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A PHYSICO-CHEMICAL APPROACH FOR UTILIZATION OF BY–PRODUCT FROM COCONUT INDUSTRY FOR HUMAN CONSUMPTION

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ABSTRACT

Copra meal flour was physico-chemically characterized to explore possibility of its consumption for human use. Acceptability of copra meal flour for human consumption is directly associated with lack of knowledge about its nutritional facts. Average protein value of copra (23.04%) which is comparatively high to any staple cereal, consumed in India. Higher poly-phenolic compound (61mg/100gm) owe to its high antioxidative power (89.62µg/gm), restrict the chances of various free radical degenerative diseases. Availability of minerals had the value of 9.139mg/100gm and 4.003mg/100gm for Fe and Zn respectively, proves its status as nutritionally rich. Anti-nutrients in the form of tannin can be eradicated just by soaking it at room temperature overnight (12-16 hr) which reduces it from 2.05% to 0.66%. Color observations for flour shifts it to the darker side owe to its lower L* value. Photomicrograph of electron microscopy shows interaction in between protein and fibre molecules.

Keywords: copra meal, dietary fibre, polyphenols, staple and tannin.

INTRODUCTION

Today foods are not only intended to satisfy hunger and to provide necessary nutrients for human but also to prevent nutrition-related diseases and improve physical and mental well-being of the consumers (Menrad, 2003; Roberfroid, 2000). Functional foods play an outstanding role and increase in further demand for such foods can be explained by the increasing cost of healthcare, the steady increase in life expectancy, and the desire of older people for improved quality of their later years.

The term "Functional foods" generally include designer foods, pharma foods and other related nomenclature (Nancy *et al.,* 1997). Successful types of functional products that have been designed to reduce the high blood pressure, cholesterol, blood sugar, and osteoporosis, improvement of gut and intestinal health and immune enhancer are available in market (Tapas *et al*., 2008). Currently available ingredients for development of functional foods primarily include antioxidants, fibers, herbs, micronutrients, probiotic, prebiotic, fat/calorie replacers, phytosterols, stanols etc (Svetlana *et al*., 2004). Present concern regarding health beneficial properties of grains make nutritionist, scientists and food technologists to design composite foods with various functional attributes such as high fibre, gluten free foods and sometime with poly-phenolic functionality.

Copra meal flour is the name applied to the food grade product made from the coconut endosperm by drying of it to desiccated coconut, followed by removal of oil using solvent extraction or pressing to give coconut meal. De-oiled copra meal has high fibre content (Swick *et al.*, 1999, Gunathilake *et al.*, 2009), High protein content with 90% high intestinal digestibility compared to other feed ingredients (Heuze *et al*., 2013). The flour has good nutritive value and contains no known substance at toxic levels, as do some other oilseeds. Due to its health promoting trait, it is eulogised as "kalpavriksha" by Indian classics (Manisha *et al*., 1995)

MATERIALS AND METHODS

Present work focussed on to explore utilization of by-products in the form of copra meal flour from coconut industry to eradicate various dietary problems such as malnutrition, constipation and heart disease. Copra consumption restricted to use only as animal feed, no one studies were found for its utilization as human food ingredient.

PROCESSING OF COPRA FLAKES TO COPRA MEAL FLOUR

Copra meal (4Kg) was procured from one of the family of Kerala, used for their animal feeding. These flakes of copra meal grounded to fine flour using pulverizer (Vivek mandua agricultural impliments, Ludhiana) passed through 16 mm mesh sieve size and packed in airtight HDPE films until their exploration physico-chemically viz. proximate evaluation, mineral study, antioxidant power, total polyphenols, color value, tannin content, electron microscopy, total dietary fibre estimation and physiological energy calculation were done to make sure about its consumption for human use.

PROXIMATE STUDY

AOAC (2000) methods were used to determine nutrient composition of copra meal flour using Microkjehldal unit for crude protein estimation, muffle furnace (Modern Industrial Corporation, Bombay) for total ash estimation, Soxplus (Pelican equipments, Chennai) for crude fat estimation, Fibraplus (Pelican equipments, Chennai) for crude fibre, and hot air oven for moisture determination. Available carbohydrate content was measured through difference, subtracting 100gm minus the sum of moisture, ash, protein, dietary fibre and lipids.

