AMINO ACID PROFILE AND COLOUR CHARACTERISTICS OF PASTA PRODUCED FROM WHOLE WHEAT AND DEFATTED SESAME SEED COMPOSITE FLOUR

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ABSTRACT

This study assessed the amino acid profile and colour characteristics of pasta produced from flour blends of whole wheat and defatted sesame seeds flour at percentages ratio of 100:00 (WF0), 95:5 (WDS1), 90:10 (WDS2), 85:15 (WDS3) and 80:20 (WDS4). The 100 % (WF0) served as the control and standard analytical protocols were used. The results showed an increase in essential amino acids with leucine, lysine and phenylalanine having dominance and ranged between 6.12 – 7.35 g/100g protein, 3.48 – 6.33 g/100 g protein and 4.36- 4.40 g/100g protein respectively. The defatted sesame seeds showed an appreciable increase in both the essential and non-essential amino acids. The colour of the pasta deepened as the defatted sesame seeds flour substitution increased. The control (WF0) had a higher lightness (L*) and b* values compared with the pasta made from the composite flour blends. Substitution with defatted sesame seeds flour improved the amino acids profile and this could be of nutritional advantage especially in the rural areas in developing countries.

Keywords: Composite flour, Wheat grains, Amino acid, Defatted sesame seeds, Pasta

INTRODUCTION

The high cost of wheat importation has paved way for the use of alternate flours referred to as composite flours. These are produced from locally available crops used to replace or in combination with wheat. It has lately become the subject of focus in innovative flour development in a bid to majorly boost the economy of non-wheat producing countries and minimize total dependence of wheat importation (Ayo- Omogie, 2023). Composite flour has the advantage of providing an improved supply of proteins and other nutrients to better human nutrition and overall health (Hasmadi *et al.*, 2020). Pasta is a common staple food worldwide due to its ease of preparation, good storage stability (dried form), low cost and simple preparation. Conventional pasta contains has low amount of essential amino acids, vitamins and minerals (Sisson, 2022). The role and importance of pasta as a staple food in the human diet has spurred the interest of enriching pasta by fortifying wheat with flour from legumes, vegetable, marine foods, and refined or whole flour from other cereals (Di Pede *et al.*, 2021).

Whole Wheat (*Triticum spp.)* grains are mainly milled for the production of wheat flour. Its flour is used in the production of pasta, bread, noodles, biscuits and confectionaries (Shima *et al.*, 2019). Though healthy positive effects and nutritional are ascribed to whole wheat flours due to the fibre and the phytochemicals contents the consumption is reported to be extremely lower than the recommended levels (Li *et al.*, 2019). Sesame seeds (*Sesamum indicum* L.), also known as beniseed are an underutilized essential, 'all-purpose nutrient bank' and ancient oil seed crop from the *Pedaliacae* family (Ayo-Omogie, 2023; Wei *et al.*, 2022). Defatted sesame is a nutritious by-product obtained after sesame oil extraction (Prakash *et al.*, 2018). It possesses exceptional nutritional value because of its high dietary fibre, certain micronutrients, high-quality protein with a balanced amino acid composition. It is however mostly used in animal feed or discarded (Han *et al.*, 2024)

Flour blends formulation using whole wheat and defatted sesame seed flours has been reported to improve the chemical properties of the composite flour and their use in production of food such as pasta has recommended (Ojo *et al.*, 2024). Pasta has also been identified as a vehicle delivering a more balanced nutrient and subsequent improvement in human nutrition. This study therefore attempts to further establish and provide a detailed knowledge of the amino acid profile and colour characteristics of the pasta produced. This can facilitate the development of a nutritionally enhanced novel pasta products with visual appeal thereby meeting the needs of the consumers.

