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Production and Evaluation of Extruded Noodles from Blends of Wheat and Toasted Soybean Flour (*Glycine Max*) By Cold Extraction Method

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Abstract

Studies were conducted on the physicochemical properties of extruded noodles formulated from wheat flour and soybean blends through cold extrusion. Six blends were formulated with compositions; Sample A 80% wheat flour, 20% of soybeans flour, sample (B) 78% of wheat flour and 22% of soybeans, Sample (C) 76% of wheat flour and 24% of soybeans, sample (D) 74% of wheat flour and 26% of soybeans, Sample (E) 72% of wheat flour and 28% of soybeans, sample (F) 70% of wheat flour and 30% of soybeans. The results for the proximate analysis, moisture contents ranged from 8.45-9.30% with sample E being the highest, while sample (B) had the lowest moisture content. The protein content of the samples ranged from 13.30-20.25% with sample (F) having the highest value while sample (A) had the least value. From the results, it was observed that increase in the ratio of soybeans in formulations, increases the protein contents of samples which ranged from 13.30-20.25% respectively. For carbohydrate content, sample (A) had the highest value and sample (F) had the lowest value. The ash content of the samples ranged from 1.75-3.30% respectively, this may be due to the increase in fibre content of soybeans. Water absorption Index (WAI), Sample (A) had the highest value of 8.1ml, while sample (F) had the least value of 6.5ml. There is a relative decrease in Water Solubility Index (WSI) as it ranges from 6.09-8.89. Bulk density, Sample (A) had the lowest value of 4.1 cm. Wettability ranges from56.34- 69.0, which shows decreases with increase in soybean content. Viscosity sample F had the highest value of 2.52 while Sample (A) had the lowest value. Expansion Ratio from 6.09-8.89. However, sample (B) was rated the best in terms of general acceptability of 7.7. The process variables for the production of noodles from blends of wheat flour and soybean were found to be feasible from the result of this study.

Keywords; Soybeans, Cold Extrusion, Formulation, Blends, Composition, Increase.

Introduction

Noodle is a convenience food made from unleavened dough which is rolled flat and cut stretched and extruded into long strings or strips. It is prepared by boiling in liquid for few minutes. It is a staple food in many regions of the world which most likely originated from China. Noodles are made from various raw materials; cereals and pseudo cereals, with wheat and rice being predominantly used (Samtiya et al. 2020).

Although legumes are rich in proteins, the quality of their protein is not nutritionally adequate. This is because they lack sulphur-containing amino acids such as methionine and cysteine.

These limiting amino acids are, however, complemented by the use of legume-cereal blends in diets. Cereals, being rich in sulphur-containing amino acids, complement the legume proteins, hence improving the quality of the protein. Other factors such as low protein digestibility, presence of antinutritional factors such as trypsin inhibitors, lectins, phytates, polyphenols, and flatulence factors make some legume seeds underutilized. Most of these antinutritional factors can, however, be reduced or eliminated by various processing techniques. Samtiya et al. (2020) reported that soybean could also be used for making nutritious food products such as cookies, snack foods, bread, soups and pasta due to the rich protein concentration as well as balanced amino acid profile. Most cereals consist of vitamins and minerals with all the essential amino acids required by humans except for lysine and tryptophan. These can be complemented with legumes (soybeans) for the low nutrients or even those lacking in the cereals when consumed with other food items.

The advent of industrial manufacturing, extrusion has found application in food processing of instant foods and snacks. The main role of extrusion was for conveying and shaping fluid forms of processed raw materials. Present day extrusion cooking technologies and capabilities have developed into sophisticated processing functions including mixing, conveying, shearing, separation, heating, cooling, shaping, co-extrusion, venting volatiles and moisture, encapsulation, flavor generation, and sterilization (Wikipedia. 2021). Products such as certain pastas, many breakfast cereals, premade cookie dough, some French fries, certain baby foods, dry or semi-moist pet foods, and ready-to-eat snacks are mostly manufactured by extrusion. It is also used to produce modified starch and to pelletize animal feed. Generally, high temperature extrusion is used for the manufacture of ready-to-eat snacks, while cold extrusion is used for the manufacture of pastas and related products intended for later cooking and consumption. The extrusion process can induce both protein denaturation and starch gelatinization depending on inputs and parameters (Wikipedia, 2021).

