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Development, Sensory and Nutrient Evaluation of Pasta Made from Wheat Semolina Flour (*Tritium durum*) and African Yam Bean Flour (*Sphenostylisstenocarpa*) blend

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Abstract

The study carried out sensory and nutrient evaluation of pasta made from wheat semolina flour (*Tritium durum*) and African yam bean flour (*Sphenostylisstenocarpa*) blend. Four flour blends were formulated by mixing wheat semolina flour and African Yam bean flour blends in different ratios to get 100g of four different flour blends with 100% wheat pasta serving as the control sample. The different ratios; 90:10, 80:20, 70:30, 50:50and coded as samples AB1, AB2, AB3 and AB4 respectively. Sensory evaluation was conducted using a 9point hedonic scale to determine the degree of acceptability of different pastas produced from the samples. Proximate, vitamin and mineral compositions of the samples were determined. Results obtained were statistically analyzed with means, standard deviation and Analysis of Variance (ANOVA). The result on sensory evaluation showed that the pasta prepared using 90:10wheat semolina and African yam bean composite flour blend had the highest score for texture and degree of general acceptability while the pasta sample prepared using 80:20wheat semolina and African yam bean composite flour blend had the highest score for taste, color and flavor. The result on proximate composition of the most accepted pasta sample revealed that the moisture content was (60.76%), fibre (0.85%), protein (14.53%), carbohydrate 21.49%, fat (2.09%) and ash (0.28%). The mineral and vitamin composition revealed that calcium contained (4.00mg/100g), magnesium (2.39mg/100g), potassium (6.77mg/100g), zinc (0.43/100g) and iron (0.79mg/100g). Vitamin C (1.30mg/100g), vitamin B1 (0.63mg/100g), vitamin B2 (0.20mg/100g), vitamin B3 (0.11mg/100g) and vitamin B9 (15.50mg/100g). The study, therefore, concluded that the utilization of wheat semolina flour and African yam bean flour with ratio 90:10in the production of pasta, yielded positive results both in general acceptability and good nutritional value. Production of pasta made from wheat semolina and African yam bean flour blends should be encouraged as it enhanced the nutritional and dietary value as well as acceptable sensory properties of pasta.

Keywords: Nutrients composition, Sensory evaluation, Pasta, Wheat semolina flour, African yam bean flour

Introduction

The word 'pasta' means dough in Italian. It refers to extruded dishes that are Italian in style, such as spaghetti or macaroni (Webb, 2019). It is defined as any shaped and dried dough made from wheat semolina flour (*Tritium durum*) and other optional ingredients (Recchiaet al., 2019). Pasta is one of the most popular and easy-to-prepare convenient foods (Dhas et al., 2021). It contains a lot of complex carbohydrate (74–77%) and protein (11–15%), but low in amino acids, and total fat (Kumar et al., 2021). Pasta products are widely consumed around the world because of their simple formulation, relative ease of processing, storability, variety in use, and their relatively low cost (Ikbalet al., 2022). It is only second to bread in world consumption as a wheat-derived staple meal with a long shelf life (Ahmad et al., 2018).

Over the years, there has been a constant transition in diet, including a shift from traditional to modern meals with high energy density and low nutrient diversity, which has resulted in numerous nutrient deficits and health concerns (Ridgway et al., 2019). Recently, consumers now seek a healthy lifestyle and a longer lifespan, as a result, food safety has gotten a lot of attention. The consumer's interest in food to fulfill hunger has shifted to more functional elements that provide a better sense of well-being while also giving satiety (Baek, 2021). Additionally, the interest in general health care and nutritious functional foods that can improve immunity is also generating much attraction, especially with the rising desire to boost our immunity. The primary focus of this transition has been on replacing conventional chemical, synthetic additives with healthier, natural alternatives (Baek, 2021). Nutrition transition, characterized by shifts from traditional diets to more processed foods, often necessitates food fortification to address nutrient deficiencies that arise from these dietary changes

Fortification is a method of supplementing nutrients in foods, particularly "convenience foods" that are commonly consumed on a daily basis (Katoch, 2020). These convenience foods are most times found lacking in some essential vitamins and minerals; this results in malnutrition (Panouet al., 2022). Malnutrition affects critical development outcomes such as poor physical and mental development in children and adolescents, illness vulnerability or exacerbation, mental retardation, blindness, and overall losses in productivity and potential due to micronutrient deficiencies (Nelson et al., 2020). Micronutrient deficiency, unlike energy-protein malnutrition, has less obvious health consequences; as a result, it is frequently referred to as "hidden hunger" (Harding et al., 2020). Fortification of staple foods with micronutrients is the strategy to gain momentum currently in many developing countries (Rajnish et al., 2022). As pasta contains predominantly starch, many studies have attempted to improve its nutritional properties. These include supplementation with protein, dietary fibre, vitamins and minerals or substituting (partially or completely) the wheat semolina with non-conventional flours (Romano et al., 2021). This provides

an opportunity for fortification and enrichment, using raw materials to increase the nutritional quality of pasta (Babich, 2022). Among these non-traditional raw materials, legumes represent an interesting source of proteins, fibres, vitamins and minerals. Legume proteins are relatively low in sulphur-containing amino acids, methionine, cysteine and tryptophan, but high in lysine. Semolina flour, however, has a limited nutritional profile and is lacking in the amino acids (Kataria & Sharma, 2022).