MATERIALS AND METHODS

Materials Procurement and Sample Preparation

Whole wheat flour was purchased from Crown flour mills, Port-harcourt, Rivers state while the sesame seeds (Ex-Sudan) was purchased from the National Cereals and Research Institute, Badeggi, Niger state. The research was carried out in the Food Processing Laboratory, Department of Food Science and Technology, Federal University of Technology Minna

Production of whole wheat and defatted sesame seeds flour

The whole wheat grains were sorted and wet cleaned to further remove extraneous particles. Wet cleaned grains werenthen solar dried for 48 h, milled and sieving (70 µm sieves) to fine flour and packaged in a Ziplock bag. While the defatted sesame seed flour was prepared using the method described by Chinma *et al.* (2012) with slight modification using n-hexane for oil extraction. The sesame seeds were sorted, soaked (12 h) in a clean tap water at ambient temperature, hand-dehulled by rubbing between palms and drained after the coating has been separated using floatation technique. The dehulled seeds were blanched in water (80 °C, 5 min), solar dried for 72 h, and milled into flour using attrition mill to obtain fat sesame seeds flour. Exactly, 500 g of sesame seed flour was poured in a white muslin cloth and immersed in an aluminium pan containing 1 L of n-hexane for 12 h to extract the oil. Thereafter, the top layer was decanted and the defatted sesame seed flour was air dried for 3 h and milled using a blender (Kenwood, model: BY-823). The flour was passed through a 70 µm mesh size sieve and stored in plastic containers with lids at 4 °C prior to further analyses

Production of pasta

Whole wheat flour and defatted sesame flour formulation for the various pasta were prepared in the ratio of 100:00, 95:5, 90:10, 85:15 and 80:20 respectively. The slightly modified method described by Raji *et al.* (2023) was employed for the production of pasta. In each case, 180 g of flour, 0.15 g of salt and 0.30 g of carboxyl methyl cellulose (CMC) were mixed with 60 mL of water and kneaded for 15 mins to form a dough. The dough was rolled out to form sheets and manually cold-extruded using hand pasta machine at room temperature and passed through 0.28 mm die aperture, dried in an oven at 60 °C for 5 h and packaged in Ziplock bags.

Determination of amino acid profile

The method previously described by Chinma *et al.* (2015) was adopted for the determination of amino acid profiles of the pasta samples. The samples were hydrolyzed with 6mol/L HCL at 116 °C for 24 h prior to analysis. subsequent profiling of amino acids composition of the sample was determined using a high- performance liquid chromatograph (Quasar, PerkinElmer, Hopkinton, USA) coupled with a photodiode array detector (ModelMD-2010; JASCO, Tokyo, Japan), operating at 254nm. The temperature was kept at 40 °C and the mobile phase was a mixture of chromatographic grade acetonitrile, methanol and acetic acid (10:40:50mL/mL/mL).

Colour Analysis

The colour of the pasta samples was measured with a Chroma-meter (Minolta, Tokyo, Japan) equipped with a D 65 illuminant using the CIE L*a*b* system. The L*a*b* (lightness, redness, yellowness) readings were obtained directly from the instrument.

Statistical Analysis

Triplicate analysis was performed and the data obtained from all analyses were subjected to statistical analysis. Analysis of variance (ANOVA) was done and significant difference was separated by simple means ($p<0.05$). To distinguish means of significant differences from the ANOVA, the Duncan multiple range test was performed.

RESULTS AND DISCUSSION

The result of the amino acid composition of the pasta samples are shown in Table 1. Among the essential amino acids, leucine, lysine and phenylalanine were dominant and as expected, higher values of essential and non- essential amino acids were observed in the pasta produced from the composite flour blends and generally increase as the defatted sesame seeds substitution increases. The total essential amino acids were highest in WDS4 at 32.69 g/100g protein which translates to a 27.30 % increase. Likewise, the hydrophobic and hydrophilic amino acids of the control (100 % whole wheat) were the lowest at 26.32 and 13.21 g/100 g respectively. It is interesting to note that a 10.87 % and 36.71 % change were observed also for the hydrophobic and hydrophilic amino acids in this study. Arise *et al.*, (2016) reported that the hydrophobic amino acids act as antioxidants by increasing the solubility of peptides in lipids which then facilitates better interaction with free radicals and this could be of health benefit as the pasta samples can be consumed as functional food (Arise *et al.*, 2022). The amount of polar (basic and acid) amino acids ranged between 10.44- 15.00 g/100g protein and 18.13-19.56 g/100g protein respectively. The basic acid is higher in WDS4 (20 % defatted sesame seeds substituted pasta) while the acidic amino acid in sample WH0 (control) was slightly higher than the pasta sample WDS4. This suggests higher protein solubility in sample WDS4. The values of the polar acids are slightly higher than the value reported by Arise *et al.* (2022) on wheat -Bambara nut isolate pasta samples. The sulphur amino acids ranged between 2.80-3.31g/100 g of protein with the highest value at WDS4. These are essential in the initiation of protein synthesis and an average adult requires a 0.9 g/day of methionine and cysteine. This pasta can adequately provide a substantial amount in the human daily requirements.