Extrusion-cooking is accompanied by the process of starch gelatinization, involving the cleavage of intermolecular hydrogen bonds. It causes a significant increase in water absorption, including the breakage of starch granules. Gelatinized starch increases the dough viscosity, and high protein content in the processed material, facilitates higher flexibility and dough aeration. After leaving the die hot material rapidly expands as a result of immediate vaporization and takes on a porous structure (Wikipedia, 2021). Studies have been reported on the effects of extrusion on protein nutrition especially for animal feeds and for human weaning foods (Ajita, 2018). Improvements in functional characteristics of proteins may be achieved through modification of temperature, screw speed, moisture content, and other extrusion parameters (Ajita, 2018). Ultimately, this research work is based on improving (from plant sources) proteins in the diet, and protein energy demands of large percentages of people, particularly students, children and individuals in rural areas, since the cost of obtaining animal protein is relatively high.

OBJECTIVE OF THE STUDY

The general objective of the study is to produce noodles from blends of wheat flour and toasted soybean flour (*glycine max*) by cold extraction method with the specific following objectives:

(i) To produce an extruded noodle. (ii) To carry out the proximate analysis. (iii) To carry out a sensory evaluation of the extrudates. (iv) To carry out some functional properties.

MATERIALS AND METHODS

Wheat and soybean were obtained from Kasuwan Dole Mubi North, Adamawa State, Nigeria. All materials were kept in a moisture free environment before processing and analysis.

The Wheat grain was winnowed to separate grain from stalks, stones and other contaminants then washed with clean portable water and drained through a plastic strainer. The drained wheat grains were sun dried for 72 hours after which it was milled using a laboratory attrition mill (Farmax – Model FCC15) and sieved through a mesh sieve of 0.85mm to obtain fine flour. The flour was stored in air tight zip lock bags.

The soybean was screened to remove stones, immature and bad seeds after which it was sorted, cracked and winnowed manually before being soaked for 3 hours to dehull the seeds. The dehulled seeds were washed using clean portable water and drained through a plastic strainer. Drained grains were sun dried for 72 hours after which it was toasted using low heated pan till it turned brown. The toasted soybean was left to cool and finally milled using a laboratory attrition mill (Farmax – Model FCC15) and sieved through a mesh sieve of 0.85mm to obtain fine flour. The flour was stored in air tight zip lock bags.

Formulation: Sample A 800g of wheat flour, 200g of soybeans flour sample (B) 780g of wheat flour, 220g of soybeans, sample (C) 760g of wheat 240g of soybeans, sample (D) 740g of wheat, 260g of soybeans, sample (E) 720g of wheat, 280g of soybeans, sample (F) is 700g of wheat and 300g of soybeans.

Moisture adjustment: Two thousand grams weight of samples were obtained by mixing the given percentage wheat flour in each with the soybean flour and the total moisture content of the blends were determined on a wet weight basis using the formulas given below (Filli *et al*., 2011).

$W = M - (C_{SF} + C_{WF})$.

$$C_{SP} = \frac{[rSF\ X\ M\ (100-W)]}{[100\ X\ (100-W_{SF})]}$$

$$C_{PF} = \frac{[rPF\ X\ M\ (100-W)]}{[100\ X\ (100-W_{F})]}$$

$W_X = M - C_{Wf} - C_{SF}$

W = Moisture content of the total blend, M = Total mass of blend, C_{wf} = Mass of wheat flour, C_{SF} = Mass of soybeans flour

rWF = Percentage of wheat flour

rSF = percentage of soybeans flour

W_X = Weight of water added

W_{wf} = Moisture content of wheat flour

W_{SF} = Moisture content of soybeans flour

The extrusion was performed in twin-screw extruder (SLG 65 model). The sample blends were fed manually through a screw operated conical hopper and extrudates (Noodles) were dried under cool ventilated area for 24 hours before packaging.

