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Nutritonal Properties of Composite Flour (Blends of Rice (*Oryza sativa*), Acha (*Digitaria exilis*) and Soybeans (*Glycine max*) and Sensory Properties of Noodles Produced from the Flour

E. E. Edet[1*], G. I. Onwuka[1] and C. O. M. Orieke[1]

[1]Department of Food Science and Technology, College of Applied Food Sciences and Tourism, Michael Okpara University of Agriculture, Umudike. P.M.B. 7267 Umuahia, Abia State, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Authors EEE and GIO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors EEE and COMO managed the analyses of the study. Author COMO managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

This study was carried out to evaluate the nutritional properties of composite flour made from rice, acha, soy beans and wheat, and to assess the sensory acceptability of the noodles made from the composite flour. Different ratios of rice, acha, soybeans and wheat flour blends 100W (wheat) which is the control; 75: 15:10, (wheat, rice and soybean), 70:20:10 (wheat, rice and soybean), 65:20:15 (wheat, rice and soybean), 60:25:15 (wheat, rice and soybean), 50:30:20 (wheat, rice and soybean), 40:40:20 (wheat, rice and soybean); 80:15:5 (wheat, acha, soybean), 70:20:10 (wheat, acha, soybean), 65: 20: 15 (wheat, acha, soybean), 60:25:15 (wheat, acha, soybean), 50: 30:20 (wheat, acha, soybean), 40:40:20 (wheat, acha, soybean) samples. Proximate composition data for protein, fat, crude fibre, ash, carbohydrate and energy ranged from (5.26-18.82%, 7.02-21.01%, 0.33- 0.79%, 0.40- 1.21%, 57.63- 74.94%, 1568.91- 1945.29%, respectively. There was a

**Corresponding author: Email: ekahedem@gmail.com;*
Email: princesscomo@gmail.com;

significant difference (P<0.05) in the mineral content of samples. Samples with rice blends had the highest mineral content and blends with acha compared favorably with the control. The result of this study shows that vitamin A and vitamin C were significantly different (P<0.05) in the sample. The result of the sensory evaluation of the noodles prepared from the composites shows that most of the noodles were generally accepted. The samples that had rice in their blends were more accepted than the samples that had acha and they all compared favorably with the control. The results shows that supplementing wheat with cereals (rice, acha) and legumes (soybean) to producing a good quality composite flour and noodles is achievable and this will increase the health benefits of noodles and promote the consumption and utilization of our local foods that will improve nutrients in the meals of children.

Keywords: Noodles; composite flour; acha; nutritional; sensory.

1. INTRODUCTION

Noodles have become one of the most staple and popular foods in many parts of the world including Nigeria. Available in an amazing range of shapes and flavours, it is incredibly versatile, and can be served in scores of different ways. Modern instant noodle was invented in Osaka Japan in 1958 by Taiwanese/Japanese businessman, Momofuku Ando, the founder of Nissin foods, one of the biggest manufacturers of noodles in the world [1]. Approximately 85 billion servings of instant noodles are eaten worldwide every year [2]. Of this number China alone consumes 44 billions packs, being the largest producer and consumer of noodles. Per capita noodle consumption in Nigeria was estimated at 650 million packs in 2005, 700 million packs in 2006 and one billion packs in 2007. Hence noodles and pasta market in Nigeria increased between 2000 - 2008 at an annual rate of 3.6% [3].

Rice is the most common and important cereal for human consumption and calorie intake. It is the staple food for over 3 billion people, constituting over half of the world's population providing more than 5th of the calories consumed worldwide [4]. Rice is grown in all the ecological and dietary zones of Nigeria, with different varieties processing adaptation traits for each ecology [5]. Rice is an economic crop, which is important in household food security, ceremonies, nutritional diversification, income generation and employment [6]. It is utilized mostly at the household level, where it is consumed as boiled or fried or ground rice with stew or soup. Rice is cooked by washing and boiling in water which leads to loss of some nutrients [6,7].

Acha (*Digitaria exillis*) is a cereal grain in the family of *gramineae* and commonly referred to as *folio* or hungry rice [8]. Nigerian people of Plateau, Bauchi and Kaduna states burns straw and Ash extracted with water through perforated basket. The filtrates are used as potash for cooking indigenous delicacies. Acha grain can also be grounded into flour to produce biscuit [9]. Acha are also classified on the color and sizes of the grain. Acha is one of the most nutritious of all grains. Its seed is rich in methionine and cystine, they are vital to human health and these amino acids are deficient to major cereals like wheat, rice, maize, sorghum, barley and rye [10].

