Chemical evaluation of pastas produced from flour blends of wheat, African breadfruit, sprouted soybeans, unripe plantain and carrot juice.

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Abstract

In Nigeria, there's a notable rise in conditions like, obesity, elevated blood cholesterol, and cardiovascular issues such as renal failure, heart diseases and blindness. There is need for alternative nutrition tailored for populations vulnerable to health issues due to poor diets and to combat protein-energy malnutrition. Therefore, this study was aimed at evaluating the chemical composition of pastas produced from flour blends of wheat, African breadfruit, sprouted soybeans and carrot juice as feed for humans. The pastas were prepared from composite flour of different ratios of wheat flour, African breadfruit flour, sprouted soybeans flour, and unripe plantain flour, referred to as blends pasta A (sprouted soybeans flour 50%, unripe plantain flour 35%,wheat flour 15%, African breadfruit flour 25% and carrot juice 100ml), pasta B (sprouted soybeans flour 35% unripe plantain flour 50%, wheat flour 25%, African breadfruit flour 15% and carrot juice 100ml), pasta C (sprouted soybeans flour 25%, unripe plantain flour 50%, wheat flour 50%, African breadfruit flour 35% and carrot juice 100ml) and pasta D (sprouted soybeans flour 15%, unripe plantain flour 25%, wheat flour 35%, African breadfruit flour 50% and carrot juice 100ml), control (dangote pasta). Pasta production method of Walsh and Gilles method with slight modifications was used. Chemical compositions of the products were determined. Semi-trained panelist comprised of students and staff of the university were used for sensory evaluation. Data were analyzed using appropriate statistics. Protein ranged from 22.95% in pasta A to 11.50% in control. Ash ranged from 4.27% in control to 2.34% in pasta B. Carbohydrate ranged from 77.00% in control to 60.00% in pasta A. Calcium ranged from 17.18mg/100g in pasta A to 5.34% in control. Beta carotene ranged from 11.78µg to 4.32µg in control. Vitamin C ranged from 51.59mg/100g in pasta A to 15.90% in control. Thiamin ranged from 8.89mg/100 in Pasta B to 2.11mg/100g in control. Riboflavin ranged from 11.54mg/100g in pasta A to 4.12mg/100g in Control. Niacin ranged from 14.81mg/100g in pasta A to 5.92mg/100g in control. General acceptability ranged from 7.01 in control to 6.01 in pasta D. Production of composite pastas as seen in this research will be of great benefit in the management of protein energy malnutrition and non-communicable diseases and also serve as alternative composite flour for food industries.

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Keywords: Chemical, Evaluation, Pastas, Flour and Blends.**Évaluation chimique des** pâtes produites à partir de mélanges de farines de blé, de fruit à pain africain, de soja germé, de plantain non mûr et de jus de carotte