Proximate analysis: The proximate analysis of the product was determined in the food analysis laboratory of the Food Science and Technology Department of the Federal Polytechnic Mubi.

Moisture content of extruded products was determined using a moisture analyzer. 5g of sample was placed in a sample plate of known weight and dried in the moisture analyzer manufactured by Fuji instrument (model LSC 60D) set at 150°C for 10 minutes. Value of moisture content was displayed on the screen of the equipment after drying. Crude fat was determined by the Soxhlet method (AOAC, 2010) using EV 16 fat extractor manufactured by Gerhardt, Germany. 5g of sample was weighed into the fat extraction thimbles and covered with cotton wool. 50ml of diethylether of boiling point range of 40 - 60°C was added. The extracted fat stayed in the hot air-oven for about 1 hour. The flask was cooled in a desiccator and weighed. The percentage fat was calculated thus: $\% \text{ Fat} = \frac{\text{Weight of extract}}{\text{Original weight of sample}} \text{ X } \frac{100}{1}$

Crude protein content was determined by Kjeldahl method (AOAC, 2010), the process involves: digestion, distillation and titration. Nitrogen/Protein determinator (KDN-2C) manufactured by Shanghai Qianjian Instrument Company Limited, China.

Total ash content of sample was determined by the AOAC (2010) method. 5g of each sample was taken in a crucible. The organic matter was burnt off and the residue ashed at 550°C in a muffle furnace (Labor Muszeripari Muvk, model LP 203, Hungry) for 4 hours. The sample was removed and cooled in a desiccator and weighed.

$$\% \text{ Ash} = \frac{\text{Weight of ash}}{\text{Original weight of sample}} \text{ X } \frac{100}{1}$$

Crude fiber was determined by AOAC (2010) method. 2g of the samples was boiled in 200 ml of weak sulphuric acid (1.25%) and sodium hydroxide (1.25%), with few drops of anti-foaming agents being added, for 30 min. The residues were filtered and washed three times with hot water, then washed with 95% ethanol and dried at 105°C for 5h to constant weight. The dried residues were ignited in a muffle furnace at 550°C for 2h. The crude fiber in grams was calculated as the difference between the weight of the residues and ash and converted as a fraction of the sample weight in percentages. The percentage carbohydrate was determined by subtracting the known amount of moisture, crude protein, crude fat, total ash and crude fibre from 100. The difference was reported as the percentage carbohydrate (AOAC, 2010).

Bulk density: A graduated measuring cylinder was filled with 4 grams of sample and gently tapped ten times on the laboratory bench until there was no space between sample particles and the volume recorded (Onwuka, 2005).

Bulk Density = $\frac{Weight\ of\ sample\ in\ grams}{Volume\ of\ sample\ in\ mills}$ g/m

Wettability: A finger was placed over a 25mL graduated cylinder 1 cm in diameter containing one gram sample on the open end, inverted and clamped at a height of 10 cm from the surface of a 600ml beaker filled with 50mL of distilled water, finger was removed allowing sample to dump into the beaker. The time taken in seconds for sample to completely soak is the wettability, (Onwuka, 2005).

Expansion ratio: The ratio of diameter of extrudate and the die diameter was used to express the expansion of extrudate (Sawant et al., 2013). The diameter was determined as the mean of ten random measurements with a venier caliper. The extrudate expansion ratio was calculated as,

Expansion ratio = $\frac{diameter\ of\ extrudate}{die\ diameter}$

Water absorption index (WAI) and water solubility index (WSI): These were determined in triplicate following the method described by Carine et al., (2010). One gram of each sample suspended in 20mL of distilled water in a 45mil centrifuge tube and stirred with a glass rod before putting it in water bath for 30 minutes at 30ºC and then centrifuged at 3,000 rpm for 15 minutes. The supernatant poured into dry evaporator dish of a known weight and stored over night at 120ºC to evaporate.

