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Enrichment of Wheat/Cassava Noodles with Partially Defatted Protein-Rich Flours

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Abstract: *Wheat/cassava composite flour was produced. Partially defatted peanut (Arachis hypogaea), bambara groundnut (Vigna subterranean), melon (Cucumeropsis manni) and soybean (Glycine max) flours were incorporated into the composite flour in the ratios of 80:10:10 (wheat:cassava:defatted flour). The blends were used to produce noodles. Proximate composition and functional properties of the flour blends were determined. Proximate analysis of all the samples showed significant differences (p>0.05) except the moisture content of the flour blends which ranged from 12.84 sample (201) to 13.38% sample (205). Addition of the defatted flour samples increased the protein content of the flour samples. Solubility of the flour blends ranged from 8.0% for sample 205 (10% CF and 90% WF) to 25.0% for sample 204 (10% PDSF, 10% CF and 80% WF). The foaming capacity also followed the same trend, with samples 205 (11.35%) and 204 (28.35%) having the lowest and highest values respectively. Addition of the defatted protein rich locally available flours affected the proximate and functional properties of the blends.*
Keywords: *bambara groundnut, cassava, melon, noodle, soybean, wheat*

I. Introduction

In many cassava growing areas, its use as food helps to alleviate the problems of hunger and carbohydrate intake deficiency and thus its importance in terms of food security in these areas cannot be over emphasized. **A**ddition of cassava flour to wheat flour to produce composite flour has being on going. Extruded and baked products consumption is continually growing and there has been increasing reliance on wheat [1]. Noodles are produced from wheat flour. Efforts are being made to partially replace wheat flour with non-wheat flours as a possibility for increasing the utilization of other crops as well as contribute to lowering the cost of baked products [2].

Cassava flour contains little protein and cassava starch contains none, since protein malnutrition is a very big problem mostly associated with children in developing countries, the demand for cheap protein enriched staples are on the uprising. This demand can be met by the production of protein enriched noodles which would be the most appropriate vehicle to get protein to the target market (children) and solve the problem of protein malnutrition.

Addition of partially defatted protein rich flours that are locally available into the composite flours of wheat-cassava will increase the nutritional value of the products [3,4]. Defatting of oil seeds before using them in composite flour production will help to increase their shelf –life. Supplementing cassava/wheat noodles with flours from other sources that are relatively higher in protein will help to improve the nutritional intake of the consumers. Hence the objective of this study was to check the physical and chemical properties of the composite blends and production of noodles from the blends.

II. Materials And Methods

Fifty kilogrammes of Cassava tubers (TMS 1368) yellow root variety were processed into high quality cassava flour. One hundred grams each of peanut, bambara groundnut, melon and soybean were separately sorted, washed, dehulled, ground and defatted using hexane in cold oil extraction method. The flour samples produced were blended in the ratios of (80:10:10) wheat flour: cassava flour : defatted flours to produce 5 different flour samples used for noodle production.

2.1 Proximate Analysis:

The procedures for the proximate analysis are as outlined by the Association of Official Analytical Chemist [5] for fat, ash, crude protein, moisture and crude fiber.

2.2 Functional Analysis:

Water Absorption Capacity was determined according to the method described by Okaka and Potter [6]. The method as described by Abbey and Ibeh [7] was adopted for oil absorption capacity. Gelling Point and Boiling Point were determined according to the method of Narayam and Narasinga Roa [8]. The gravimetric method was employed in determination of the bulk density. A weighed sample (10 g) was put in a calibrated measuring cylinder and tapped gently for 10 times on the bench to obtain a constant volume. The bulk density was calculated as mass of the sample over the volume. The swelling index was determined as a ratio of the swollen volume to the ordinary volume of a unit weight of the flour. The foaming capacity was determined using standard method [9]. The cold water extraction method was adopted [10] for solubility determination.

