As. J. Food Ag-Ind. **2009**, 2(03), 382-391

Asian Journal of Food and Agro-Industry
ISSN 1906-3040
Available online at www.ajofai.info

Research Article

Use of coconut flour as a source of protein and dietary fibre in wheat bread

K.D.P.P. Gunathilake*, C. Yalegama and A.A.N. Kumara

Coconut Processing Research Division, Coconut Research Institute, Bandirippuwa Estate, Lunuwila, Sri Lanka.

*Author to whom correspondence should be addressed, email: kdppgunathilake@yahoo.com

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Abstract

Bread made with wheat flour is an important part in the diet of many Sri Lankan. A substantial amount of refined wheat flour imported from Europe is being used by bakeries. However, refined wheat flour is not a good source of dietary fibre and protein. An attempt was made to utilize coconut flour, a byproduct of the Virgin Coconut Oil (VCO) industry for the partial substitution of wheat flour. Chemical analysis of coconut flour revealed that it contains 21.65% protein, 10.45 fibre, 59.77% carbohydrates and 8.42% fat. The fibre fraction contains 38.3% neutral detergent fibre, 24.4% acid detergent fibre, 14.1% hemicelluloses, 10.3% celluloses and 38.0% dietary fibre. Wheat-coconut flour blends were prepared by incorporating 10%, 20% and 30% coconut flour in all purpose wheat flour. Blends were evaluated for bread making qualities. Mixing behaviour (water absorption, arrival, dough development time and stability) of the blends was determined by Farinograph. Water absorption decreased with the increase in substitution, whereas dough development time, arrival time and stability were increased up to 20% substitution level. However, at 30% level, an unstable Farinogram was observed. Breads were evaluated for sensory properties (general appearance, crust colour, crumb grain, texture and taste). Coconut flour addition up to 10% was ranked 'good' and 20% ranked 'satisfactory', whereas 30% substitution negatively affected appearance, texture and overall acceptability of the product, ranked 'poor' in sensory evaluation. This study revealed that up to 20% substitution is possible to produce bread with acceptable qualities.

Introduction

Coconut plays an important role in the diet of the people in Sri Lanka supplying about 22% of the total calories, second only to rice. Coconut production in Sri Lanka in 2008 was estimated as 2,776 million nuts [1], of which over two thirds were consumed domestically. Sri Lanka offers a wide variety of kernel-based food products to the international market. Research and development on coconut-based food products has taken place over a long period of time and new knowledge and technologies have contributed to the diversification of products and byproducts which have in turn opened up new industries in Sri Lanka. Virgin coconut oil (VCO) is a recently emerging high demand product in the world and various types of cold presses are used for extraction of VCO from the coconut kernel at low temperature. The whitish residue remained after extracting VCO from cold press can be milled to flour [2]. Trinidad *et al* [3], reported that coconut flour can provide not only value added income to the industry, but also a nutritious and healthy source of dietary fibre. Coconut flour may play a role in controlling cholesterol and sugar levels in blood and prevention of colon cancer. Studies revealed that consumption of high fibre coconut flour increases fecal bulk [4].

Bread made with wheat flour is an important part of the diet of many Sri Lankans. A substantial amount of wheat flour imported from Europe is used in bakeries. However, refined wheat flour is not a good source of dietary fibre. Therefore, partial substitution of wheat by other locally available raw materials in the bakery can be undertaken in order to improve the nutritional value of bread. Reduction of dependence on wheat imports will also lead to savings in foreign currency. Rodgers [5], has described the necessity of having efficient, environmentally friendly research for the conversion of industrial by-products into functional ingredients, including coconut flour made from coconut residue. It is thus apparent that coconut flour can be incorporated with wheat flour in order to improve the health benefits of bread. Similarly, many studies have been conducted to assess the possibilities of adding natural ingredients to improve the nutritive value of wheat bread [6, 7, 8, 9, 10]. Masoodi [11], has studied the possibilities of incorporating apple pomace as a source of dietary fibre in wheat bread. Researchers also have recommended the addition of wheat bran, wheat whole grain and mixtures of different seeds, grain of other cereals (oat, rye and barley), dry fruit or probiotic bacteria to improve the nutritional status of various wheat food products [10].