Colour characteristics of whole wheat and defatted sesame seeds-based pasta

The colour of pasta is an important factor in pasta products, its plays an essential role in consumer perception and acceptance. The various pasta samples colour characteristics evaluated in terms of CIE (International Commission on Illumination) values is as summarized in Table 2. Statistical analysis revealed a significant ($p \leq 0.05$) difference in L^*, a^*, and b^* among the pasta samples. Lightness (L^*: 0 is black and 100 is white), was observed in the range of 45.34 – 61.67. The highest L* value was observed in the control sample and there was no significance between the WDS3 and WDS4 pasta samples.

Table 1. Amino acid profile of pasta produced from wheat and defatted sesames seed composite flour

Amino acid g/100g protein	WF0	WDS1	WDS2	WDS3	WDS4
Valine	3.32^{d}±0.03	3.43^{c}±0.04	3.34^{c}±0.04	3.60^{b}±0.03	3.73^{a}±0.06
Isoleucine	3.02^{e}±0.04	3.21^{d}±0.01	3.26^{c}±0.03	3.68^{a}±0.08	3.49^{b}±0.05
Leucine	6.12^{e}±0.12	6.80^{d} ± 0.04	6. 97^{c}±0.00	7.02^{b}±0.10	7.35^{a}±0,05
Threonine	1.34^{d}±0.04	3.34^{c}±0.15	3.50^{b}±0.31	3.51^{b}±0.90	3.62^{a}±0.04
Methionine	1.73^{a}±0.06	1.47^{b}±0.03	1.34^{c}±0.10	1.32^{c}±0.20	1.22^{d}±0.02
Lysine	3.48^{e}±0.04	5.54^{d}±0.03	5.77^{b}±0.04	5.68^{c}±0.05	6.33^{a}±0.02
Histidine	2.31^{c}±0.01	2.30^{c}±0.01	2.43^{b}±0.15	2.43^{b}±0.03	2.57^{a}±0.03
Phenylalanine	4.36^{a}±0.06	4.40^{a}±0.10	3.90^{b}±0.28	4.40^{a}±0.11	4.38^{a}±0.04
TEAA	25.68	30.49	30.51	31.64	32.69
Arginine	4.65^{e}±0.04	4.93^{d}±0.05	5.52^{b}±0.06	5.41^{c}±0.01	6.10^{a}±0.01
Proline	3.51^{bc}±0.13	3.37^{c}±0.06	3.44^{c}±0.17	3.68^{ab}±0.07	3.85^{a}±0.14
Tyrosine	3.37^{b}±0.09	3.42^{b}±0.02	3.34^{b}±0.15	3.48^{b}±0.10	4.12^{a}±0.01
Cystine	1.28^{d}±0.04	1.49^{c}±0.09	1.46^{c}±0.06	1.71^{b}±0.04	2.09^{a}±0,03
Alanine	4.26^{c}±0.05	4.40^{b}±0.57	4.70^{b}±0.03	4.68^{b}±0.04	5.16^{a}±0.03
Glutamic acid	12.61^{a}±0.04	11.53^{b}±0.09	11.44^{c}±0.01	11.83^{d}±0.03	11.81^{d}±0.08
Glycine	3.15^{c}±0.05	3.26^{c}±0.11	3.58^{a}±0.02	3.41^{b}±0.05	3.60^{a}±0.02
Serine	4.07^{abc}±0.07	3.55^{c}±0.67	3.98^{bc}±0.07	4.42^{ab}±0.07	4.63^{a}±0.08
Aspartic acid	6.70^{c}±0.03	6.73^{c}±0.05	6.69^{c}±0.03	7.05^{b}±0.10	7.75^{a}±0.08
TNEAA	43.60	42.68	44.15	45.67	49.11
TAA	69.28	73.17	74.66	77.31	81.80
Hydrophobic AA	26.32	27.08	26.95	28.38	29.18
Hydrophilic AA	13.21	15.06	15.86	16.53	18.06
Basic AA	10.44	12.77	13.72	13.52	15.00
Acidic AA	19.31	18.26	18.13	18.88	19.56
TSulfurAA	3.00	2.96	2.80	3.03	3.31