MINERAL ESTIMATION

Estimation of iron and zinc were done through dry digestion method (Pollman e*t al.,* 1991) using AA-7000 atomic absorption spectrophotometer (Shimadzu, Japan) using air-acetylene flame against range of standards and blank. Glassware and crucibles were kept with chromic acid solution overnight and washed with double distilled water next day to avoid any interference with other impurities.

TOTAL PHENOLIC CONTENT

Total phenols were elucidated using Folin-Ciocaltau reagent for copra meal flour by extracting them in acidified methanol solution for a minimum of 2 h of shaking followed by treatment with 10% FC reagent, 15% Na_2Co_3 and incubating it in dark (Singelton *et al.,* 1999). Readings were taken at 734 nm using water as blank.

ANTIOXIDANT CAPACITY

Antioxidant activity of copra meal flour is determined as Trolox equivalent using freshly prepared DPPH (2, 2-Diphenyl-1-pikryl hydrazyl) with a method described by Velazquez *et al*., 2003. The test and blank samples were incubated in dark at 37ºC for 40 min for the generation of adequate free radical and then observed spectrophotometrically at 517 nm using Backman coulter spectrophotometer.

COLOR VALUE

Color of finely ground copra meal flour was measured using a colorflex colorimeter supplied by Hunter Associated Laboratory, Inc., VA, USA. Instrument was calibrated with standard black and white tile as prescribed by the supplier. The light source was dual beam xenon flash lamp, data were received through software in terms of L* (Lightness), ranging from zero (black) to 100 (white), a* (Redness), ranging from +60 to -60 (green) and b* (yellowness), ranging from +60 (yellow) to -60 (blue) values (Mallikarjunan and Mittal, 1994). Total colour difference (ΔE) was determined using measured colour attributes with the following equation:

$$\Delta E^2 = \sqrt{\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2}}$$

TANNIN ESTIMATION

Tannin estimation was done through vanillin assay method using tannic acid standard curve (Scoyoc and Butler, 1978). Sample was extracted using 70% acetone; Color was developed during boiling of sample at 100 °C for about 60 min and read against blank at 500 nm. Blank were not subjected to the boiling step of 1 hour.

TOTAL DIETARY FIBRE ESTIMATION

Total dietary fibre was calculated through Megazyme standard assay kit, Ireland. It uses a combination of enzymatic and gravimetric methods, based on AOAC (2000). Filtered crucibles of porosity grade #G 2 (coarse 40-60µ) of 30 ml from Labco were utilized for separation of fibres for soluble and insoluble fraction. Correction of result was employed after subtraction of protein, blank and ash value of the digested samples.

ELECTRON MICROSCOPY OF COPRA MEAL

The special character of copra meal flour were viewed in the form of micrographs with 500x and 1000x magnified lens of electron microscope, resulted in almost three-dimensional effect. Scanning electron microscope used were of Zeiss make up imported from Cambridge (UK) and the sample observations was done after gold-palladium coating of 300-400Å dusted in high vacuum chamber.

TANNIN (ANTI-NUTRIENT) MINIMIZATION

Tannins are responsible for chelation of minerals of human importance and also to some nutrients (proteins) and thus impair their digestion. So their minimization is done by soaking of copra overnight in oxygenated water (Mukhopadhyay *et al.,* 1999a), used after drying and crushing of soaked sample in tray drier.

NUTRITIONAL QUALITY

Proximate results of crude fat, crude protein and carbohydrate were utilised to calculate the physiological energy (kcal/100gm) by using relation (crude protein x 4) + (crude fat x 9) + (crude carbohydrate x 4) (Anju *et al*., 2010).

STATISTICAL ANALYSIS

The data presented as mean ± SD (standard deviation) of three replicates. Graphical representations were shown with bars to evaluate their limits of deviation.