Soybean is one of the protein rich legumes consumed around the world and used as enrichment in many food formulations especially in Africa. Soybean contains about 40% protein; it is higher than other legumes in protein. The protein of soybean yields all the essential amino acids in adequate amount except methionine and cystine which are deficient [11]. Soybean is a rich source of vitamins like thiamine, riboflavin, niacin, folic acid. It is also a rich source of iron. It contains high amount of phosphorus, magnesium and potassium, and fair source of carotene and vitamin D. It is a poor source of calcium [12]. Soybean is nutritionally valued for their unsaturated fatty acids, protein, and fibre content. The oil contains about 85% unsaturated fatty acid and 15% saturated fatty acids. It contains 30-32% carbohydrate (soluble and insoluble). The soluble carbohydrate includes sucrose and oligosaccharide, starchyose and raffinose. Soybean is rich in lecithin and linoleic acid [11].

Despite the wide consumption of noodles in Nigeria the products are regarded as unhealthy (junk) food [13]. This is orchestrated by the fact that the conventional instant noodles are high in carbohydrate (<70%) and low in protein, fibre, vitamins and minerals.

To worsen the case instant noodles are typically fried as part of the manufacturing process resulting in high levels of saturated fat and trans-fat. Conventionally, noodles are made from the dough of unleavened durum wheat flour [14] which unfortunately is not a good source of fibre and protein. The unique ability of wheat flour to form cohesive, elastic extensive dough as a result of its gluten protein makes it an ideal material for noodles production and baked product such as breads, cakes, biscuits and cookies. In baking gluten forms, as glutenin molecules, cross-link to make a sub-microscopic network and associates with gliadin, which contributes with viscosity and extensibility to the mix. Gluten content was implicated as a stalling factor of bread, because it binds water by hydration. The development of gluten affects the texture of the baked goods [15].

Enrichment of cereal based food with other protein source such as legumes has received considerable attention. The use of cereal-legume based food has long been advocated as alternative protein and energy source for infant and young children food products [16]. It is evident that when cereals and legumes are judiciously selected and combined, desirable pattern of essential amino acids of high biological value is obtained [17].

This study is one of the efforts to promote the use of composite flours in which flour from locally grown crops and soybean with high protein content shall be used to produce protein-enriched composite flour. Thus, the aim of this work is to produce and evaluate the nutritional, optimum proportion of rice flour, acha flour and soybean flour for production of composite flour and sensory evaluation of noodles produced compared with wheat flour (as control sample).

2. MATERIALS AND METHODS

2.1 Sample Collection

The raw materials for this study were rice (*Oryza sativa*) [5], acha (*Digiteria exillis*) [8], soybean (*Glycine max*) [18] and wheat (*Triticum aestivum*) [18]. The raw materials were purchased from Ubani market in Umuahia, Abia state.

2.2 Sample Preparation

The rice grains were sorted and washed five times with water, sun dried, and then dried in the oven for 12 h at 60°C. It was then milled and sieved with 0.05 mm screen and then packaged in a plastic container.

Acha grains were sorted and washed five times with water. After washing, they were sun dried for 12 h, oven dried for 30 min at 65°C and milled with hammer mill to a fine texture. The flour was sieved with 0.05 mm screen to obtain fine flour and stored in an air tight container.

The soybean seeds were sorted and soaked for 12 h, then dehulled. The seeds were boiled for 30 min at 100°C, drained and oven dried for 12 h at 65°C, milled and sieved with 0.05 mm screen to fine flour.

2.3 Composite Flour Formulations

The flours were mixed in the following ratios 75:15:10, 70:20:10, 65:20:15, 60:25:15, 50:30:20, 40:40:20 for wheat, rice and soybean'', ''while wheat, acha and soybean were blended in the following ratios 80:15:5, 70:20:10, 65:20:15, 60:25:15, 50:30:20, 40:40:20 and 100% wheat flour served as the control.

2.4 Noodle Production

Noodles were produced by blending separately the flour samples with warm water (40°C) and 5% CMC according to the method described by [18]. The mixtures were thoroughly worked to form dough. The formed dough was allowed to rest for 20 min, then kneaded and rolled with a rolling pin to form sheets. The sheets were extruded using a cold extruder (Eurosonic, Globe 150) model. The noodle strands were put in cleaned aluminium trays and oven dried at 60°C for 2 h. The process is as shown in Fig. 1.