Résumé

Au Nigéria, on constate une augmentation notable de maladies telles que l'obésité, un taux de cholestérol sanguin élevé et des problèmes cardiovasculaires tels que l'insuffisance rénale, les maladies cardiaques et la cécité. Il est nécessaire de proposer une alimentation alternative adaptée aux populations vulnérables aux problèmes de santé dus à une mauvaise alimentation et de lutter contre la malnutrition protéino-énergétique. Par conséquent, cette étude visait à évaluer la composition chimique des pâtes produites à partir de mélanges de farines de blé, de fruit à pain africain, de soja germé et de jus de carotte destinés à l'alimentation humaine. Les pâtes ont été préparées à partir de farine composée de différents ratios de farine de blé, de farine de fruit à pain africain, de farine de soja germé et de farine de plantain non mûr, appelées mélanges de pâtes A (farine de soja germé 50 %, farine de plantain non mûr 35 %, farine de blé 15 %. , farine de fruit à pain africain 25% et jus de carotte 100 ml), pâtes B (farine de soja germé 35% farine de plantain non mûr 50%, farine de blé 25%, farine de fruit à pain africain 15% et jus de carotte 100 ml), pâtes C (farine de soja germé 25% , farine de plantain non mûr 50%, farine de blé 50%, farine de fruit à pain africain 35% et jus de carotte 100 ml) et pâtes D (farine de soja germé 15%, farine de plantain non mûr 25%, farine de blé 35%, farine de fruit à pain africain 50% et carotte jus 100ml), contrôle (pâtes de Dangote). La méthode de production de pâtes de Walsh et Gilles avec de légères modifications a été utilisée. Les compositions chimiques des produits ont été déterminées. Des panélistes semi-formés composés d'étudiants et de membres du personnel de l'université ont été utilisés pour l'évaluation sensorielle. Les données ont été analysées à l'aide de statistiques appropriées. La teneur en protéines variait de 22,95 % dans les pâtes A à 11,50 % chez les témoins. Les cendres variaient de 4,27 % dans le groupe témoin à 2,34 % dans les pâtes B. Les glucides variaient de 77,00 % dans le groupe témoin à 60,00 % dans les pâtes A. Le calcium variait de 17,18 mg/100 g dans les pâtes A à 5,34 % dans le groupe témoin. Le bêta-carotène variait entre 11,78 µg et 4,32 µg pour le contrôle. La vitamine C variait de 51,59 mg/100 g dans les pâtes A à 15,90 % dans les pâtes témoins. La thiamine variait de 8,89 mg/100 dans les pâtes B à 2,11 mg/100 g dans le groupe témoin. La riboflavine variait de 11,54 mg/100 g dans les pâtes A à 4,12 mg/100 g dans le contrôle. La niacine variait de 14,81 mg/100 g dans les pâtes A à 5,92 mg/100 g dans le contrôle. L'acceptabilité générale variait de 7,01 pour le contrôle à 6,01 pour les pâtes D. La production de pâtes composites, comme le montre cette recherche, sera d'un grand bénéfice dans la gestion de la malnutrition protéino-énergétique et des maladies non transmissibles et servira également de farine composite alternative pour les industries alimentaires. La production de pâtes composites, comme le montre cette recherche, sera très utile dans la gestion de la malnutrition protéino-énergétique et des maladies non transmissibles et servira également de farine composite alternative pour les industries alimentaires.

Mots-Clés : Chimie, Évaluation, Pâtes, Farine et Mélanges.

في نيجيريا، هناك ارتفاع ملحوظ في حالات مثل السمنة وارتفاع نسبة الكوليسترول في الدم ومشاكل القلب والأوعية الدموية مثل الفشل الكلوي وأمراض القلب والعمى. هناك حاجة إلى تغذية بديلة مصممة خصيصًا للسكان المعرضين للمشاكل الصحية بسبب سوء النظم الغذائية ومكافحة سوء تغذية الطاقة البروتينية كانت هذه الدراسة تهدف إلى تقييم التركيب الكيميائي للباستا المنتجة من مزيج الدقيق من القمح وفاكهة الخبز الأفريقية وفول الصويا المنبت وعصير الجزر كعلف للبشر تم تحضير الباستا من دقيق مركب بنسب مختلفة من دقيق القمح ودقيق فاكهة الخبز الأفريقي ودقيق فول الصويا المنبت ودقيق موز الحمل غير الناضج يشار إليها باسم مزيج المعكرونة A (دقيق فول الصويا المنبت 50٪، دقيق موز غير ناضج 35٪، دقيق القمح 15٪، دقيق فاكهة الخبز الأفريقي 25٪ وعصير الجزر 100 ميليمتر) المعكرونة B (دقيق فول الصويا المنبت 35٪ دقيق موز غير ناضج 50٪ ودقيق القمح 25٪ ودقيق فاكهة الخبز الأفريقي 15٪ وعصير الجزر 100 ميليمتر) المعكرونة C (دقيق فول الصويا المنبت 25٪ ودقيق موز غير ناضج 50٪ ودقيق القمح 50٪ ودقيق فاكهة الخبز الأفريقي 35٪ وعصير الجزر 100 ميليمتر) المعكرونة D (دقيق فول الصويا المنبت 15٪ ودقيق موز غير ناضج 25٪ ودقيق القمح 35٪ ودقيق فاكهة الخبز الأفريقي 50٪ وعصير الجزر 100 ميليمتر) تم استخدام طريقة إنتاج المعكرونة من طريقة والش وجيل مع تعديلات طفيفة.تم تحديد التركيبات الكيميائية للمنتجات، تم استخدام عضو اللجنة شبه المدرب المكون من طلاب وموظفي الجامعة للتقييم الحسي.تم تحليل البيانات باستخدام الإحصاءات المناسبة تراوح البروتين من 22.95٪ في المعكرونة A إلى 11.50٪ تحت السيطرة تراوحت نسبة التحكم في الرماد من 4.27٪ إلى 2.34٪ في المعكرونة B, تراوحت نسبة الكربوهيدرات من 77.00٪ في السيطرة إلى 60.00٪ في المعكرونة A, تراوح الكالسيوم من 17.18 مليجرام/100 جرام في المعكرونة A إلى 5.34٪ تحت السيطرة تراوح بيتا كاروتين من 11 .g788 à إلى 4 .g32 à في السيطرة، تراوح فيتامين سي من 51.59 مليجرام/100 جم في المعكرونة A إلى 15.90٪ تحت السيطرة. تراوح الثيامين من 8.89 مليجرام/100 في المعكرونة ب إلى 2.11 مليجرام/100 جرام في التحكم. تراوحت Riboflavin من 11.54 مجم/100 جرام في المعكرونة A إلى 4.12 مليجرام/100 جرام في التحكم. تراوحت نياسين من 14.81 مليجرام/100 جرام في المعكرونة A إلى 5.92 مجم/100 جرام في التحكم. تراوحت المقبولية العامة من 7.01 في السيطرة إلى 6.01 في المعكرونة D، سيكون لإنتاج الباستا المركبة كما يتضح من هذا البحث فائدة كبيرة في إدارة سوء تغذية الطاقة البروتينية والأمراض غير المعدية وتعمل أيضا كدقيق مركب بديل للصناعات الغذائية. سيكون لإنتاج الباستا المركبة كما رأينا في هذا البحث فائدة كبيرة في إدارة سوء تغذية طاقة البروتين.الأمراض غير المعدية وتعمل أيضا كدقيق مركب بديل للصناعات الغذائية