This present study was thus undertaken with the objective of utilizing coconut flour for human consumption as a source of dietary fibre and protein. This paper reports on the effects of coconut flour on some baking properties of wheat flour bread.

Materials and Methods

Preparation of flour

Different mixtures of all purpose wheat flour and coconut flour were used in this study. The coconut flour was made from coconut residue after extracting VCO and was ground into fine particles using a grinder (model HL 3294/C Phillips) and was then sieved using US mesh 100 to obtain the coconut flour. This coconut flour was mixed with all purpose wheat flour at the levels of 10%, 20% and 30%. One hundred percent all purpose wheat flour used as the control. All purpose wheat flour was purchased from a local super market in Colombo (Sri Lanka) under the brand name of “Prima”.

Farinograph properties
Three hundred grams of different blends of wheat flour and coconut flour were mixed with the required amount of distilled water. Water absorption, dough development time, arrival time and stability were determined using the Farinograms of the Brabender OHG Duisburg (West Germany) instrument.

Baking
Breads were prepared by dry mixing of wheat flour with different levels (0%, 10%, 20% and 30%) of coconut flour. The blends were then again passed through a 30 mesh sieve for their uniform mixing. Yeast breads were prepared from all blends and straight dough development procedure [12] was used with slight modification for baking studies. The ingredients for two loaves are given below:

Flour/blend: 500g
Compressed yeast: 5g
Sucrose: 10g
Shortening (vegetable fat):10g
Salt: 7g
Water: 300ml

Fermentation was conducted at 30^0C. Total fermentation period of dough was 150 min with first punching after 90 min and second after an additional 35 min. Baking was done at 230^0C for 25 min. Figure 1 shows the flow chart of bread making process.

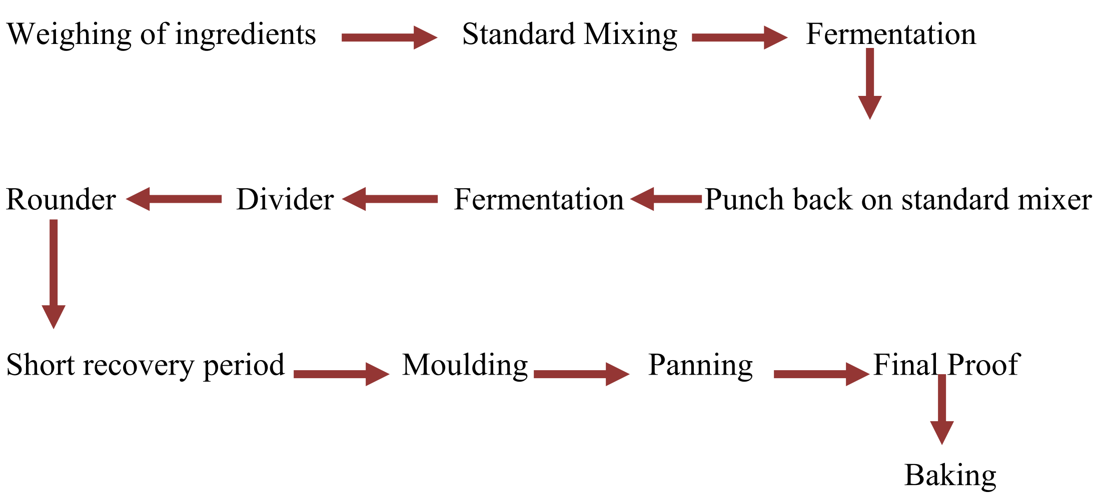


Figure 1.Flow chart of bread making process.

Chemical analysis
Moisture content (Oven dry method), fat content (Soxhlet extraction), crude fibre content and ash (Gravimetric) content were determined according to methods proscribed by AOAC [13]. Protein content was determined by the method described by Pearson [14]. Carbohydrate content was

determined by difference. Coconut flour was analyzed for different fibre fractions. Dietary fibre, neutral detergent fibre, acid detergent fibre, hemicellulose and cellulose [15].