2.5 Chemical Analysis

The proximate compositions of the samples were determined using AOAC [19]. The samples were analyzed for moisture content, ash, crude protein, lipids and crude fibre. Carbohydrates content was determined by difference and energy value was calculated by method describe by [20].

The minerals (sodium, calcium, magnesium and phosphorus) contents were determined using standard method according to the [21]. The vitamins compositions of the samples were determined using Barakat titration method for Ascorbic acid and vitamin A according to the [19].

2.6 Sensory Evaluation

The noodles samples were cooked and the 100 W was used as the control. The noodles was soaked in boiled water for 1-2 min, and decanted. The noodles was poured in a pot and heated, for 2 min then salt was added to taste and served. Five variables were used for this study to test for acceptability of the samples. The variables were taste, appearance, texture, aroma and general acceptability. The panel comprising of a 20 man semi-trained judges who were asked to rank the samples using 9 point Hedonic scale [22], where, 1 = dislike extremely, 5 = neither like nor dislike 9= like extremely. Samples were coded and presented in a random sequence to the panellist.

2.7 Statistical Analysis

Data obtained from nutritional and sensory evaluation of the noodles were recorded in triplicates and subjected to One-way analysis of variance (ANOVA) using Statistical Program for Social Science (SPSS) version 21.0 (IBM SPSS inc., Chicago, IL). Where difference existed, LSD was used to separate means and accepted at 5% significance level [23].

3. RESULTS AND DISCUSSION

3.1 Proximate Composition of the Flour Samples

Table 1 shows the results of the proximate composition of the composite flour samples and the control.

There was significant difference (P>0.05) observed between the samples and the control for moisture, protein, fat, crude fibre, ash, carbohydrate and energy. In terms of moisture content the composite flour samples and the control values ranges from 8.02 to 10.82%. The moisture content values of the samples and the control were within the recommended moisture content of 15% acceptability value for long term storage of grains and acceptable limit for dry product [24]. The relatively low moisture content of this flour samples is important because, it will help in extending the shelf life if adequately protected, by inhibiting the development of contaminating microorganism whose growth and activities are favoured by presence of moisture [25].

Flour
↓
Mixing of Ingredients (Flour, Warm water 40^{o}C, 5%CMC)
↓
Dough resting (20 min)
↓
Rolling
↓
Extruding/cutting
↓
Oven Drying at 60^{o}C for 2 h
↓
Packaging
↓
Noodles

Fig. 1. Flow diagram showing the production of Noodles [18]

It is believed that materials such as flour and starch containing more than 12% moisture have less storage stability than those with lower moisture content, for this reason water content of 10% is generally specified for flour and related products [26]. According to [27], high quality noodles should have an adequate shelf life without any microbiological deterioration and therefore the low moisture content of these flour samples will be seen to extend the shelf life of the final product.

The crude protein content of the formulated samples and the control ranges from 5.26 to 18.82%. In this case, there was significant different ($P<0.05$) between the samples and control. The protein content of the control 100W reported in this study was found to be lower than the 14.70% [28] and 12.86% [29] for wheat flour but close to the values of 10.23% reported by [30]. This could be attributed to the geographical location, since soil with high nitrogen levels can influence protein level in the grain [31]. Wheat variety play more important role in determining the protein content of wheat. The variety of wheat used was the soft red winter grown in countries like America, Europe and Australia. The protein content of this variety ranges from 8.00-11.0% [24].

Sample 65W20A15S had the highest crude protein value, while the rest of the samples had reasonable amount of crude protein in them and they compared favorably with the control but sample 80W15A5S had the least value of 5.26%. The protein content of these flour blends with rice, acha and wheat in this study suggests that they may be useful in food formulation systems [30]. The protein content of most of the samples and the control were above the standard value of 8-12% and may definitely contribute to the nutritional needs of children and adults [11].

The higher protein values of these wheat, rice, soybean and wheat, acha, soybean composites will be of nutritional importance in most developing countries like Nigeria where many people can hardly afford high proteinous food because of cost [32]. With these results high protein content of ready to eat noodles will be achieved. The presence of soybean in the formulation also was contributed to the high crude protein recorded in this study.