Durum wheat semolina (DWS) is the dominant raw material for pasta production. Wheat is considered a good source of protein, minerals, B-group vitamins and dietary fiber i.e. an excellent health-building food. Thus, it has become the principal cereal, being more widely used for the making pasta as a result of the quality and quantity of its characteristic protein called gluten (Kumaret al., 2011). Although wheat flour is the most commonly used type of flour, Unfortunately wheat are not grown in Nigeria in large quantity, hence it has to be imported adding to the fact that federal government banned the importation of wheat into the country hence the need for composite flour from other food source such as African yam bean (*Sphenostylisstenocarpa*).

African yam bean (*Sphenosty-lisstenocarpa*) is a leguminous plant that has been gaining a lot of recognition in the market for its high-quality nutritional profile. African yam bean contains a large quantity of high-quality protein, along with a good balance of amino acids (Arukweet al., 2021). It is high in calories, carbohydrate, protein, fat, fiber, B Vitamins, folate, iron, magnesium, potassium, and manganese, among other minerals. It contains a lot of antioxidants, such as vitamin C which helps protect cells from damage and helps to reduce the risk of cancer (Maphosa & Jideani, 2017). In addition, they are also high dietary fiber, which has been shown to reduce the risk of colon cancer by as much as 50% (Adegboyega et al., 2020). The consumption of African yam beans has been proven to decrease blood sugar levels, improve insulin sensitivity and also have a satiety effect which helps in weight loss (Gbenga-Fabusiwa, 2021). According to Petitot et al. (2010), high fortification levels with legume flours, such as African yam beans can enhance the nutritional status of pasta products. By blending African yam bean flour with wheat semolina, the resulting pasta could offer enhanced protein content, improved amino acid profile, and other beneficial nutrients, contributing to both dietary improvement and food security, especially in sub-Saharan Africa (Adeyanju et al., 2022).This study therefore aimed to develop pasta using a blend of wheat semolina and African yam bean flour, evaluating its sensory attributes and nutrient composition. The goal is to produce a nutritious and sensory-acceptable pasta that provides an alternative to traditional wheat-based pasta, addressing the increasing demand for high-protein, nutrient-dense food products.

Objective of the study

The broad objective of this study was to determine the sensory and nutrient evaluation of pasta made from wheat semolina flour (*Tritium durum*) and

African yam bean flour (*Sphenostylisstenocarpa*) blend. The specific objectives of the study were to;

1. develop fortified pasta products with different ratios (90:10, 80:20, 70:30, 50:50) of African yam bean flour and wheat semolina flour blends;
2. carry out a sensory evaluation of the different pastas produced;
3. determine the proximate composition (protein, fat, carbohydrate, ash, crude fibre, moisture) of the most acceptable pasta and the control;
4. analyze the vitamin composition (Vitamin C, B1, B2, B3, B9) of the most acceptable pasta produced; and
5. determine the mineral composition (iron, magnesium, potassium, calcium and zinc) of the most acceptable pasta and the control.

Materials and methods

Study design: The study adopted true experimental research design. A true experimental research design is a type of research methodology that is used to establish cause-and-effect relationships between variables. It involves manipulating one or more independent variables to observe their effect on dependent variables while controlling for extraneous variables.

Procurement of raw materials: African Yam bean (*Sphenostylisstenocarpa*), semolina wheat flour (*Tritium durum)* and other ingredients for pasta preparation was obtained from Ogige main market in Nsukka Local Government of Enugu state.

Sample preparation: The African yam beans flour was processed according to the method described by Oyeyinkaet al. (2016). One kilogram of African yam seeds was sorted, washed and soaked in potable water for 20 minutes. Thereafter, the seeds were drained, dehulled manually, boiled at 100°C for 30 minutes and then dried in oven of 65°C for 6hrs. The dried seeds were milled, sieved using 1mm mesh screen and packaged in air-tight containers for analysis.

Formulation of flour blends: Semolina flour was blended with African yam bean flour in the following ratios – 90:10, 80:20, 70:30, 50:50and coded as samples AB1, AB2, AB3 and AB4 respectively.

Recipe for pasta production: The pasta was made with 400 grams of flour, 64 grams of egg, and 100 milliliters of water.

Method of pasta production: Mix 400g of flour on a board, make a well and gradually add 64g of whisked eggs while mixing to form a dough. Knead the dough on a floured surface for 5 minutes until smooth and elastic. Wrap the dough in plastic and let it rest for 20 minutes, then knead briefly. Roll out the dough into a circle, check for thickness, and even out thick spots. Let the dough rest until slightly dry but manageable. Roll the dough loosely on a rolling pin, slide it out, and cut it into strips. Unfold the strips and dry them on a rack for 3 hours before storing in an airtight container for up to 4 days.