RESULTS AND DISCUSSION

PROXIMATE STUDY

The analytical exploration for copra meal flour proves its status as an ingredient with high fibre and protein value and can be utilized to overcome malnourishment, constipation and cardio-vascular disease.

MINERAL ESTIMATION

Minerals were estimated through dry digestion method using AAS for Fe and Zn as 9.139 mg/100gm and 4.003 mg/100gm respectively. These findings studied against a range of standards for iron and zinc and were in agreement with those studied by Salunkhe and kadam in 1995.

TOTAL PHENOLS

Folin ciocaltau's reagent was utilised for the prediction of total polyphenols content of copra meal flour resulted in 61mg/100gm when read at 734nm in conjuction with Gallic acid standard curve. It was hypothesized that high total phenolic content is directly proportional to the high free radical scavenging activity thus liable to show higher antioxidant power of foods. (Anoma *et al*., 2011)

ANTIOXIDANT ACTIVITY

Sample extraction in acidified methanolic solution explored using 2,2-Diphenyl-1- pikryl hydrazyl (DPPH) resulted in of 89.62µg/gm. This high level of antioxidative power is directly associated with the reduced oxidative damage to the body.

COLOR VALUE

Color parameters of copra meal flour showing L* value (38.93) thus indicating its brightness. On the other hand a* value (7.22), and b* values shift as most yellow (13.67) i.e. it was the darkest (towards brownness) among all the ingredients. The total colour difference (ΔE) was resulted in ΔE = 41.8873. Low L* value for copra flour provide darker color hence suits to impart various baked characteristics.

TANNIN ESTIMATION

As depicted by application of Vanillin assay for tannin estimation had a value of 2.05mg/gm in relation with tannic acid standard curve. These results for tannin concentration in de-oiled copra meal were agreed and supported with that reported by Mukhopadhyay *et al*., in 2001. Thus the present outcomes lend further support of presence of tannins in copra, reduced to 0.66mg/gm on soaking of it overnight. Higher amount of tannins impairs protein digestion and mineral absorption of human concern. Lower doses have heart beneficial properties as like consumption of tea in Indian tradition.

DIETARY FIBRE

Adequate amount of dietary fibre in food is good for proper bowel movements, which was traced after successive steps of hydrolysis by the enzymes amylase, protease and glucosidase obtained from megazyme TDF (Total Dietary Fibre) estimation kit and different stages of treatment with hot and cold water bath for copra meal flour resulted in 50.44%, 27.81% and 22.63% for total, insoluble and soluble fraction respectively (Figure-1), support the findings studied by Trinidad *et al*., 2006. Dietary fibre is directly associated with lowering of obesity, coronary heart and diabetic disease.

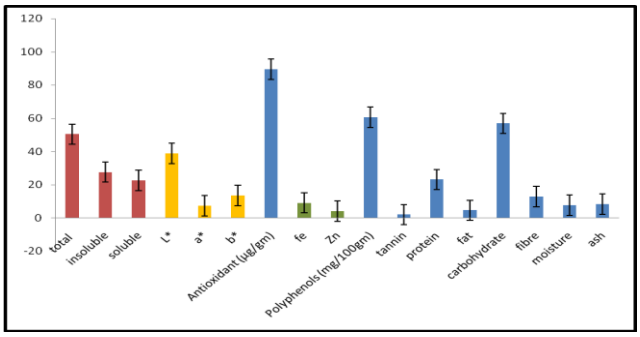

Figure-1 Graphical representation showing physico-chemical and nutritional results

ELECTRON MICROSCOPIC STUDY

Unavailability of studies related to microscopic view for copra meal flour lend me its investigate through Scanning electron microscopy (Zeiss, UK) with a magnification range of 500x (Figure-2) and 1000x (Figure-3). Outcomes in the form of photomicrographs were compiled and differentiate together. The resultant pictures for individual flour particles reveal only two molecules as fibre and protein of copra flour, round shape protein molecules and fibres are usually in an association with each other, can be seen by embedded protein within the fibrous matrix present in copra meal flour.