$WAI = \frac{weight\ of\ sediment}{weight\ of\ dry\ sample}$

$WSI = \frac{weight\ of\ disolved\ solid\ in\ supernatant}{weight\ of\ dry\ samples\ in\ the\ original\ sample}\ x\ 100$

Viscosity: Viscosities of extrudates were analyzed at 30ºC using digital A&D Vibro-Viscometer SV – 10. Five grams of sample was added to 50 mils of distilled water stirred and allowed to stand for 39 minutes and then poured into the viscometer and allowed to run at 5 seconds interval for 5 minutes. Final values at this temperature were recorded in mPa/s.

Sensory evaluation: \The method described by Iwe (2002), was adopted for sensory evaluation after production of extruded product. Samples was served to 25 panelists to rate them using a 9-point hedonic scale on the basis of their quality attributes (taste, appearance, aroma, and overall acceptability). The best sample was ranked 9 with descriptive term "like extremely" while the worst sample ranked 1 with descriptive term “dislike extremely” on the questionnaire. The samples were served in transparent plastic cups and they were asked to rinse their mouth with clean water provided before next serving. The containers with samples were coded and kept apart to avoid crowding and for independent judgment. Panelist were selected based on availability for the entire period of evaluation, willingness, interest to serve, good health and not allergic to the product. The panelists were asked to assess and freely comment on the quality attributes of the samples.

Analysis: All analytical determinations were conducted in triplicate. Means and standard deviations were calculated and data subjected to analysis of variance (ANOVA). Duncan’s Multiple Range Test (DMRT) was used in separating the means and significance accepted at $p<0.05$.

RESULTS AND DISCUSSION

Table1. Observed Mean Values of Proximate Mean Composition of Extrudates (%)

Sample	Protein	Fats	Moisture	Ash	**Carbohydrates**
A	4.5 ± 21^{x}	4.1 ± 0.58^{g}	3.2 ± 0.70^{d}	3.0 ± 0.48^{e}	**85.20 ± 0.66^{gh}**
B	4.9 ± 0.73^{y}	4.7 ± 0.57^{m}	$3.4\pm0{,}96^{i}$	3.4 ± 0.67^{a}	**83.60 ± 0.48^{z}**
C	5.4 ± 0.34^{k}	5.3 ± 0.54^{w}	3.7 ± 0.42^{s}	3.1 ± 0.23^{g}	**$82.50.76^{s}$**
D	5.7 ± 0.14^{h}	5.9 ± 0.79^{c}	3.6 ± 0.93^{b}	3.7 ± 0.8^{jl}	**$81.10.79^{z}$**
E	5.8 ± 0.68^{l}	6.5 ± 0.16^{f}	3.8 ± 0.54^{lm}	4.0 ± 0.94^{p}	**$79.90.38^{v}$**
F	6.2 ± 0.28^{xy}	6.9 ± 0.12^{p}	3.7 ± 0.98^{c}	4.3 ± 0.12^{z}	**$78.90.48^{c}$**

Any two means in the same column followed by the same letter are not significantly different ($P > 0.05$).

Protein content of extrudates increases with increase in soybean as it rises from 4.5-6.2 with sample F having the highest value and A with the lowest value may be due to high protein content of soybean. Fats content of extrudates increased in sample A to F being the highest this could be due to the significant amount of fats found in soybean. Moisture content of extrudates slightly increased from 3.2 to 3.8 which could be due to increase soybean. There is similar increase in Ash from 3.0 to 4.3 this may be because of the level of fibre present in soy bean. The carbohydrate content of extrudates shows decrease from 85.2 to 78.9 may be due to the decrease in wheat as the ratio decrease.

Table 2. Observed mean value of functional properties.