Method of preparation of the pasta: For each of the samples, all ingredients used was measured and set aside. Boil water in a saucepan. Add salt to the boiling water. Add pasta, stir gently, and cook for 10 minutes. Stir occasionally while cooking. Drain the pasta and let it steam dry for 5 minutes until the surface looks matte. Allow the pasta to cool to room temperature for 15 minutes, then package it in labeled ceramic plates for sensory evaluation.

Sensory evaluation of Pasta: The products were evaluated for their sensory attributes; colour, flavour, taste, texture (mouth feel) and degree of overall acceptability. A nine-point hedonic scale ranging from like extremely to dislike extremely (9-like extremely to 1-dislike extremely) was completed by 30 trained panelists consisting of staff and students of University of Nigeria, Nsukka. The coded samples were presented separately at room temperature to each panelist for evaluation. Panelists were provided with water to refresh their mouth before evaluating successive samples to avoid carry over effect of the samples.

Sensory evaluation

The sensory test was carried out by employing 20 untrained panelists from the university students and staff. They were asked to score their preferences for sensory attributes (colour, aroma, taste, mouth feel, and overall) of cooked noodles, ranging from 1 (dislike very much) to 9 (like very much), using questionnaire sheets.

Nutrient analysis of cooked pasta: All nutrient analyses were carried out in duplicate determinations

Proximate analysis: Association of Analytical Chemistry [AOAC] (2005) was used to determine the proximate composition of all the samples**.** Carbohydrate content was determined by Difference.

Vitamin analysis: Vitamin C, Vitamin B_1, Vitamin B_2, Vitamin B_3, Vitamin B_9contentwere determined using standard methods described by AOAC (2010)**.**

Mineral analysis: Iron (Fe) content was determined using the Phenanthroline method as described by AOAC (2005). Calcium, Zinc, Potassium, Magnesium were carried out according to AOAC (2005) method.

Statistical analysis: Data obtained from sensory evaluation and nutrient composition were analyzed statistically using Statistical Product and Service Solution (SPSS) version 22.0 and presented as Mean ± Standard deviation. One-way Analysis of variance (ANOVA) was used to determine any significance ($p< 0.05$) difference between variables.

Results

Sensory evaluation of the different pasta produced from the flour blends

Table 1 shows the sensory evaluation of pasta produced with wheat semolina flour and African yam bean flour blends in different ratios (AB1; 50:50, AB2; 70:30, AB3; 80:20, AB4; 90:10, AB5;100:0). The score for colour ranged between 6.60-8.30. For flavour, the score ranged from 6.50-8.00. In taste, AB5 recorded the highest (8.20) while AB1 was lowest (6.40). In texture, the highest score was recorded in AB5 (8.37) while AB1 had the lowest score (6.83). In the overall degree general acceptability test, pasta from AB5 was the most accepted at 8.30 while AB1 was the least accepted at 5.93.

Table 1: Sensory evaluation of pasta produced using wheat semolina and African yam bean flour blends in different ratios

Sensory property	AB1	AB2	AB3	AB4	AB5
Colour	6.60 ± 1.71	7.66 ± 0.95	7.23± 1.25	7.53 ± 1.65	8.30 ± 0.70
Flavour	6.50 ± 1.50	7.60± 1.65	7.16± 1.28	7.20 ± 1.88	8.00 ± 0.79
Taste	6.40 ± 1.75	7.73 ± 1.28	7.56 ± 0.97	6.96 ± 2.05	8.20 ± 0.81
Texture	6.83 ± 1.62	7.03 ± 1.90	7.13 ± 1.22	7.26± 2.03	8.37 ± 0.76
General acceptability	5.93 ± 2.03	6.66 ± 2.23	6.40 ± 2.28	6.73 ± 2.06	8.30 ± 0.92

Values are Means ± SD (standard deviation).Where;AB1 = Wheat semolina flour + African yam bean flour (50:50), AB2 = Wheat semolina flour + African yam bean flour (70:30), AB3 = Wheat semolina flour + African yam bean flour (80:20), AB4 = Wheat semolina flour + African yam bean flour (90:10), AB5 = Wheat semolina flour – African yam bean flour blend (100:0)

Proximate composition of pasta produced using the flour blend (90:10)

Table 2shows the proximate composition of pasta produced using wheat semolina and African yam bean flour blend. The moisture contents of sample AB5 was 64.09% while AB4 60.76%. Crude fat for AB4was 1.39%while 2.09 AB5%. The protein content of AB4 was 14.53% while in AB5 it was recorded as 13.43%. The ash content of sample AB4 was 0.28%and 0.20% in AB5. The crude fibre content of the sample AB4 was0.85% and 0.40% in AB5. Also, the carbohydrate content of AB4 was 21.49% and 20.49% in AB5.