The fat content of the flour samples and the control 100 W ranges from 7.02 to 21.01%. blend sample 65 W 20R 15S had the highest value while the least value was recorded by sample 60W 25R 15S .The high fat content observed in this sample blends will be attributed to the presence of soybean as reported by [33], that malted soybean have high fat content. Since all the samples had soybean so their fat content were high. The results obtained in this study were similar to the 12.02-18.34% fat content that was obtained by [8] for the production and evaluation of malted soybean – acha composite flour bread and biscuit.

The increase in the fat content could be a good source of energy to the human body. Fats and oils provide more than twice as much energy as the carbohydrate on a weight-weight basis [33]. One gram of fat or oil will yield about 368 k/cal of energy when oxidized in the body. High fat content of the product may not provide a conducive environment for microbial growth and activities hence improving the shelf life of the product [24]. High lipid content can reduce clarity of starch paste and hinder the swelling of starch granules because of high rate formation of amylose lipid complex [34]. Nevertheless the protein and lipid played important role in retention of amylose in starch noodles during cooking in minimizing cooking loss [35].

The crude fibre values of the samples and the control ranges from 0.33 to 0.79%. The control 100W had the highest fibre content with the value of 0.79%, this value was close to the 0.85% value of wheat reported by [36]. The crude fibre is most likely from the bran of the whole wheat and the hull of soybean represents variable fraction of dietary fibre which include mostly the lignin, cellulose and hemicellulose [37].

The rest of the samples also had similar fibre content compared to the control this could be attributed to the presence of wheat and soybean due to the fact that malted soybean are relatively high in crude fibre [33], which are important in bowel movement and reduces constipation. The crude fibre content obtained in this study is lower than the range of 0.47 – 1.04% obtained for malted soybean-acha composite flour bread and biscuit by [8]. Dietary fibre results in reduction of the risk of bowl disorders and fight constipation [38]. The crude fibre results of the samples were generally low so this could be attributed to the separation processes carried out from milling to obtaining fine flour used for the blend with wheat and acha.

Table 1. Proximate composition of rice, acha, soybean and wheat composite flour at different proportions

Samples	Moisture %	Protein %	Fat %	Crude fibre %	Ash %	Carbohydrate %	Energy %
75 W 15R 10 S	$9.96^{e}\pm0.12$	$9.63^{f}\pm0.00$	$14.51^{e}\pm0.12$	$0.42^{cd}\pm0.06$	$0.61^{d}\pm0.12$	$65.19^{f}\pm0.21$	$1808.91^{f} \pm 0.18$
70 W 20R 10 S	$10.32^{b}\pm0.12$	$6.13^{l}\pm0.15$	$19.52^{b}\pm0.15$	$0.40^{c}\pm0.06$	$0.80^{c}\pm0.00$	$63.03^{h}\pm0.06$	$1897.84^{b} \pm 0.47$
65 W 20R 15 S	$9.33^{e}\pm0.12$	$9.17^{g}\pm0.20$	$21.01^{a}\pm0.17$	$0.39^{de}\pm0.06$	$0.80^{c}\pm0.00$	$59.59^{j}\pm0.06$	$1946.29^{a} \pm 0.50$
60 W 25R 15 S	$9.06^{g}\pm0.00$	$7.87^{i}\pm0.12$	$7.02^{k}\pm0.15$	$0.37^{ef}\pm0.06$	$1.00^{b}\pm0.00$	$74.94^{a}\pm0.06$	$1667.28^{l} \pm 0.31$
50 W 30R 20 S	$8.02^{l}\pm0.12$	$13.57^{c}\pm0.12$	$16.51^{c}\pm0.10$	$0.35^{fg}\pm0.12$	$1.00^{b}\pm0.00$	$60.69^{i}\pm0.38$	$1873.27^{c} \pm 0.19$
40 W 40R 20 S	$8.38^{k}\pm0.12$	$14.02^{b}\pm0.12$	$11.01^{h}\pm0.17$	$0.33^{h}\pm0.06$	$1.21^{a}\pm0.12$	$65.82^{e}\pm8.7$	$1755.93^{i} \pm 0.40$
80 W 15A 5 S	$10.82^{a}\pm0.12$	$5.26^{m}\pm0.12$	$9.49^{i}\pm0.12$	$0.46^{b}\pm0.06$	$0.40^{e}\pm0.00$	$74.11^{b}\pm0.20$	$1698.21^{k} \pm 0.94$
70 W 20A 10 S	$9.41^{d}\pm0.23$	$7.44^{j}\pm0.00$	$12.02^{g}\pm0.20$	$0.39^{de}\pm0.12$	$0.40^{e}\pm0.00$	$70.65^{c}\pm0.31$	$1772.21^{g} \pm 0.56$
65 W 20A 15 S	$8.47^{j}\pm0.10$	$18.82^{a}\pm0.20$	$14.01^{f}\pm0.17$	$0.38^{de}\pm0.23$	$1.00^{b}\pm0.00$	$57.63^{k}\pm0.15$	$1818.20^{e}\pm 0.51$
60 W 25A 15 S	$9.23^{f}\pm0.15$	$13.12^{d}\pm0.12$	$12.01^{g}\pm0.12$	$0.38^{de}\pm0.12$	$1.00^{b}\pm0.00$	$64.51^{g}\pm0.35$	$1764.20^{h} \pm 0.51$
50 W 30A 20 S	$8.64^{i}\pm0.00$	$6.57^{k}\pm0.12$	$9.52^{i}\pm0.15$	$0.35^{fg}\pm0.06$	$0.81^{c}\pm0.12$	$74.41^{b}\pm0.15$	$1728.61^{j} \pm 0.14$
40 W 40A 20 S	$8.68^{h}\pm0.21$	$8.76^{h}\pm0.00$	$16.02^{d}\pm0.15$	$0.39^{de}\pm0.12$	$1.21^{a}\pm0.12$	$65.16^{f}\pm0.15$	$1849.20^{d} \pm 0.66$
100 W (control)	$10.82^{a}\pm0.12$	$10.51^{e}\pm0.06$	$8.51^{j}\pm0.12$	$0.79^{a}\pm0.12$	$1.00^{b}\pm0.00$	$69.06^{d}\pm0.21$	$1667.55^{l} \pm 0.04$
LSD	0.25	0.02	0.03	0.02	0.01	0.45	2.05