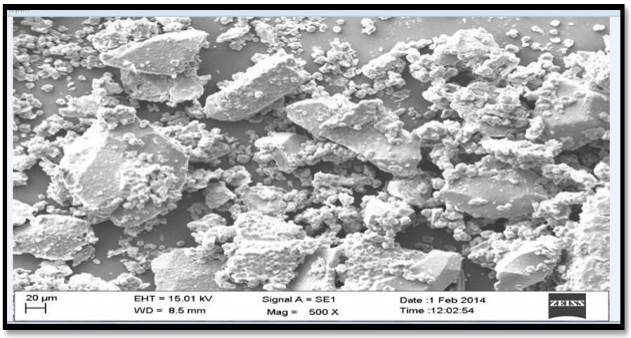

Figure-2: Photomicrograph viewed under 500 x magnifications for copra meal flour

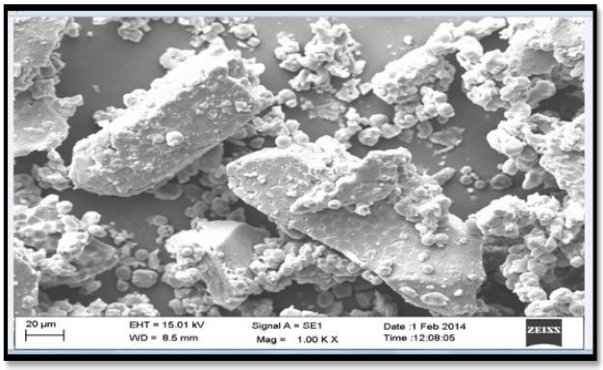

Figure-3: Photomicrograph viewed under 1000x magnification for copra meal flour

Table-1-Avg: Average, St. dev: Standard Deviation

	Dietry fiber (mg/100gm)			Colour				Minerals mg/100g				Proximate Composition					
	Total	Insoluble	Soluble	L*	A*	B*	Antioxidant (µg/gm)	Fe	Zn	Polyphenols (mg/100gm)	Tannin	Protein	Fat	Carbohydrate	Crude fibre	Moisture	ash
	50.44	27.81	22.63	38.93	7.22	13.7	89.62	9.139	4.003	61	2.05	23.04	4.48	56.94	12.79	7.33	8.21
	50.22	27.23	22.86	39.14	7.92	13.9	89.001	9.004	4.37	59.82	1.98	22.95	4.53	57.02	13	7.71	8.63
	50.69	27.94	22.19	38.51	7.02	13.2	89.94	9.21	3.91	61.25	2.21	23.21	4.96	56.81	12.85	7.93	8.24
Avg	**50.45**	**27.66**	**22.56**	**38.86**	**7.387**	**13.6**	**89.52**	**9.118**	**4.0943**	**60.69**	**2.08**	**23.067**	**4.657**	**56.92**	**12.88**	**7.657**	**8.36**
St. dev	**0.2352**	**0.378**	**0.3404**	**0.321**	**0.473**	**0.33**	**0.4774**	**0.105**	**0.2432**	**0.762**	**0.118**	**0.132**	**0.264**	**0.106**	**0.109**	**0.304**	**0.23**

NUTRITIONAL QUALITY

A total of 360.24 kcal/100gm of energy contained in the flour sample of copra meal, support the findings of Anju *et al.*, 2010.

CONCLUSION

Nutritional richness of by-product as seen by approaching physico-chemically proves its suitability to be a part of Indian diet to combat malnutrition disease, thus its recommendations in human diet should be a good consideration. Its higher phenolic and antioxidative capacity is directly associated with the cardio protective effect. High fibre content also adds value to it, responsible for prevention of atherosclerosis, risk of carcinogenesis, diabetes mellitus and necessary for proper bowl movement. High protein and minerals availability prove it to be used as an ingredient for different bakery formulation. Negligible amount of anti-nutrient (tannin) that remains after soaking of it in potable running water (minimal processing treatment) imparts positive approach to the body revealed from antioxidative outcomes rather than its negative influence of chelation and impairing protein absorption to the consumer. Photomicrograph shows interaction of fibre and protein molecules together observed through 1000x magnification.

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