Table 2: Proximate composition of pasta produced using wheat semolina and African yam bean flour blends in different ratios (90:10) per 100g

Proximate (%)	AB4 (90:10)	AB5 (100:0)
Moisture	60.76 ± 0.23	64.09 ± 0.47
Crude fat	2.09 ± 0.01	1.39± 0.01
Crude protein	14.53 ± 0.07	13.43 ± 0.04
Ash	0.28 ± 0.00	0.20 ± 0.00
Crude fibre	0.85 ± 0.63	0.40 ± 0.00
Total carbohydrate	21.49 ± 0.21	20.49 ± 0.49

Values are mean ± standard deviation. Where, AB4 = Wheat semolina flour + African yam bean flour (90:10) and AB5 = Wheat semolina flour + African yam bean flour (100:0)

Vitamin composition of pasta produced using the flour blends (90:10)

Table 3 shows the vitamin composition of pasta produced using wheat semolina and African yam bean flour blends. The result revealed that vitamin B_9 content was higher in AB4 15.50mg/100g and lower in AB5 20.40mg/100g. Vitamin C had higher value in AB4 (2.10mg/100g) and lower value in AB5 (1.30mg/100g). Vitamin B_3 was higher in AB4 (3.00mg/100g) and lower in AB5 (0.11mg/100g). Vitamin B_1 is higher in AB4 (0.9mg/100g) and lower in AB4 (0.63mg/100g). Vitamin B_2 is higher in AB4 (0.20mg/100g) and lower in AB5 (0.10mg/100g).

Table 3: Vitamin composition of pasta produced using wheat semolina and African yam bean flour blends

Parameter (mg\100g)	AB4	AB5
Vitamin B_1	0.95 ± 0.07	0.63 ± 0.04
Vitamin B_2	0.10 ± 0.00	0.20 ± 0.00
Vitamin B_3	3.00±0.00	0.11 ± 0.01
Vitamin B_9	20.40 ± 0.28	15.50 ± 0.14
Vitamin C	2.10 ± 0.14	1.30 ± 0.14

Values are mean ± standard. Where, AB4 = Wheat semolina flour + African yam bean flour (90:10) and AB5 = Wheat semolina flour + African yam bean flour (100:0)

Mineral composition of composition of pasta produced using the flour blends (90:10)

Table 4 shows the mineral composition of pasta produced using wheat semolina and African yam bean flour blends. Zinc content was 0.43mg/100gin AB4 while no value was recorded in AB5 (0.00mg/100g). The iron content was higher in AB5 (0.92mg/100g) and lower in AB4 (0.79mg/100g). Potassium content was more in AB4 (6.77mg/100g) and lower in AB5 (2.55mg/100g). Magnesium was found to be higher in AB4 (2.39mg/100g) and lower in AB5 (2.12mg/100g). Calcium was higher in AB4 (4.00mg/100g) and lower in AB5 (2.67mg/100g).

Table 4: Mineral content scores of pastas fortified using wheat semolina and African yam bean flour blends

Parameter (mg/100g)	AB4 (90:10)	AB5 (100:0)
Zinc	0.43 ± 0.00	0.00 ± 0.00
Iron	0.79 ± 0.07	0.92± 0.07
Potassium	6.77 ± 0.05	2.55 ± 0.11
Magnesium	2.39 ± 0.32	2.12 ± 0.03
Calcium	4.00 ± 0.00	2.67 ± 0.00

Values are mean ± standard deviation. Where, AB4 = Wheat semolina flour + African yam bean flour (90:10) and AB5 = Wheat semolina flour + African yam bean flour (100:0)

Discussion

The results of the sensory evaluation revealed that all pasta samples compared favorably with the control sample (100 wheat semolina flour). The results indicated that the pasta sample made from (90:10) wheat semolina – African yam bean flour blends had the highest score for all the sensory parameters evaluated. However, the pasta sample (90:10) wheat semolina flour and African yam bean flour compared more favorably in terms of texture and general acceptability while the sample substituted with 70:30 wheat semolina flour and African yam bean compared more favorably in terms of color, flavor, and taste. Effiong et al. (2018) also reported similar results of high sensory ratings for colour, flavor, taste, texture, and degree of general acceptability respectively. The sensory scores showed that the preference of texture decreased with the addition of more African yam bean flour. This could be as a result of the presence of moisture and fat content which affects sensory experience. The texture of a product is one of the factors that determine acceptability of a product. Food texture modifies eating rate and through that the energy intake of foods (Wee et al., 2018). It has been observed that harder, chunkier, more viscous and more voluminous foods decrease eating rate of foods and thus decrease energy intake (McCrickerd & Forde, 2016).

The result of the proximate analysis revealed that the moisture content of the pasta made from (90:10) wheat semolina and African yam bean flour blends is within the expected range, which is 62%, this correlates with the range (51.19-55.21- 64.69-67.97%) reported by Teterycz et al. (2020). The study also showed that the ash content of the most accepted blend was lower recording less than 1% of the value for high ash content depicted by the Codex Alimentairus Commission (2009) and Mengistie et al. (2018), and 0.84% less when compared to the work done by Biernacka et al. (2018). Ash is a non-organic compound containing minerals in food and nutritionally it aids in the metabolism of other organic compounds such as fat and carbohydrate (Ukonze, 2018). According to Udomsil et al. (2019), a solid or liquid food is said to contain high protein when the protein content is greater than 5% per 100g of the food. Thus, the results showed that the protein contents of thepasta made from the flour blends were higher compared with 4.0-6.9% protein reported for plantain soy flour blends by Abata et al. (2019) and 11.79% reported by Effiong et al. (2018) in a similar composite of African yam bean flour for the production of pasta. The high value of protein recorded could be attributed to the fact that African yam bean is a protein rich food and could be useful tool in food product supplementation to combat protein energy malnutrition. The fat contents of the pasta made from (90:10) wheat semolina and African yam bean flour blends was comparable to that of the control, but lower than 3% reported for high fat contents of food items as depicted by Codex Alimentarius Commission (2009) and Goyal et al. (2016). The results were comparable to 0.20-0.58% fat reported by Abata et al. (2019) for plantain-based flour blends and Effiong et al. (2018) who recorded 1.75% fat in similar composite flour. The low-fat contents of the pasta made from flour blends samples could be attributed to the low-fat contents of the individual food items.