Sensory Evaluation

A sensory evaluation was undertaken to assess the bread quality using 50 consumer panelists with the following score card (Table 1). Samples were coded with three digit random numbers and served in random order for the panelists. Panelists were asked to rank each quality parameter of the bread.

Table 1. Sensory scoring.

Sensory Attributes	Scores
General appearance	25
Crust colour	10
Crumb grain	20
Texture	20
Taste and odour	25
Total	100

Acceptability of the breads was determined according to the following grading (Table 2).

Table 2. Acceptability ratings.

Grading score	Acceptability rating
91-100	Excellent
81-90	Good
66-80	Satisfactory
51-65	Fair
50-less	Poor

Statistical analysis

The data were analyzed and means and standard deviation were determined. Mean comparison was done using ANOVA and Independent sample t-test using SPSS 10 statistical package.

Results and Discussion

Table 3 shows the proximate composition of coconut flour and all purpose commercial wheat flour while Table 4 shows the various fibre fractions.

Table 3. Nutrient composition of coconut flour and all purpose wheat flour.

Component	All purpose wheat flour	Coco flour from cold press
Moisture	9.76± 0.12	4.20±0.23
Ash	0.51±0.10	5.96 ±1.19
Fat	0.87±0.13	8.42 ±0.87
Protein	9.90±0.21	21.65±0.06
Crude fiber	0.50±0.10	10.45± 2.50
carbohydrates	78.46±0.15	59.77 ±3.32

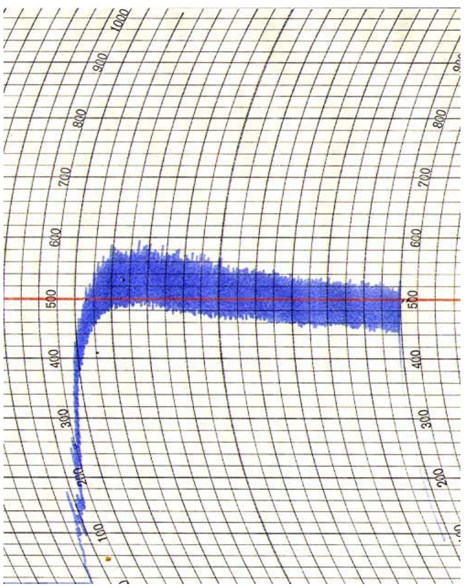
Table 4. Different fibre fractions present in coconut flour.

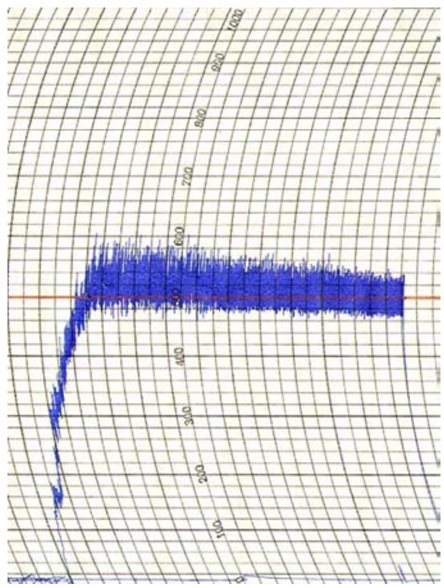
Fibre fraction	Percentage
Neutral detergent fibre	38.3± 0.4
Acid detergent fibre	24.2±0.5
Hemi cellulose	14.1±0.8
Cellulose	10.3±0.5
Dietary fibre	38.0±0.8