Values are means of data of triplicate determinations. Values in the same column having the same superscript are not significantly difference (P>0.05). W- Wheat, R- Rice, A –Acha, S- Soybean

The ash content of the samples and the control ranges from 0.40 to 1.21%. Samples 40W40R20S and 40W40A20S had the highest ash content value of 1.21%. The samples with the highest portion of soybean were observed to have the highest ash content value. The increase could be attributed to the fact that soybean are high in mineral [18]. Ash is a non organic compound containing mineral content of food and nutritionally it aids in the metabolism of other compounds. The ash content of the samples were similar and could be a source of minerals which apart from its nutritional value are good for good skin and strong bones [8]. The ash content represents the total mineral content in foods and serves as available tool for nutritional evaluation [39].

The carbohydrate content of the samples and the control varied from 57.63 to 74.94%. Sample 60W25R15S had the highest value of carbohydrate content with value of 74.94% and the least value is sample 50W30R20S with 57.63% value. The differences in the carbohydrate contents of the samples and control could be attributed to the differences in their protein and fat content values of the samples.

The high carbohydrate content of these samples suggests that the flours would be a very cheap source of energy for the body [40]. The high carbohydrate content of the samples is attributed to the high carbohydrate content in the cereals that are the principle ingredients in the samples. A marginal difference was observed when the results are compared with the values reported by [41] for breakfast cereal based porridge.

The energy content of the samples and control ranges from 1568.91% – 1945.29%. Sample 65W20R15S had the highest energy value content of 1945.29KJ and the least value was recorded by sample 75W15R10S. This result could be attributed to the values of protein and fat content of the samples. This is highly desired especially in famine and war locations where the next meal is not easy to come by. High energy foods have shown to have protective effect in the optimal utilization of other nutrients [42]. Energy was observed to be high for all the samples, so energy content is a parameter used to determine the quality of food especially for formulation designed for adults with high energy requirements.

3.2 Mineral and Vitamin Compositions of the Flour Samples

The result of mineral (sodium, calcium, phosphorus and magnesium) and Vitamin (vitamin A and vitamin C) values of rice, acha, soybeans and wheat composite flours at different proportions is shown in Table 2.