Introduction

Pasta, originating from Italy, is typically crafted from a mix of durum wheat flour (semolina), water, or eggs, shaped and then either boiled or baked (Padalino *et al.,* 2016). As noted by Kaur *et al.* (2017), the global consumption of pasta has surged over the past decade. This rise is attributed to an uptick in pasta-based offerings at fast-food outlets and restaurants, causing global production to jump from 7 to 12 million tons annually. Functional characteristics pertain to the vital physicochemical attributes of foods that showcase intricate interactions between their structures, molecular configurations, compositions, and how these components interact with their surroundings and testing conditions (Suresh and Samsher, 2013; Kaur and Singh, 2006 as referenced in Awuchi, 2019). Sensory evaluation employs experimental design principles and statistical analyses using human senses (vision, smell, taste, touch, and hearing) to gauge consumer responses (Janes *et al.,* 2017). Wheat stands as a historical global staple, addressing civilization's food needs for over 10,000 years (Curtain and Grafenauer, 2019). Among various wheat species, common durum wheat or Triticum turgidum durum is predominant (Curtain and Grafenauer, 2019; Padalino *et al.,* 2016). Currently, wheat ranks as the top globally produced food crop, historically offering unparalleled nutrients through bread (Curtain and Grafenauer, 2019). Additionally, the blending of wheat flour with other flours, termed composite flour, is common, incorporating ingredients like legumes, maize, soybean, and cassava (Nilusha *et al.,* 2019).*African breadfruit, scientifically known as Treculia africana Dcene, belongs to the Moracea family.*

Soybean, recognized as Glycine max L, is a notable crop in both the pulse and oilseed categories (Hameed and Suryavanshi, 2007 cited in Glacco, Vitale, and Riccardi, *2016 .These can be reduced through processes like sprouting, enhancing the soybean's nutritional and functional attributes (Padalino et al., 2016). Sprouting involves soaking and allowing grains or seeds to germinate, improving digestibility and nutrient availability. This process also enhances amino acid content and vitamin availability (Jideani and Onwubali, 2019).*

Plantain belong to the Musacace family, plantain is cultivated extensively in tropical and subtropical regions worldwide and is particularly significant in Nigeria, ranking third in sustainability after yams and cassava (Akomolafe and Aborisade, 2017; Yarkwan and Uvir, 2015).