Different research using different methods has come up with different figures for coconut flour composition [16]. Composition of coconut flour depends on the retention of components after the extraction of coconut milk or oil from scraped/desiccated coconut. Therefore, composition of coconut residue also will change proportionately. Hagenmaier [17], reported that coconut flour contains 7.6% protein, 14% oil, approximately 17% crude fibre and 5% moisture. According to Arancon [2], nutrient composition of coconut flour is mentioned as; protein 13.41%, moisture 2.80%, crude fat 10.23% and crude fibre 19.3%. Trinidad, *et.al* [18], showed that the dietary fibre content of coconut flour was 60.0 +/- 1.0g/100g sample, 56% insoluble and 4% soluble. Further, they described that the total dietary fibre content of coconut flour was greater than other dietary fibre sources such as oat bran (8.3g/100g) and flaxseed (28.0g/100g). Ash, fat, moisture and protein content of wheat flour used in this experiment were 0.51%, 0.87% and 9.76% and 9.9%, respectively, on dry weight basis.

Neutral detergent fibre and acid detergent fibre obtained from the Vansoest method was 38.3% and 24.2% respectively. The coconut flour contained 14.1% hemicelluloses, which consist mostly of acid soluble carbohydrates. Cellulose, the most insoluble fibre, is 10.3% in coconut flour. These results indicated that coconut flour is rich in different types of edible fibres.

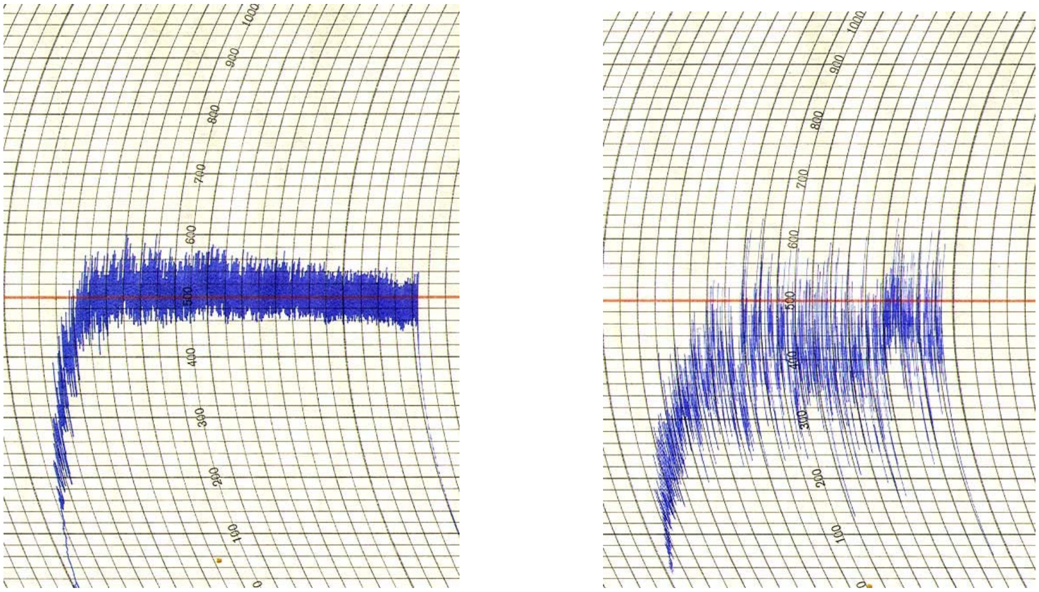
The use of a substitute for wheat flour affects the nutritive value of the product. The protein content of the wheat flour for bread making generally ranges from 10-14%. The protein content of coconut flour is about 21%. Thus the partial substitution of wheat flour by non-wheat flours, such as coconut, slightly increases the protein content. According to Bressani, *et al* [19], cereal protein, including wheat, is limited in lysine content and they also recommended that the biological value of wheat flour can be significantly improved by the addition of lysine. Boceta, as cited by Barrett *et.al* [20], stated that coconut flour when incorporated into wheat flour increases the amino acid content, especially lysine. Therefore, incorporation of coconut flour into wheat flour improves the protein content of composite flour and thus improves the nutritional status of food items such as bakery products made from that composite flour.





(A) 100% Wheat Flour

(B) 10% Coco Flour, 90% Wheat Flour



(C) 20% Coco Flour
80% Wheat Flour

(D) 30% Coco Flour
70% Wheat Flour

Figure 2. Farinograms of different substitution levels of wheat flour and coco flour blends.