There was significant difference ($P<0.05$) that existed among the composite flour samples and the control for the minerals and vitamins analyzed. In terms of sodium (Na) content samples 50W30R20S and 40W40R20S had the highest Na values of 4.02 and 4.06 mg/100 g respectively and the control 100 W had the least value of 3.05 mg/100g. This result could be attributed to the fact that all the other samples had soybean substitution. Soybean seeds have been reported to contain appreciable amount of mineral and fat [43]. Sodium intake needs to be monitored as it can become a major dietary problem where high blood pressure problems are concerned. The low level of sodium observed in this study will make the product suitable for use in sodium restricted diets [44].

In terms of calcium content sample 50W30R20S had the highest Calcium value of 45.07 mg/100 g and sample 80 W15A5S had the least value of 29.63 mg/100g, this could be attributed to the fact that it had the least amount of soybean. All the samples compared favorably with the control (100 W) which had a value of 35.13 mg/100g.

Calcium is by far the most important mineral that the body requires and its deficiency is more prevalent than many other minerals, it helps in the formation of strong bone and teeth [45]. Calcium content of the flour samples and control where similar so their products would still give a little calcium for both children and elderly people for strong bone and body development [46]. Though there will still be need for mineral fortification to meet the average daily needs.

In terms of magnesium content, the magnesium content values of the flour samples and the control ranges from 110.80 – 136.17 mg/100g, where sample 50W30R20S had the highest value and sample 70W20A10S had the least value. The blends with acha had slightly lower values than the blends with rice but all the samples compared favorably with the control (100 W).

Table 2. Mineral and vitamin compositions of rice, acha, soybean and wheat flour at different proportions

Samples	Sodium mg/100g	Calcium mg/100g	Magnesium mg/100g	Phosphorus mg/100g	Vitamin A IU	Vitamin C mg
75 W 15R 10 S	$3.37^{d}\pm0.81$	$39.20^{c}\pm6.95$	$128.60^{d}\pm1.21$	$363.33^{a}\pm1.15$	$1505.33^{c} \pm 1.16$	$6.33^{d}\pm0.06$
70 W 20R 10S	$3.15^{f}\pm0.12$	$38.00^{d}\pm5.12$	$117.40^{f}\pm5.1962$	$311.00^{h}\pm1.73$	$1508.33^{b} \pm 1.16$	$6.36^{d}\pm0.06$
65 W 20R 15 S	$3.51^{c}\pm0.12$	$39.13^{c}\pm0.58$	$131.57^{c}\pm6.33$	$337.33^{d}\pm1.15$	$1508.33^{b} \pm 0.58$	$6.57^{bc}\pm0.06$
60 W 25R 15 S	$3.52^{c}\pm0.12$	$39.23^{c}\pm0.58$	$131.60^{c}\pm1.21$	$334.33^{e}\pm5.77$	$1505.33^{c} \pm 0.58$	$6.46^{bcd}\pm0.06$
50 W 30R 20 S	$4.05^{a}\pm0.06$	$45.07^{a}\pm0.58$	$136.17^{a}\pm0.58$	$342.33^{c}\pm5.77$	$1506.33^{c} \pm 0.58$	$6.41^{cd}\pm0.06$
40 W 40R 20 S	$4.02^{a}\pm0.06$	$42.68^{b} \pm0.58$	$134.10^{b}\pm1.73$	$336.67^{d}\pm5.77$	$1600.67^{a} \pm 0.58$	$6.59^{b}\pm0.06$
80 W 15A 5 S	$3.64^{b}\pm0.23$	$29.63^{i}\pm0.58$	$115.90^{fg}\pm5.20$	$325.67^{f}\pm1.15$	$1350.00^{e} \pm 0.00$	$5.67^{e}\pm0.06$
70 W 20A 10 S	$3.46^{c}\pm0.06$	$32.47^{f}\pm1.16$	$110.80^{i}\pm1.21$	$315.33^{g}\pm1.15$	$1300.33^{h} \pm 0.58$	$5.13^{f}\pm0.06$
65 W 20A 15 S	$3.26^{e}\pm0.06$	$30.37^{h}\pm0.58$	$114.47^{gh}\pm4.62$	$326.33^{f}\pm5.77$	$1321.67^{g} \pm 0.58$	$5.07^{f}\pm0.06$
60 W 25A 15S	$3.31^{e}\pm0.06$	$32.47^{f}\pm1.16$	$116.40^{f}\pm6.93$	$297.67^{j}\pm5.77$	$1330.33^{f} \pm 0.58$	$4.19^{g}\pm0.06$
50 W 30A 20 S	$3.28^{e}\pm0.12$	$31.33^{g}\pm1.16$	$113.53^{h}\pm5.78$	$302.67^{i}\pm5.77$	$1281.33^{i} \pm 1.16$	$5.06^{f}\pm0.06$
40 W 40A 20 S	$3.13^{f}\pm0.17$	$31.27^{g}\pm0.58$	$115.83^{fg}\pm6.35$	$317.33^{g}\pm5{\cdot}77$	$1170.33^{j} \pm 0.58$	$5.13^{f}\pm0.06$
100 W (control)	$3.05^{g}\pm0.01$	$35.13^{e}\pm0.58$	$123.33^{e}\pm5.76$	$348.67^{b}\pm1.15$	$1400.00^{d} \pm 0.00$	$7.03^{a}\pm2.31$
LSD	0.05	0.45	1.32	1.71	0.30	0.01