Crude fibre is important for digestive health and regular bowel movements in humans. Fibre helps people to feel fuller for longer, can improve cholesterol and blood sugar levels and reduce your risk of diseases, including bowel cancer (Rubin, 2019). Increasing the fibre content in food products is useful to alleviate diseases such as

hypertension, diabetes, colon cancer and coronary heart disease (Romano et al., 2021). The crude fibre content of the pasta made from (90:10) wheat semolina and African yam bean flour blends was comparable to the values recorded for the control. The low fiber contents of the flours could be attributed to processing methods employed in the production of the flour such as sieving, milling as well as the variable fibre contents of the individual food items. The crude fibre content of the pasta made from (90:10) wheat semolina and African yam bean flour blend is comparable to the work done by Parvin et al. (2020) which only accounted for 0.65%. The carbohydrate content of the pasta produced from (90:10) and (100:0) wheat semolina flour and African yam beans flour blends was also comparable. The values were low compared to 59.38- 75.03% reported by Mepba et al. (2021) on quality characteristics and sensory properties of noodles produced from blends of wheat, acha, Bambara groundnut and cocoyam composite flours. This is not surprising as the composite flour produced contains about 70% carbohydrate.

The importance of minerals cannot be overemphasized and thus should be consumed appropriately. The following shows the mineral composition of pasta made from (90:10) wheat semolina and African yam bean flour blends per 100g. The values recorded were higher when compared to the control sample. However, Dendegh et al. (2021) reported similar of values of 0.68mg/100g calcium, magnesium 0.41mg/100g, potassium 0.34mg/100g, iron 3.11mg/100g on flour blends of pearl millet (*Pennisetumglaucum*) and African yam bean (*Sphenostylisstenocarpa*) while lower values (calcium, iron, magnesium and potassium 66.60, 7.72, 23.80 and 100.34 mg/100g respectively) was reported by El-Baz et al. (2017). Increased potassium level could be an added advantage in product formulation where potassium is an important macronutrient among other minerals. Consequently, inadequate intakes of micronutrients are associated with severe malnutrition, increases disease conditions and mental impairment (Azzolino et al., 2019). Calcium is essential for the normal development of the body. It is an important constituent of bones and teeth. It is also essential for many metabolic processes including nerve function, muscle contraction and blood clothing (De & De, 2019). Magnesium like calcium is important for proper functioning of muscle and nervous tissues. It is required as a cofactor for many enzymes in the body. Potassium helps enhance muscle strength, metabolism, water balance, electrolytic functions, and the nervous system (Yang et al., 2018).

Vitamins are micronutrients which the body needs for essential bodily functions such as enzyme reactions and in metabolic processes. The values for the vitamin composition of pasta produced from 90:10 wheat semolina and African yam bean flour blend was higher compared to the values of the control sample. This was expected as African yam beans are good sources of the B complex vitamins. Sarkar et al. (2022) recorded a similar increase (B1-0.01mg/10g, B2- 0.5701mg/10g, B3- 0.4101mg/10g, B6 – 0.9701mg/10g). Vitamin B1 is an important nutrient in the body. Its benefits include boosting energy production, safeguarding the nerves, slowing the body aging process, stimulating digestion and enhancing memory. It also helps to prevent Alzheimer's disease, and boost body immunity (Gibson et al., 2016). Vitamin B2 is also beneficial for eye health, migraines, energy production, decreasing cardiovascular risk, and boosting antioxidant status. B2 is a water-soluble and heat-stable nutrient used by the body to metabolize fats, proteins, and carbohydrate

for energy (Mahabadi et al., 2022). Vitamin B9 (folic acid), regulates the level of homocysteine in the body to support good heart health (Maqbool et al., 2018). It also controls the level of deposition of cholesterol in the human heart, to prevent many heart disorders (Makhmudovich et al., 2021), stroke, cancer, and birth defects during pregnancy. Folic acid also helps in building muscles, cell enhancement, hemoglobin formation, and provides relief from mental and emotional disorders (Tardy et al., 2020). Vitamin C is a water-soluble vitamin that must be obtained from diets or supplements. It has been linked to many impressive health benefits, such as boosting antioxidant levels, lowering blood pressure, protecting against gout attacks, improving iron absorption, boosting immunity, and reducing heart disease and dementia risk (Zeng et al., 2018).