Table 5. Mixing behaviour of blends of wheat flour and coco flour.

Level of substitution	Water absorption	Dough development time (min)	Arrival time (min)	Stability
0%	61.0%	5.5	4.0	18
10%	61.0%	6.0	5.0	>19
20%	60.5%	6.5	5.0	>18
30%	58.0%	>10	>10	ND

ND- Not determined

The Farinograph provides information on wheat quality, water absorption and mixing behaviour (dough development time, arrival time and the stability). Farinogram curves are shown in Figure 2. The amount of water absorption decreases as the level of substitution increases in order to get the Farinograms to 500 brabender units for the evaluation of flour. Studies done by Mashayekh, *et al* [21], revealed that oil seed flour added to wheat flour increased the Farinograph water absorption. However, addition of coconut flour reduced the water absorption, even though coconut is considered as an oil crop, coconut flour contains a considerably low amount of fat as it is produced from defatted coconut residue and also there may be some interference of high fibre in coconut flour in the dough development process. Dough development time and arrival time increased when the level of substitution increased, suggesting that more time is required to compare with 100%

wheat flour with dough mixing for the preparation of bread. However, flour with 30% coconut flour showed a much deviated form of Farinogram compared to 10% and 20% coconut flour blends and 100% wheat flour. Ten percent and twenty percent substituted blends showed much more stable dough, compared with 100% wheat flour, and this may be due to the stabilization of gluten structure of the dough by coconut protein present in coco flour. However, as shown in Figure 2(D), an unstable Farinogram curve can be observed at 30% substitution level, probably due to variation in dough development characteristics upon addition of more than 20% coconut flour, which may have contributed to over dilution of gluten forming protein resulting in weakening of the dough. Similar studies have been done for the determination of supplementation of wheat flour with cowpea flour by Sharma*, et al* [22] and they described that the changes in hydrating properties of two proteins may be another reason for differences in dough characteristics.

Table 6. Effect of coconut flour on sensory quality of bread.

Coco flour level	General appearance	Crust colour	Crumb grain	Texture	Odour and taste	Total score
0%-Control	21.8	8.8	18.0	17.6	19.8	86.0
10%	21.5±0.3	8.5±0.2	17.0±0.3	16.9±0.7	19.5±0.3	83.4
20%	14.5±0.3	8.6±0.3	14.1±0.3	15.7±0.3	17.4±0.3	70.3
30%	9.5±0.3	7.5±0.3	8.4±0.3	10.7±0.3	10.1±0.3	46.2
P value	<0.001	<0.001	<0.001	<0.001	<0.001	

Table 6 shows the sensory evaluation scores of bread samples at different levels of coconut flour. It is evident from the results that the scores for each sensory parameter decreased significantly with the increase in coconut flour concentration. According to the results of sensory evaluation, at 10% substitution level breads were graded as “good”, at 20% coconut flour level, breads were rated as “satisfactory” and at 30% substitution level, the breads were rated as “poor”. Thus, these results show that up to 20% substitution is possible to produce bread with acceptable qualities. Similar results have been observed by Gunathilake, *et al* [23] for the incorporation of coconut flour into wheat flour noodles and it was also shown that the addition of up to 20% coconut flour is feasible to produce organoleptically acceptable noodles.

Conclusion

The present study confirmed that the blending of wheat flour with coconut flour at different levels altered the organoleptic and rheological properties of different blends, even though it is acceptable up to 20% fortification level. It is therefore concluded that adding up to 20% coconut flour actually gives organoleptically acceptable bread. Fortification with coconut flour is advantageous due to the increased nutritional value, as coconut flour is rich in protein and dietary fibre.

Acknowledgements

The authors acknowledge the assistance provided by Mrs. Damitha Rajapaksha, Industrial Technology Institute, Sri Lanka, for the Farinograph study and staff of the Coconut Processing Research Division, Coconut Research Institute, Sri Lanka for their assistance.

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