Carrot, scientifically termed Daucus carota L, is a globally recognized root vegetable, rich in β-carotene, fiber, and various micronutrients (Sarfaraz *et al.,* 2016).

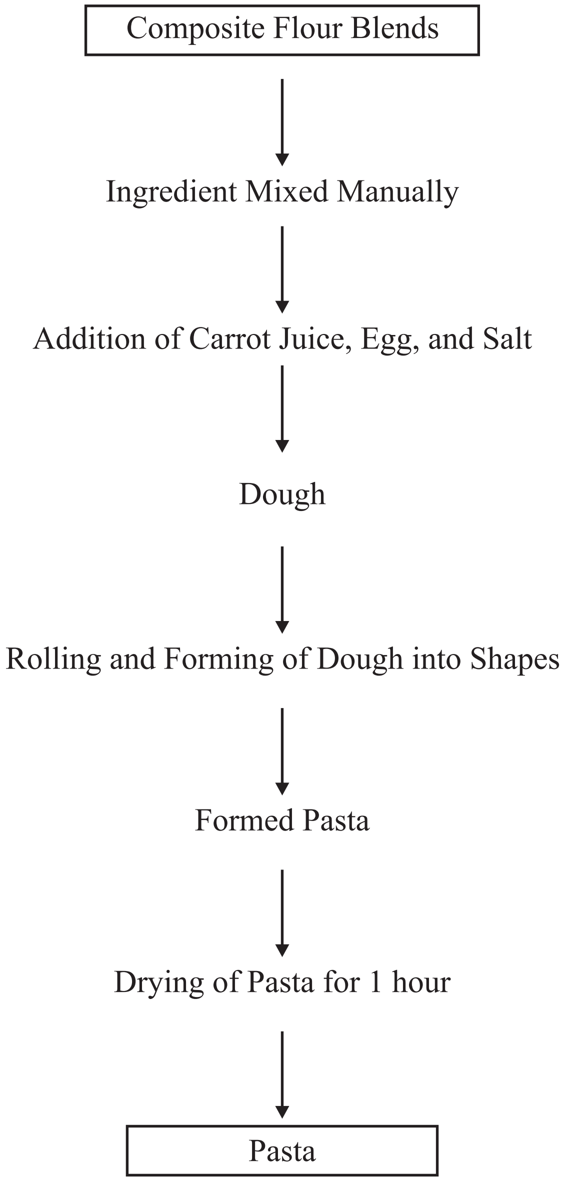
The objective of this research is to develop high nutritious pasta alternatives tailored for populations vulnerable to health issues due to poor nutrition and to combat protein-energy malnutrition (PEM).

Materials and methods

Carrot (*Daucus carota*), durum wheat (*Triticum turgidum durum*), African breadfruit (*Treculia Africana Decne*), soy beans (*Glycine max*), and unripe plantain (*Musa paradisiaca*) were purchased from Umuahia Main Market, Urbani, Umuahia, Abia State, was taken to the department of Human Nutrition and Dietetics for identification and further processing.

Proximate, Mineral, vitamin, anti-nutrient, phytochemical, functional properties by AOAC (2012).Pastas were prepared from different ratios of Wheat Flour, African Breadfruit Flour, Soybeans Flour, and Unripe Plantain Flour referred to as Blends A, B, C, and D, following the Pasta Production Method of Walsh and Gilles (1977) (cited in Yahya *et al.,* 2022; Cheng and Bhat, 2016; Mitra *et al.,* 2012) with slight modifications. The ratios/ percentages used were selected due to the suitable range of flour protein substitution in flours in pasta formulation.

Pasta produced from each flour blends had a total composite flour and prepared as follows – the composite flour of 250g was measured/weighed using a digital table weighing scale as well as 3.8g of ginger and 0.2g of salt were weighed and poured into a smooth stainless steel bowl and then a well in the pile of flour blends was created, 20g of egg and 100mL of carrot juice were measured and weighed using a digital table weighing scale and poured into the well and a fork was used to mix them with the flour. The dough was rolled out thinly (5mm) using the pasta extruding machine roller compartment. The pasta extruding machine was used to shape the pasta. The pasta samples were dried for 1hour with hot air using a hot air oven (*UNISCOPE 5M 9023 Laboratory Oven*). Samples were coded and stored in a dry container until they were used for further analysis. Portions used for proximate analysis were ground into flour.