Values are means of data of triplicate determinations. Values in the same column having the same superscript are not significantly difference (P>0.05). W- Wheat, R- Rice, A –Acha, S- Soybean

For phosphorus content, the phosphorus content of the samples and the control varied from 297.67 to 363.33 mg/100, where sample 75W15R10S had the highest value while the least value was recorded by sample 60W25A15S.

The samples with acha had slightly lower values of phosphorus than the samples with rice but all samples still compared favorably with the control (100 W). The phosphorus content of the samples and control obtained in this study were higher than the phosphorus content 183.10 mg/100g of wheat soy flour reported by [47]. The relatively high phosphorus content of the samples and the control is an indication that the flour products will help in the formation of teeth and bones in children and in their proper development [46]. The result from this study shows that the noodles would contribute substantially to the recommended dietary requirement for mineral [42].

Vitamin A is very essential for growth, reproduction, good vision, healthy skin, hair and nail and to balance energy level in the human body. The deficiency of vitamin A in the body causes keratomalacia (night blindness) [48]. The vitamin A content in this study ranges from 1176.33 to 1600.67IU, where sample 40W40R20S had the highest value while sample 40W40A20S had the least value. The samples with acha had values lower than the control but they still comparable with control. Vitamin A plays an beneficial roles in vision, bone growth, reproduction, cell division and cell differentiation [49], and also regulate the immune system, which helps to fight off infections by producing white blood cells that destroy harmful bacteria and viruses [50,51].

In terms of vitamin C content, the control 100 W had the highest vitamin C value of 7.03 mg and the least value of 4.19 mg was recorded by sample 60W25A15S. Vitamin C is required by the body for maintenance of health, gum, healing of wounds, mopping excess of oxygen from the system and is a powerful antioxidant. Deficiency of vitamin C in the body will cause sore gum and scurvy [48]. Vitamin A and C content of the samples were comparable with the control but may not be a significant source of these nutrients.

3.3 Sensory Evaluation of Noodles

The result of the sensory evaluation of the formulated samples and the control (100 W) into noodles are represented in Table 3.

In terms of taste, there was no significant difference (P>0.05) between the samples and the control except for samples 65 W20A15S, 60W25A15S and 40W40A20S. The control (100 W) had the highest value of 6.77 but the rest

Table 3. Sensory evaluations of noodles from rice, acha, and soybean flour at different proportions