Conclusion

The pasta produced from 90:10 wheat semolina and African yam bean flour blend had the highest degree of acceptability value. The pasta produced was accepted by the panel assessors and had comparable scores on texture and taste with the control sample made from 100% wheat semolina flour. The pasta produced from the flour blends was rich in crude protein, ash, and carbohydrate. It was a great source of folate, potassium and calcium, moderate sources of fat, magnesium but low sources of vitamin C, B1, B2, B3, iron, zinc and crude fibre. The study concludes that the production of the pasta with 90:10 wheat semolina – African yam bean flour blends could be one of the cost-effective way of enriching the nations' food basket for contributing to food diversification and improved dietary health.

Recommendations

The following recommendations were made based on the findings of this study.

1. Food manufacturers should consider using African yam bean flour as a partial substitute for wheat semolina in pasta production to enhance the protein content and nutritional value, particularly in regions facing protein-energy malnutrition. A 90-10% substitution level is recommended to maintain desirable sensory properties while significantly improving the nutritional profile.
2. The government and health organizations should promote the consumption of this nutrient-rich pasta blend, particularly in food security initiatives, school feeding programs, and regions where nutritional deficiencies are prevalent.
3. Additional research should explore the potential of other underutilized legumes and grains in pasta production. Studies focusing on consumer acceptance, storage stability, and large-scale production will provide valuable insights for commercial adoption.

References

A.O.A.C(2010). *Official Method sof Analysis(15thedition).* Association of Official Analytical Chemistry. Washington, D.C., U.S.A.

A.O.A.C(2015). *Official Methods of Analysis(18thedition).* Association of Official Analytical Chemistry, Washington D.C., U.S.A.

Abata, G.D., Abata, E.O., Lene, B.D., & Akande, Y.O. (2019). Proximate, mineral and sensory properties of African yam bean-semolina flour blends. *International Journal of Research and Scientific Innovation*, *6*(3), 21-26. https://www.researchgate.net/publication/333353294_Proximate_Mineral_and_Sensory_Properties_of_Plantain-Soy_Flour_Blends

Adegboyega, T. T., Abberton, M. T., AbdelGadir, A. H., Dianda, M., Maziya-Dixon, B., Oyatomi, O.A. & Babalola, O.O. (2020).

Evaluation of nutritional and antinutritional properties of African yam bean (*Sphenostylisstenocarpa* (Hochstex. A. Rich.) Harms.) Seeds. *Journal of Food Quality*, *2020*. https://doi.org/10.1155/ 2020/6569420

Ahmad, N., Ur-Rehman, S., Shabbir, M.A., Shehzad, M.A., & Roberts, T.H. (2018). Fortification of durum wheat semolina with detoxified matri (Lathyrussativus) flour to improve the nutritional properties of pasta. *Journal of Food Science and Technology*, *55*(6), 2114-2121. https://doi.org/10.1007/s13197-018-3126-x

Arukwe, D.C., Ezeocha, V.C., & Ubbor, S.C., (2021). Production and evaluation of cookies from composites of sprouted wheat, sorghum and African yam bean seed flours. *Nigerian Agricultural Journal*,*52*(2), 277-283. https://www.researchgate.net/publication/355034841

Azzolino, D., Passarelli, P. C., De Angelis, P., Piccirilo, G.B., D'addona, A., & Cesari, M. (2019). Poor oral health as a determinant of malnutrition and sarcopenia. *Nutrients*, *11*(12), 2898. https://doi.org/10.3390/nu11122898

Babich, O., Sukhikh, S., Larina, V., Kalashnikova, O., Kashirskikh, E., Prosekov, A. & Dolganyuk, V. (2022). Algae: Study of edible and biologically active fractions, their properties and applications. *Plants*, *11*(6), 780. https://doi.org/10.3390/plants11060780.

Baek, J. (2021, June 2). *Modified Cellulose Nanocrystals (CNC) for Functional Foods*. University of Waterloo. https://hdl.handle.net/10012/17083

Biernacka, B., Dziki, D., & Gawlik-Dziki, U. (2022). Pasta enriched with dried and powdered leek: Physicochemical properties and changes during cooking. *Molecules*, *27*(14), 4495. https://doi.org/10.3390/molecules27144495

Codex Alimentarius Commission. (2009). *Guidelines for food and nutrition labeling*. FAO/WHO Codex general guidelines on food labeling, 47-65. https:// www.fao.org

De, L. C., &De, T. (2019). Healthy food for healthy life. *Journal of Global Biosciences*, *8*, 6453-6468. https://www.mutagens.co.in/jgb/vol.08/09/Journal%20of%20Global%20Biosciences%20080904.pdf

Dendegh, T. A., Yelmi, B. M., & Dendegh, R. A. (2021). Evaluation of stiff porridge (Ruam nahan) produced from composite flour blends of pearl millet (*Pennisetumglaucum*) and African yam bean (*Sphenostylisstenocarpa*). *Asian Food ScienceJournal*,*20*(9), 63-77. https://doi.org/10.9734/AFSJ/2021/v20i930343

Dhas, T. A., Rao, V. A., Sharon, M. E. M., Manoharan, A. P., & Nithyalakshmi, V. (2021). Development of fibre enriched ready-to-cook pasta with foxtail millet and tapioca flour. *Pharma Innovation Journal*,*10*(5), 1432-1435. www. thepharmajournal.com