Ethical Approval clearance was gotten from Federal Medical Center, Umuahia, Abia State for approval of the research before it was carried out and with approval clearance number: FMC/QEH/G.596/Vol.10/529 Informed Consent forms were signed by all the participants in the Sensory Evaluation Panel and Volunteers in Feeding Experiment after the purpose and benefits of the research was explained to them (appendix II).

Sensory evaluation

Ingredients: blended fresh tomatoes 200g, 150g of tin tomatoes, 100g of onions, 50g of blend fresh pepper, 2.5g of table salt, 4cubes of bullion cubes seasoning, 0.5liters of vegetable oil, 10g of mixed spices (ginger, turmeric, and garlic), 3cooking spoon-full of water, eggs.

Method: Boiling method was used in preparing the tomato sauce – all ingredients were added same time as well as the vegetable oil and they were allowed to boil for 30mintues and then stir and allowed to continue boiling for extra five minutes, and eggs were boiled in clean water for 10minutes. Four different pastas produced at different flour ratios were cooked in water separately for 30minutes, water was drained, and served with tomato stew and boiled chicken egg to the panelists and the control pasta was also cooked and served with tomato stew and boiled chicken egg. The cooked pasta and sauce were served in a transparent glass dish and the panelist were asked to eat and evaluate.

Texture, taste, flavour, colour (organoleptic properties) assessment, and general acceptability of the cooked pasta products. Forty semi-trained panelists selected from the Department of Human Nutrition and Dietetics, Michael Okpara University which included staff and students.

The panelists were trained on the procedures which were – to gently and properly rinse their mouth after tasting each product (sample) and identify the product codes in order to fill in the sensory evaluation forms properly. A seven-point hedonic scale was used for the evaluation where the panelists determined the levels of satisfactions for each pasta blends and there are: "7 = liked extremely," "6 = liked moderately," "5 = liked slightly," "4 = neither liked nor disliked," "3 = disliked slightly," "2 = disliked moderately," "1 = disliked extremely."

Statistical Analysis

Package for Social Sciences (SPSS, Version 20.0, IBM SPSS Inc, Chicago) was used for data analysis.

Results

Table 1: Proximate Composition of the Pasta Samples

Samples	Moisture (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Carbohydrate (%)
Pasta A	1.03^{d}±0.02	22.95^{a}±0.03	10.83^{a}±0.02	2.40^{a}±0.01	2.79^{b}±0.01	60.00^{e}±0.05
Pasta B	0.17^{e}±0.03	20.24^{b}±0.04	8.11^{b}±0.04	2.45^{a}±0.05	2.34^{e}±0.02	66.69^{d}±0.01
Pasta C	2.80^{b}±0.03	17.70^{d}±0.02	7.74^{c}±0.02	2.23^{c}±0.02	2.64^{c}±0.01	66.89^{c}±0.01
Pasta D	1.17^{c}±0.03	18.97^{c}±0.03	7.69^{c}±0.01	2.32^{b}±0.03	2.45^{d}±0.05	67.40^{b}±0.02
Control	3.73^{a}±0.02	11.50^{e}±0.01	2.30^{d}±0.05	1.20^{d}±0.05	4.27^{a}±0.03	77.00^{a}±0.03

Table 1 showed proximate analysis of the pasta samples are shown in Table 1. The moisture content ranged from 0.17% in pasta B to 3.73% in control. There was significant difference ($p<0.05$) in the moisture content of the samples. Sample pasta B had the lowest value 0.17%, while sample control had the highest value 3.73%. The result showed significant differences ($p<0.05$) Protein content ranged from 11.50% control to 22.95% sample A respectively. Control had the least protein content 11.50% while sample pasta A had the highest protein content 22.95%. Samples pasta B, pasta C and pasta D had values of 20.24%, 17.70% and 18.97% respectively. There was significant difference ($p<0.05$) in the protein content of all the samples. The fat content ranged from 2.30% in control to 10.83% in pasta A, there was significant difference between samples pasta A 10.83%, pasta B 8.11% and control 2.30%. The fat content shows there was significant difference ($p>0.05$) between pasta C 7.74% and pasta D 7.69%.The crude fiber content ranged from 1.20% control to 2.45% sample B respectively, which shows that there is significant difference ($p<0.05$) between the two samples. There is no significant difference ($p>0.05$) between pasta A 2.40% and pasta B 2.45%.