Sample	Wettability	Water Absorption Index	Water Solubility Index (%)	Viscosity mpa/s	Expansion ratio	Bulk density (g/mil)
A	69.01±0.01^{a}	5.44±0.31^{v}	8.89±0,06^{m}	8.29±0,06^{m}	8.89±0,06^{m}	0.49±0.05^{w}
B	62.02±0.11^{l}	6.57±0.19^{f}	8.53±0.37^{d}	8.43±0.37^{d}	8.03±0.37^{d}	0.53±0.12^{gh}
C	58.39±0.07^{b}	6.42±0.58^{ad}	8.22±0.036^{a}	8.62±0.036^{a}	9.22±0.036^{a}	0.67±0.13^{nm}
D	59.05±0.08^{w}	5.82±0.23^{c}	6.86±0.46^{b}	8.86±0.46^{b}	6.86±0.46^{b}	0.63±0.15^{l}
E	57.07±0.12^{d}	4.47±0.34^{v}	6.09±0.07^{e}	9.09±0.07^{e}	6.09±0.07^{e}	0.67±0.08w
F	56.34±0.11^{z}	4.23±0.89^{x}	6.29±0.08^{ij}	9.79±0.08^{ij}	6..02±0.08^{ij}	0.69±0.24^{g}

Any two means in the same column followed by the same letter are not significantly different (P > 0.05).

Table 2 shows the results of the functional properties of extruded. Wettability value ranges from 56.34-69.01, Water Absorption Index (WAI) increased from 4.23-6.57, Water Solubility Index (WSI) decreased from 8.89-6.09, Viscosity of extrudates increases gradually with increase in soybean ratio from 8.29-9.79, Expansion Ratio decreases with increase in soybean ratio from 8.89-6.02 and the Bulk Density ranges from 0.49-0.69. From the results there is effect of the increase in soybean ratio on the functional properties of the extrudates may be due to the amount of fat and fibre content of soybean.

T**able 3.** Observed mean values of sensory evaluation (%)

Sample	Taste	Aroma	Colour	Appearance	General Acceptability
A	7.7±0.86^{m}	6.4±0.23^{e}	7.7±0.77^{f}	6.4±0.59^{l}	7.7±0.48^{d}
B	7.8±0,94^{s}	6.9±0.19^{d}	6.7±063^{kj}	6.5±0.53^{jh}	8.1±0.19^{gh}
C	7.2±0.48^{a}	6.6±0.83^{w}	5.6±061^{n}	6.3±0.57^{h}	7.5±.49^{s}
D	6.5±0.76^{z}	6.6±0.27^{d}	6.9±074^{r}	6.7±0.29^{x}	6.8±0,14^{z}
E	7.0±0.14^{lm}	6.3±0.86^{f}	5.2±0.90^{kl}	6.8±0.14^{a}	7.1±0,19^{z}
F	7.0±0.17^{c}	6.3±0.17^{f}	6.8±0.56^{h}	5.6±028^{y}	7.8±0.29^{b}

Any two means in the same column followed by the same letter are not significantly different (P > 0.05).

The results of sensory evaluation of the samples are presented in table 3 above. Taste of extrudates ranged from (7.0 -7.7), Aroma from (6.3-64), Colour from 5.2-7.7, Appearance from 5.6-6.8 and General acceptability from6.8-8.1 respectively. From the results, sample B has the highest values in terms of Taste, Aroma and General acceptability; while sample A has the highest value in terms of Colour, and sample E in terms of Appearance. There was a significant difference between all the samples at 0.0 5% significant level.

CONCLUSION

Extruded Noodles were produced from blends of wheat flour and toasted soybeans using a twin-screw extruder. Significant differences existed in the physiochemical properties of the blends formulated from the different levels of feed composition. Sample B with composition ratio of 780g of wheat flour 220g of soybean flour is acceptable to supplement the production of extruded noodles which will go a long way in reducing protein deficiency syndrome of malnutrition among children in the developing countries of Africa. Therefore, the process variables for processing of noodles from blends of wheat flour and soybeans were found to be feasible from the result of this study.

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