2.3 Noodle Production:

Noodles were produced using the flour blends. One hundred (100)g of each blend was mixed with 87g of raw egg to form a dough. The dough was allowed to rest for 20 minutes before rolling severally and extruded using a manually operated extruder (Eurosonic, globe 150). Noodle strands were extruded and put in clean aluminum trays then oven dried at 60^{o}C as shown in the chart below (fig.1).

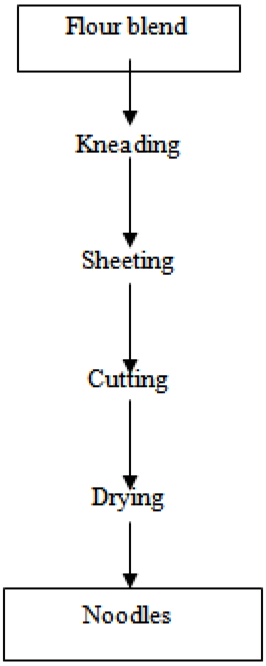

Figure .1: Flow chart for noodle production.

2.5 Statistical Analysis:

The results obtained were subjected to statistical analysis using analysis of variance (ANOVA) and Fishers least significant difference (LSD) procedure.

III. Result And Discussion

3.1 Proximate Composition of Flour Samples

The moisture content of the composite flour blends ranged between 12.84% and 13.38% and were not significantly different ($p<0.05$) Table 1. The moisture content of the noodles were high, which suggested that their shelf-life will be reduced. Therefore proper drying of the noodles would be required. The moisture content of any food material is of significance to shelf life, packaging and general acceptance [11]. The reduction of moisture content of any food during production helps to enhance its suitability and adaptability for further use in food formulation [12].

The ash content of the composite flour blends ranged from 1.39 to 2.84%. There were significant differences ($p>0.05$) between all the samples except for samples 202 that contained defatted bambara groundnut, and sample 203 that contained partially defatted melon flour (PDMF), which were not significantly different ($p< 0.05$). The differences in the ash content of the samples were as a result of compositional differences. Generally, the ash content of the flour blends increased with addition of the partially defatted flour samples to the wheat-cassava composite flour. The ash content represents the total mineral content in foods and thus serves as a viable tool for nutritional evaluation [13].

The crude fiber content of samples 202 (10% PDBG, 10% CF and 80% WF) and 203 (10% PDWMF, 10% CF and 80% WF) were not significantly different ($p<0.05$) but differed significantly ($p>0.05$) from the other samples. The differences observed in the crude fiber content of the different samples could be as a result of the different compositions of the samples. The crude fiber content of the wheat-cassava composite flour increased with the incorporation of the partially defatted samples. Crude fiber contributes to the health of the gastrointestinal system and metabolic system in man [14].

The results showed a positive correlation between the addition (incorporation) of partially defatted flour samples and the crude protein contents of the composite flour blends. The low protein content of sample 205(10% CF and 90% WF) was as a result of the low protein content of cassava. Defatting increased the protein content of the flour samples, which was also reported by other works [15]. The crude protein content of the partially defatted samples ranged from 36.53 - 52.00% with samples 302 (PDBGF) and 304 (PDSF) having the lowest and highest values respectively. Samples 301 (PDGF) and 303 (PDWMF) were not significantly different ($p<0.05$), but differed significantly ($p> 0.05$) from the other samples. There were correlation between the crude protein content of the raw samples and the defatted samples.

The fat content of the blends also increased with incorporation of the defatted samples, though the fat content were generally low. The slight increase in the fat content of the flour blends was due to the residual fat retained in the partially defatted flour samples which made up 10% of the wheat-cassava composite flour. The low fat content of the samples could make them useful for the formulation of low fat food for certain category of people especially for the obese.

