, texture, taste, aroma and overall acceptability of products were done by the sensory panelists. All health foods were acceptable by the sensory panelists, among these HF3 was highly acceptable by all the sensory panelists.

Conclusion

From the present study, it can be concluded that the raw materials such as cooked copra cake, cooked sesame cake, and mature coconut kernel can be used as food supplements in the food industries because of their nutrients like protein, dietary fiber (both soluble and insoluble), minerals and potent antioxidants such as lignans in sesame cake. Coconut water solids can be obtained by removing the water content in the tender coconut water, the coconut water solids are a rich source of minerals mainly sodium and potassium and it can be used as food supplements. Rice bran oil and sesame oil were used to enrich the antioxidants like oryzanol in rice bran oil and lignans in sesame oil, rice bran oil gives stability to the products which have got the balanced ratio of saturated, mono unsaturated and poly unsaturated fatty acids (S:M:P ratio). Based on these findings it can be concluded that these can be mixed in particular proportions to make health products. We have prepared four different health foods (HF1, HF2, HF3, and HF4). The results showed that these health foods are having nutritional values since these are rich in health improving nutrients. All these four products had very low moisture content; the protein content was in the range of 9.2% to 12.2%. Phenolics content was in the range of 54.65-105.7 mg/100 g, Mineral contents were also analyzed, potassium content was in the range of 39-120.6 mg/100 g, sodium 9.9-49.6 mg/100 g, calcium 7.8-219.6 mg/100 g, iron 3.1-22.0 mg/100 g and zinc 1.9-6.4 mg/100 g. These products were accepted from the sensory panelists, among four, HF3 was best rated by the panelists. Finally, it can be concluded that oilseed cakes can be used for human consumption by appropriate processing and giving certain treatments.

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