Samples	Taste	Texture	Aroma	Appearance	General acceptability
75W 15R 10S	6.57^{ab}±1.63	6.33^{ab}±1.67	6.07^{ab}±1.87	6.70^{a}±1.82	6.80^{a}±1.81
70W 20R 10S	6.23^{abc}±2.01	6.43^{ab}±1.94	6.53^{a}±1.89	6.47^{ab}±1.68	6.50^{a}±2.00
65W 20R 15S	6.10^{abc}±2.07	5.87^{abc}±1.96	5.73^{ab}±1.86	6.37^{ab}±1.94	6.43^{a}±1.36
60W 25R 15S	6.77^{a}±1.57	6.57^{a}±1.50	6.13^{ab}±1.85	6.17^{ab}±2.07	6.53^{a}±1.91
50W 30R 20S	6.37^{ab}±1.61	6.17^{abc}±1.50	6.30^{ab}±1.86	6.53^{a}±1.53	6.47^{a}±1.30
40W 40R 20S	6.40^{ab}±1.16	5.77^{abc}±1.70	6.23^{ab}±1.74	6.30^{ab}±1.97	6.27^{a}±1.41
80W 15A 5S	6.37^{ab}±1.96	6.20^{abc}±2.02	6.27^{ab}±1.76	6.63^{a}±1.79	6.53^{a}±1.36
70W 20A 10S	5.97^{abc}±2.25	5.70^{abc}±2.42	5.57^{ab}±2.34	5.67^{ab}±2.15	5.97^{ab}±1.99
65W 20A 15S	5.07^{bcd}±2.38	5.47^{abc}±0.06	5.27^{ab}±2.13	4.80^{bc}±2.11	5.60^{abc}±2.06
60W 25A 15S	4.30^{d}±2.09	4.83^{bc}±1.98	4.87^{ab}±2.26	3.43^{c}±1.91	4.33^{c}±1.75
50W 30A 20S	5.37^{abcd}±2.36	4.77^{bc}±2.25	5.47^{ab}±1.94	4.80^{bc}±2.11	5.57^{abc}±2.03
40W 40A 20S	4.67^{cd}±2.37	4.60^{c}±2.24	4.77^{b}±2.11	5.73^{ab}±2.60	4.70^{bc}±2.56
100W (control)	6.77^{a}±1.59	5.80^{abc}±2.19	6.53^{a}±1.83	6.10^{ab}±2.37	6.93^{a}±1.62
LSD	1.10	1.12	1.10	1.14	1.03

Values are means of data of triplicate determinations. Values in the same column having the same superscript are not significantly difference (P>0.05). W- Wheat, R- Rice, A –Acha, S- Soybean

of the samples comparable with it except for the samples that were significantly different from the control. Taste is an important parameter when evaluating sensory attribute of food. The product might be appealing and having high energy density without good taste, such a product is likely to be unacceptable [52]. The samples with rice flour were more liked than the samples with acha flour; it was observed that as the acha flour increased in the mix the less its taste was liked.

In the case of texture, there was no significant difference (P>0.05) between the noodles formed from samples and the control except for samples 60W25A15S, 50W30A20S, 40W40W10S, that there was significant difference (P<0.05). The panelist preferred the texture of the noodles made from samples with rice flour to the control and the blends with the acha flour was slightly lower to the control, though the noodles of the samples still compared favorably with the control. Texture is the prevailing textural characteristics of the product at the point of consumption, that usually determine whether such food is swallowable or chewable [53,54] and [18] reported similar results for noodles produced from cassava/wheat flour and from wheat, acha, soybean respectively.

In terms of aroma, there was no significant difference (P>0.05) between the samples and the control except sample 40W40A20S. The control (100 W) and sample 70W20R10S had the highest values of 6.53 and the rest of the noodles made from the other samples comparable with them. Smell is an integral part of taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing acceptability of formulated food [52]. From this study the noodles produced from rice samples performed slightly better than the samples with acha.

In terms of appearance, there was no significant difference (P>0.05) between the samples and the control except for samples 65W20A15S, 60W25A15S, 50W30A20S, which were significantly different (P<0.05) from them. Appearance is an important attribute in food choice and acceptance [52]. Outcome of sensory evaluation indicates that some samples were similar in appearance while others differed significantly. The noodles made from the samples that had rice were more appreciated in terms of appearance this could be attributed to the presence of rice that would have brightened its color a little. The noodles made from acha did not compare favorably with the control especially for sample 60W25A15S.

In terms of general acceptability, there was no significant difference (P>0.05) between noodles made from the samples blends and control except for those noodles made from samples 60W25A15S, 40W40A20S that were significantly different (P<0.05) from them. Although all the noodles made from the samples compared favourably with control (100 W) which has already gained popularity for acceptability. This study shows that all the flour samples could be used for noodle and products will have good organoleptic acceptability.

4. CONCLUSION

Through this study, there have been a lot of interesting findings that noodles can be produced from blends of soybean, acha, rice and wheat flour. The use of composite flour in noodles production has showed good potential improved product quality in terms of nutritional values as were observed in the proximate, mineral components, vitamins. At the same time, development and consumption of such blends will not only improve the nutritional status of the general population but also helps those suffering from degenerative diseases associated with today's changing lifestyles and environment. The sensory evaluation results indicated that, noodles produced from the blends of soybean, acha, rice and wheat flours had a good sensory attributes and were able to compare favourably with the control sample.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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