Table 2 Functional Properties of the Pasta Samples

Samples	Bulk Density (g)	Oil Absorption Capacity (%)	Emulsion Absorption Capacity (%)	Water Capacity (%)	pH Measurement
Pasta A	$1.45^{b}\pm0.02$	$0.70^{d}\pm0.02$	$1.00^{c}\pm0.01$	$15.75^{b}\pm0.05$	$6.40^{e}\pm0.03$
Pasta B	$1.65^{a}\pm0.02$	$1.14^{c}\pm0.02$	$1.18^{b}\pm0.02$	$12.33^{c}\pm0.03$	$7.00^{c}\pm0.10$
Pasta C	$0.58^{d}\pm0.02$	$1.56^{b}\pm0.05$	$1.44^{a}\pm0.02$	$20.23^{a}\pm0.02$	$7.32^{a}\pm0.03$
Pasta D	$1.73^{a}\pm0.10$	$1.90^{a}\pm0.02$	$0.44^{d}\pm0.01$	$10.96^{d}\pm0.02$	$7.12^{b}\pm0.04$
Control	$1.10^{c}\pm0.01$	$1.14^{c}\pm0.01$	$0.96^{c}\pm0.07$	$8.08^{e}\pm0.02$	$6.60^{d}\pm0.04$

Table 2 showed some functional properties of the pasta sample. The bulk density ranged from 0.58g to 1.73g in samples pasta C and control respectively. There was no significant difference ($p>0.05$) between sample pasta B 1.65g and pasta D 1.73g. Sample pasta D was significantly higher ($p<0.05$) than the other samples. The percentage oil absorption capacity ranged from 0.70% to 1.14% in samples pasta A and pastas B and control respectively. There was no significant difference ($p>0.05$) between samples pasta B 1.14% and control 1.14%. Emulsion capacity ranged from 0.44% in sample pasta D to 1.44% in pasta C. Sample pasta C (20.23%) was significantly higher ($p<0.05$) than the other samples. The water absorption capacity ranged from 8.08% to 20.23% in samples control and pasta C respectively. Sample pasta C water absorption capacity was significantly higher ($p<0.05$) than the other samples. The pH ranged from 4.40 in pasta A to 5.32 in pasta C. pH of all the samples was within the acidic medium which in the pH acidic range of 1-6.

Table 3 Sensory Scores of the Pasta Samples

Samples	Texture	Taste	Flavour	Colour	General Acceptability
Pasta A	$5.10^{b}\pm0.01$	$4.60^{b}\pm0.02$	$4.40^{b}\pm0.06$	$5.63^{b}\pm0.01$	$6.95^{ab}\pm0.04$
Pasta B	$4.65^{c}\pm0.02$	$4.50^{b}\pm0.04$	$4.03^{b}\pm0.02$	$4.87^{d}\pm0.02$	$6.82^{b}\pm0.03$
Pasta C	$4.74^{c}\pm0.18$	$4.53^{b}\pm0.92$	$4.07^{b}\pm0.13$	$4.09^{e}\pm0.04$	$6.12^{c}\pm0.18$
Pasta D	$4.67^{c}\pm0.28$	$3.93^{b}\pm0.00$	$3.77^{b}\pm0.84$	$5.03^{c}\pm0.01$	$6.01^{c}\pm0.12$
Control	$6.00^{a}\pm0.00$	$6.03^{a}\pm0.03$	$5.33^{a}\pm0.05$	$5.87^{a}\pm0.07$	$7.01^{a}\pm0.02$