Effiong, B., Maduka, N., & Essien, A. (2018). Evaluation of wheat and orange-fleshed sweet potato composite flour fortified with African yam bean flour for instant noodle production. *Archives of Current Research International*, *13*(4),1-15https://doi.org/10.9734/ACRI/2018/41174

El-Baz, F.K., Abdo, S. M., & Hussein, A. M. (2017). Microalgae Dunaliella salina for use as food supplement to improve pasta quality. *International Journal of Pharmaceutical Science Review Research*, *46* (2), 45-51. www.globalresearchonline.net

Gbenga-Fabusiwa, F. J. (2021). African yam beans (Sphenostylisstenocarpa): A review of a novel tropical food plant for human nutrition, health and food security. *African Journal of Food Science*,*15*(2),33-47. https://doi.org/10.5897/AJFS2020.1961

Gibson, G. E., Hirsch, J. A., Fonzetti, P., Jordan, B. D., Cirio, R. T., & Elder, J. (2016). Vitamin B1(thiamine) and dementia. *Annals of the New York Academy of Sciences, 1367*(1), 21-30. https://doi.org/10.1111/nyas.13031

Goyal, A., Sharma, V., Sihag, M. K., Singh, A. K., Arora, S., &Sabikhi, L. (2016). Fortification of dahi (Indianyoghurt) with omega-3 fatty acids using microencapsulated flaxseed oil microcapsules. *Journal of Food Science and*

Technology,53(5), 2422-2433. https:// doi.org/10.1007/s13197-016-2220-1

Harding, K. L., Aguayo, V. M., & Webb, P. (2018). Hidden hunger in South Asia: A review of recent trends and persistent challenges. *Public Health Nutrition*, *21*(4),785-795. https://doi.org/10.1017/ S1368980017003202

Ikbal, A., Chowdhury, S., Murmu, P., Dora, K. C., Nath, S., Roy, S., & Saklani, P. (2022). Surimi powder inclusion with semolina-based pasta product–A potential method of protein fortification. https://doi.org/10.23910/1.2022.2435

Kataria, A., & Sharma, S. (2022). Envisioning Utilization of Super Grains for Healthcare. In *Phytochemicals and Medicinal Plants in Food Design* (pp.237-281). Apple Academic Press. https:// doi.org/:10.1201/9781003150336-12

Katoch, R. (2020). Value-added products from rice bean .In *Ricebean* (pp.315-346).Springer, Singapore. https://doi.org/10.1007/978-981-15-5293-9_17

Kumar, G.S., Sh, A., Krishnan ,R.,& Mohammed, T.(2021).Pasta: Raw materials, processing and quality improvement. *Pharmaceutical Innovative Journal,10*, 185-197. https://doi.org/ 10.22271/tpi.2021.v10.i5Sc.6205

Kumar, P., Yadava, R.K., Gollen, B., Kumar, S., Verma, R.K., & Yadav, S. (2011). Nutritional contents and medicinal properties of wheat: A review. *Life Sciences and Medicine Research*, *22*, 1-10. http://astonjournals.com/lsmr

Mahabadi, N., Bhusal, A., & Banks, S. W. (2022). *Riboflavin deficiency*. StatPearls publishing. https://www.ncbi. nlm.nih.gov/books/NBK470460/

Makhmudovich, A. M., Sattarovna, R. G., Maksudovna, V. N., &Azamatovich, J. S.(2021).Hyperhomocysteinemia and pathogenetic mechanisms ofIschemic stroke. *The American Journal of Medical Sciences and Pharmaceutical Research,3*(02),66-76. https://doi.org/10.37547/TAJMSPR/

Maphosa, Y., & Jideani, V. A. (2017). The role of legumes in human nutrition: Functional food improve health through adequate food. *Frontiers in Plant Science,1*, 13. https://doi.org/10.5772/ intechopen.69127

Maqbool, M. A., Aslam, M., Akbar, W., & Iqbal, Z. (2018). Biological importance of vitamins for human health: A review. *Journal of Agricultural and Basic Sciences* 2(3),50-58. http://www.jabsjournal.com/

McCrickerd, K., & Forde, C. G. (2016). Sensory influences on food intake control: Moving beyond palatability. *Obesity Reviews*, *17*(1),18-29. https://doi.org/10.1111/obr.12340.

Mengistie, T., Alemu, A., & Mekonnen, A. (2018). Comparison of physicochemical properties of edible vegetable oils commercially available in Bahir Dar, Ethiopia. *Chemistry International*, *4*(2), 130-135. https://doi.org/10.31221/osf.io/jeabt

Mepba, H. D., Emelike, N. J. T., Agiriga, E., & Mary, E.U. (2021). Quality characteristics and sensory properties of noodles produced from blends of wheat, Acha (Digitaria exilis), Bambara groundnut and cocoyam composite flours. *Asian Food Journal,20*(8), 15-25. https://doi.org/ 10.9734/afsj/2021/v20i830327.