The carbohydrate content of the samples were significantly different ($p>0.05$) from each other. The differences in the carbohydrate contents of the composite flour blends would be attributed to the differences in the carbohydrate contents of the partially defatted samples. Sample 202 (67.88%) had the highest carbohydrate content when compared with the other samples containing the same quantity of different defatted flour samples. This would be because of the high carbohydrate content of Bambara groundnut (54.5 – 69.3)% [16]. The high carbohydrate content of these samples suggested that the flours would be a very cheap source of energy for the body.

3.2 Functional Properties

The results of the functional properties of the samples shows that the bulk density of samples 202, 204 and 205 were not significantly different ($p<0.05$) from each other but differed significantly ($p>0.05$) from the other samples (Table 2). Sample 201 (2.13 g/ml) had high bulk density. The high bulk density of sample 201 (10% PDGF, 10% CF and 80% WF) may be attributed to its higher fat content when compared with other samples. Bulk density is an indication of the porosity of a product which influences package design and could be used to determine the type of packaging material required. Low bulk density is important and desirable for infant foods [17].

There were no significant differences ($p<0.05$) in the swelling index of samples 201, 203 and 204 but these samples differed significantly ($p>0.05$) from other samples. Sample 205 (1.24g/ml) had the highest swelling index. This result may be due to the composition (most especially the low protein and fat content) of the sample and the processing method adopted. The amount of protein and fat of a flour could inhibit the starch granules from swelling [18]. High swelling capacity has been reported as criteria for a good product [19].

The water absorption capacity (WAC) of the composite flour blends ranged from 1.10 – 1.20g/cm^3. There were no significant differences ($p<0.05$) in WAC of all the samples studied except for sample 205 (1.10g/cm^3). The improved water absorption capacity of the samples containing the partially defatted flours could have resulted from their high protein and carbohydrate content. Water absorption capacity improves with increase in protein and carbohydrate content of particular flour blends [20, 21]. WAC characteristics represent the ability of a product to associate with water under condition where water is limiting, in order to improve its handling characteristics [22] and dough making potentials [17], also water absorption capacity is important in bulking and consistency of products as well as baking applications[23 , 24].

The oil absorption capacity (OAC) of the samples ranged from 0.93 – 1.11g/cm^3. The results showed that there were no significant differences ($p<0.05$) in the oil absorption capacity of samples 201 (10% PDGF, 10% CF, 80% WF) and 204 (10% PDSF, 10% CF and 80% WF) as well as between samples 202 (10% PDBGF,10% CF and 80% WF) and 205(10% CF and 80% WF). From the result, the OAC of the flour blends increased with increase in protein content, There was increase in OAC of extruded rice products enriched with defatted soybean flour with increase in protein content [25]. Fat acts as flavor retainer and increases the palatability of foods. Oil absorption capacity is an important property in food formulation.

The foaming capacity of the composite flour blends ranged from 11.35 – 28.35% with samples 205 (10% CF and 90% WF) and 204 (10% PDSF, 10% CF and 80% WF) having the lowest and highest values respectively. The composite flour blends showed significant difference ($p>0.05$) in their foaming capacity. The study showed that foaming capacity increased with increase in the protein content of the samples. Indeed, proteins were denatured and aggregated during agitation leading to foam formation [26]. The foaming capacity of the samples can be rated as high owing to the fact that they contain considerably high amount of protein which is a good foaming agent.

The gelation point of the composite flour blends ranged from 50.00 – 62.00^{o}c. The result showed that the gelation point of samples 201(10% CF and 80% WF) and 204(10% PDSF, 10% CF and 80% WF) were not significantly different ($p<0.05$) from each other but differs significantly ($p>0.05$) from other samples. Sample 205(10% PDGF, 10% CF, 80% WF) had the highest gelation point. The variation in gelation point among samples may be attributed to compositional dissimilarities especially with regards to their starch contents. Gelatinization affects digestibility and texture of starch containing foods [27:28]. The boiling point of the flour blends ranged from 53.00 – 66.00^{o}c with samples 201(10% CF and 90% WF) and 205(10% PDGF, 10% CF, 80% WF) having the lowest and highest values respectively. The boiling point of samples 202 (10% PDBGF, 10% CF and 80% WF) and 203 (10% PDWMF, 10% CF and 80% WF) were not significantly different ($p<0.05$) as well as those of samples 202 (10% PDBGF, 10% CF and 80% WF) and sample 204 (10% PDSF, 10% CF and 80% WF), but samples 203 (10% PDWMF, 10% CF and 80% WF), sample 204 (10% PDSF, 10% CF and 80% WF)and sample 205 (10% CF and 80% WF) were significantly different ($p>0.05$) with respects to their boiling point.