Table 3 showed sensory scores for texture ranged from 4.65 in Pasta B to 6.00 in control and control 6.00 was significantly higher ($p<0.05$) than the mean scores of the other samples. There is no significant difference ($p>0.05$) in the scores of pasta B 4.65, pasta C 4.74 and pasta D 4.67. The mean score of sample pasta B 4.65 for texture, was significantly ($p<0.05$) lower than those of the other samples. The mean scores for taste ranged from 3.93 to 6.03 in pasta D and control respectively. Taste scores for control 6.03 was significantly ($p<0.05$) higher than the scores of the other samples. There was no significant ($p>0.05$) difference in the means scores of samples pasta A 4.60, pasta B 4.50 and pasta C 4.53. The score of sample pasta D 3.93 was significantly ($p<0.05$) lower than other samples. The flavour scores ranged from 3.77 to 5.33 in pasta D and control. There was no significant ($p>0.05$) difference in the scores of pasta A 4.40, pasta B 4.03 and pasta C 4.07, sample pasta D was significantly ($p<0.05$) lower than other samples. The mean scores for colour ranged from 4.09 in pasta C to 5.87 in control. Sample control 5.87 was significantly ($p<0.05$) higher than the scores of the other samples. Also, there was significant ($p<0.05$) difference in the scores of Sample Pasta A 5.63, Pasta B 4.87, pasta C 4.09 and pasta D 5.03. The mean scores for general acceptability ranged from 4.01 to 6.01 in pasta D and Control respectively. Sample control 6.01 was significantly ($p<0.05$) higher than the scores of the other samples. There was no significant ($p>0.05$) difference in the scores for pasta A 4.95 and pasta B 4.82. Also, there were no significant ($p>0.05$) difference in the mean scores of samples pasta C 4.09 and pasta D 4.01. However, control had a mean of 6.01 higher than the rest samples in general acceptability.

Discussion

The following samples pasta A, pasta C and pasta D had mean score of 1.03%, 2.80% and 1.17% respectively. The moisture content values 0.17% - 3.73% obtained in this study were lower than the values 10.08% obtained by Dilek and Nermin (2003) cited in Utah-Iheanyichukwu (2017) and Grizotto *et al*. (2006) cited in Utah-Iheanyichukwu (2017); the differences of the present value from the previous findings could be attributed to the difference in raw material composition, handling process and method of processing. High moisture content in food indicates that the food will have a low shelf-life quality while low moisture content in food signifies that the food will be less prone to deterioration (Grizotto *et al*., 2006 cited in Utah-Iheanyichukwu, 2017). Therefore, the lower moisture content values obtained in this study suggest that the pasta will have a better shelf-life quality which may last up to three months if properly stored in an air tight container. The difference may be in nutritional composition of the individual flour quantities used in the formulation of flour blends and other environmental conditions like exposure to air (Utah-Iheanyichukwu, 2017).These differences in the protein content of pasta samples could be attributed to variation in the nutritional composition of the raw materials and their ratio in formulation of the flour used in producing the samples. Moreover, the increase in protein content could be as a result of incorporating soybeans in the pastas and sprouting process used in the soybeans production (*Šca et al., 2012*). It is therefore not surprising that sample pastas with high percentage of soybean flour had higher protein content. The difference in fat content range 2.30% - 10.83% observed among the samples could be attributed to the variations in each pasta composition which could have altered the fat content of the samples. Lipids in foods is of great importance because they act as flavor retainer and also increase the mouth feel of food respectively (Onimawo and Akubor, 2005 cited in Akubor and Fayashe, 2018). Parmar and Dahiya (2015) observed that food material rich in fat could be useful in improving palatability of food in which they are incorporated. This can be compared to the work done by Onimawo *et al*. (2006) cited in Utah-Iheanyichukwu (2017) in which fat content was 12.56% which falls within the range in this work (Abdulmaguid, 2018). Onimawo *et al* (2006) cited in Utah-Iheanyichukwu (2017) attributed low fiber content to better processing of flour. However, Abdelkarim *et al*. (2014) observed that fiber is essential in food as it absorbs water and provide roughages for easy bowel transit, reduce constipation and diverticulosis. Variation in the ash content values obtained in this study could be attributed to different raw materials, different nutritional composition of flours that make up the samples, variation in processing methods and handling techniques and instruments used. High ash content value in food materials is an indication of high content of mineral elements which is attributed to loss of dry matter (Foster *et al.,* 2018). Therefore, the ash content value obtained in this study implies that the pastas have an appreciable mineral content. This is similar to the result 3.55% in the biscuit samples from mungbeans by Onimawo and Akubor (2005) cited in Utah-Iheanyichukwu (2017).The carbohydrate content of all the samples were above 55.00%, the highest carbohydrate value obtained was 67.40% in sample pasta D. Carbohydrates are complex sugars present in food materials that are responsible for providing the body with energy (Beniwal and Jood, 2015), thus, its high content in the samples. The difference in carbohydrate content may be attributed to the difference in ratio of ingredients used in the production (Lui *et al.,* 2011).Bulk density of the pasta samples showed that sample control has the highest bulk density value while sample pasta C has the least bulk density value. This could be because of the usage of non-composite flour in the sample control unlike the flour blends in the sample Pastas. The Bulk density gives an indication of the mouth feel and flavour of the food (Onimawo and Akubor, 2005 cited in Akubor and Fayashe, 2018) was in consonance within the range (1.66g), this is as a result of the composite flour. The oil absorption capacity of sample pasta A and Control were same at the value of 1.14% which is a good range as indicated by Tadesse *et al. (*2019) (1.88%) in produced pastas formulated from composite flour of soybeans. Oil absorption capacity is important because oil retains flavor and increase the satiety and palatability of foods (Szezesniak, 2012).The relatively low levels of emulsion capacity (1.44%) in pasta A amongst sample pastas and control suggest that the products were produced from flour of highly desirable quality, in comparison to the emulsion capacity of biscuits produced by Nwosu (2013) which has emulsion capacity of 6.05%.The higher value of sample pasta C water absorption capacity (20.23%) could be as a result of the composite flour blend ratio used in producing pasta samples and this shows that sample will form good dough, this finding is not far from the result (18.34%) of Suresh and Samsher (2013), and Akubor and F ayashe (2018). All the samples have an average pH on neutral, as this will ensure that all sample pastas have a longer shelf-life, as low pH helps to improve the shelf life during storage (Kaur *et al.,* 2017).