Nelson, C. A., Bhutta, Z. A., Harris, N. B., Danese, A., & Samara, M. (2020). Adversity in childhood is linked to mental and physical health throughout life. *BioMedical Journal*, *371*. https://doi.org/10.1136/bmj.m3048

Oyeyinka,S.A.,Oyeyinka,A.T.,Opaleke,D.O.,Kari m,O.R.,Kolawole,F.L.,Ogunlakin,G.O.,& Olayiwola, O.H. (2016). Pasta production from wheat (triticumaestivum) and African yam bean (Sphenostylisstenocarpa)flours using date fruit as a sweetener. *Annals of Food Science and Technology*, *15*(1),20-28. https://doi.org/10.9734/ ACRI/2018/41174

Panou, G., Stavridou, A., Bacopoulou, F., Psaltopoulou, T., & Tsitsika, A. (2022). The investigation of the relationship between attention deficit-hyperactivity disorder and eating disorders in adolescents: *Developmental and Adolescent Health*, *2*(1). https://doi.org/ 10.54088/8gfh

Parvin, R., Farzana, T., Mohajan, S., Rahman, H., & Rahman, S. S. (2020). Quality improvement of noodles with mushroom fortified and its comparison with local branded noodles. *NFS*

Journal, *20*, 37-42. https://doi.org/10.1016/j.nfs.2020.07.002

Petitot, M., Boyer, L., Minier, C., & Micard, V. (2010). Fortification of pasta with split pea and faba bean flours: pasta processing and quality evaluation. *Food Research International, 43*, 634–641. https://doi.org/10.1016/j.foodres.2009.07.020

Rajnish, K., Chijina, K., Ravu, M., & Pawan P. K. (2022). Fortification of micronutrients in chickpea (*Cicer arietinum L.)* Innovative approaches to combat malnutrition. *Pharma Innovation Journal,11*(6), 886-894.www.thepharmajournal.com

Recchia, L., Cappelli, A., Cini,E., GarbatiPegna, F., & Boncinelli, P. (2019). Environmental sustainability of pasta production chains: An integrated approach for comparing local and global chains. *Resources*, *8*(1), 56. https://doi.org/10.3390/resources8010056

Ridgway, E., Baker, P., Woods, J., & Lawrence, M. (2019). Historical developments andparadigm shift in public health nutrition science, guidance and policy actions: A narrative review. *Nutrients*, *11*(3), 531. https://doi.org/10.3390/nu11030531

Romano, A., Ferranti, P., Gallo, V., & Masi, P. (2021). New ingredients and alternatives to durum wheat semolina for a high quality dried pasta. *Current Opinion in FoodScience,41*, 249-259. https://doi.org/10.1016/j.cofs.2021.07.005

Sarkar, T., Salauddin, M., Roy, S., Chakraborty, R., Rebezov, M., Shariati, M. A., Thiruvengadam, M., &Rengasamy, K. R. R. (2023). Underutilized green leafy vegetables: frontier in fortified food development and nutrition. *Critical Reviews in Food Science and Nutrition*, *63*(33), 11679–11733. https://doi.org/10.1080/10408398.2022.2095555

Tardy, A. L., Pouteau, E., Marquez, D., Yilmaz, C., & Scholey, A. (2020). Vitamins and minerals for energy, fatigue and cognition: a narrative review of the biochemicalandclinical evidence. *Nutrients,12*(1), 228. https://doi.org/10.3390/nu12010228

Teterycz, D., Sobota, A., Zarzycki, P., & Latoch, A. (2020). Legume flour as a natural colouring component in pasta production. *Journal of Food Science and Technology*, *57*, 301–309. https://doi.org/ 10.1007/s13197-019-04061-5

Udomsil, N., Imsoonthornruksa, S., Gosalawit, C., & Ketudat-Cairns, M. (2019). Nutritional values and functional properties of house cricket (*Acheta domesticus*)and field cricket (*Gryllus bimaculatus*). *Food Science and Technology Research,25*(4),597-605. https://doi.org/10.3136/fstr.25.597

Ukonze, J. A. (2018). Impact of clarification process on the nutritional, mineral and vitamin composition of cashew (*Anacardium occidentale*) apple juice. *African Journal of Biotechnology,17*(10), 337-342. https://doi.org/10.5897/ AJB2017.16337

Webb, D. (2019). Pasta's history and role in healthful diets. *Nutrition Today*, *54*(5),213-220. https://doi.org/10.1097/ NT.0000000000000364

Wee, M. S. M., Goh, A. T., Stieger, M.,& Forde, C. G., (2018). Correlation of instrumental texture properties from textural profile analysis (TPA) with eating behaviours and macronutrient composition for a wide range of solid foods. *Food & Function*, *9*(10), 5301–5312. https://doi.org/10.1039/c8fo00791h

Yang, T., Richards, E. M., Pepine, C. J., & Raizada, M. K. (2018). The gut microbiota and the brain–gut–kidney axis in hypertension and chronic kidney disease. *NatureReviewsNephrology,14*(7), 442-456. https://doi.org/10.1038/s41581-018-0018-2

Zeng, Y., Pu, X., Yang, J., Du, J., Yang, X., Li, X., Li, L., Zhou, Y., & Yang, T. (2018). Preventive and Therapeutic Role of Functional Ingredients of Barley Grass for Chronic Diseases in Human Beings. *Oxidative Medicine and Cellular Longevity*, *2018*, 3232080.