The solubility of the composite flour blends ranged from 8.00 – 25.00% with samples 205 (10% CF and 90% WF) and 204 (10% PDSF, 10% CF and 80% WF) having the lowest and highest values respectively. The result showed that there were significant differences ($p> 0.05$) among all the samples. Solubility reflects the extent of intermolecular cross bonding within the starch granules.

IV. Conclusion

The study showed that partially defatted protein rich flours had protein content higher than that of their whole undefatted flour and blending them with wheat flour and cassava flour invariably increased the protein content of the wheat-cassava composite flour. The functional analysis results showed that substitution of composite flour of wheat/ cassava with (10%) partially defatted protein rich flours also showed improvement in the properties. The flour blends was used in the production of noodles with high nutrient value, and improved functional properties.

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Table 1: Proximate composition of different composite flour blends

Sample	Moisture (%)	Ash (%)	Fiber (%)	Protein (%)	Fat (%)	Carbohydrate (%)
201	12.84^{a}	2.84^{a}	2.13^{a}	16.80^{b}	3.00^{a}	62.39^{e}
202	12.98^{a}	1.81^{c}	0.78^{c}	14.12^{c}	2.43^{b}	67.88^{b}
203	12.89^{a}	1.83^{c}	0.74^{c}	16.80^{b}	2.63^{ab}	65.20^{c}
204	13.04^{a}	2.06^{b}	1.11^{b}	17.55^{a}	2.45^{b}	63.79^{d}
205	13.38^{a}	1.39^{d}	0.43^{d}	12.35^{d}	2.33^{b}	70.12^{a}

Table 2: Functional properties of composite flour blends

Flour Sample	Bulk Density (g/ml)	Swelling Index (g/ml)	Water absorption capacity (g/cm^3)	Oil absorption capacity (g/cm^3)	Foaming Capacity (%)	Gelling point (°c)	Boiling point (°c)	Solubility (%)
201	0.17^{a}	1.00^{c}	1.20^{a}	1.30^{a}	22.94^{b}	50.00^{d}	53.00^{d}	16.00^{b}
202	0.66^{c}	1.09^{b}	1.20^{a}	0.93^{c}	14.94^{d}	56.00^{b}	60.00^{bc}	10.00^{d}
203	0.68^{b}	1.02^{c}	1.20^{a}	1.11^{b}	15.90^{c}	52.00^{c}	59.00^{c}	14.00^{c}
204	0.66^{c}	1.00^{c}	1.20^{a}	1.30^{a}	28.35^{a}	50.00^{d}	62.00^{b}	25.00^{a}
205	0.71^{c}	1.24^{a}	1.10^{b}	0.93^{c}	11.35^{c}	62.00^{a}	66.00^{a}	8.00^{e}
LSD	0.0382	0.0256	0.0314	0.0750	0.157	1.994	2.303	0.328

Means with different superscripts within the same column are significantly different ($P < 0.05$)

Key:
201 = 80% WF: 10% CF: 10% GF
202 = 80% WF: 10% CF: 10% BGF
203 = 80% WF: 10% CF: 10% WMF
204 = 80% WF: 10% CF: 10% SF
205 = 90% WF: 10% CF

Where;
WF = Wheat flour
CF = Cassava flour
GF = Groundnut flour
BGF = Bambara groundnut flour
WMF = White melon flour
SF = Soybean flour