The outstanding high score of the sample control (dangote pasta) can be attributed to the fact that the panelists are already familiar with the sample control. Therefore, other quality pastas have been produced from wheat, maize, rice and cassava flour blends and have given similar texture sensory score (Szezesniak, 2012).Sample pastas A, B, and C had taste mean score above 4.50, yet the sample control has the highest taste mean score of 6.03. This is not surprising since the panelists were familiar with the control sample. The pasta produced has a higher taste scores when compared with the works of Foster *et al.* (2018), Nochera and Ragone (2019), and Ojure and Quadri (2013). Pastas A, B, and C have flavour scores above 4.00 while pasta D has score of 3.77 which is below 4.00, and the sample control has the highest flavour score of 5.33. Low score of sample pasta D can be attributed to the high content of african breadfruits flour (ABF) which has been reported to reduce flavour especially when utilized with other food materials (Raza *et al.,* 2022). The colour mean scores of the sample pastas and control were above 4.00. there was little difference in colour scores between the sample control and sample pastas. This can be attributed to the material used in the pastas composite flours, the processing techniques employed (*Laleg et al., 2016*), and the usage of carrot juice – which has been said to be a source of colour enhancer (Christian *et al*., 2015).Sample pastas A, B, and Control have general acceptability scores above 4.50. According to Ezeama (2004) cited in Utah-Iheanyichukwu (2017), general acceptability score has a range of 4.50 for such food material to be seen as accepted. Despite the same food materials, production processes and techniques used for all sample pastas, pastas A and B scored above 4.50 bench mark while pastas C and D were below the bench mark; this may be because of the variations of in the quantity of each composite used.

Conclusion

The study showed that flour blends of durum wheat, African breadfruit, sprouted soybeans, unripe plantain, and carrot juice can be used to produce nutritious pasta. The pastas produced were high in vitamins and mineral. Sprouting played a great role in improving the nutrient content and reducing the anti-nutrients in Soybeans flour with increased protein content and reduced carbohydrate. The usage of carrot Juice – which was high in beta-carotene – in the making the pasta samples increased the vitamin A content of the produced pastas. Its high protein content and fiber contents can be effective in the management of diabetics mellitus, protein energy malnutrition, anemia, and scurvy. The sensory evaluation results of the pasta produced showed that samples pasta A and pasta B have general acceptability result closer to that of the control pasta. The production of composite flour pastas as seen in this research will be of great benefit in Nigeria, also in Africa whose populations are highly predisposed to malnutrition and non-communicable diseases.

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