The value are mean of replicate determination. Mean with different superscript in the same row are significantly different ($p>0.05$) while those with same superscript are not significantly different ($p>0.05$).
WF0=100% Wheat flour, WDS1=95% Wheat flour 5% of defatted sesame seed flour, WDS2=90% Wheat flour 10% of defatted sesame seed flour, WDS3=85%Wheat flour 15% OF defatted sesame seed flour and WDS4=80% Wheat flour 20% of defatted sesame seed flour.
TEAA =Total essential Amino acids (phenyalanine + valine + methionine + lysine + leucine + isoleucine + thronine + histidine)
TNAA =Total non-essential Amino acids (Arginine + cystene + glycine + tyrosine + proline + serine + glutamine + alanine + aspartate)
Hydrophobic AA= Hydrophobic amino acids (methionine+ alanine+valine+ leucine+ isoleucine+ proline+ phenyalanine). Hydrophilic AA= Hydrophilic amino acids; serine+ threonine + cystene + tyrosine + glycine
Basic amino acids; lysine +histidine + arginine
Acidic amino acids = glutamic acid + aspartic acid. TsulfurAA= Total sulfur amino acids; methionine + cysteine

Table 1: Color characteristics of pasta produced from whole wheat and defatted sesame seeds

Parameters	WF	WDS1	WDS2	WDS3	WDS4
L*	61.67±1.31^{a}	58.79±0.31^{b}	56.82±1.33^{c}	44.20±0.24^{d}	45.34±0.96^{d}
a*	0.13±0.04^{d}	1.21±0.18^{c}	0.96±0.07^{c}	3.65±0.38^{b}	4.55±0.46^{a}
b*	20.01±0.46^{a}	11.20±0.48^{b}	9.15±0.47^{c}	7.50±1.00^{d}	8.07±0.44^{cd}

Values are means ± standard deviation of triplicate determinations. Values in the same row with different superscript are significantly different ($p<0.05$). L= Lightness, b*= Yellowness, a*= Redness
WFO = 100% Wheat fLour (control), WDS1 = 95% Wheat flour: 5% Defatted sesame seeds flour, WDS2 = 90% Wheat flour: 10% Defatted sesame seeds flour, WDS3 = 85% Wheat flour: 15% Defatted sesame seeds flour
WDS4 = 80% Wheat flour: 20% Defatted sesame seeds flour

WF0 and the lowest in WDS4. This implies that the pasta produced from the 100 % whole wheat had lighter colour and the lightness decreased with increase concentration of defatted sesame seeds flour substitution. The CIE a value which indicates red and green colour difference ranged from 0.13 (WH0) to 4.55 (WDS4). L* values have been negatively related with a* values (Gałkowska et al. 2022) and this is evident in this study as the a* value was the lowest at WF0.*

The *b** value ranged from 8.07 to 20.01with the WF0 pasta having higher values than the defatted sesame seeds substituted pasta. The b* measures the yellow (positive values) and blue (negative values) coordinate. This implies that the pasta produced from the control (100 % whole wheat) tends more to the yellowish attributes hence may have more acceptability and consumer preference may shift towards the control more than the substituted (Ainsa *et al*., 2022). The decrease in yellowness could be due to increase ash content (Bhuvaneswari and Nazni, 2021) and the presence of plants pigments observed in the defatted sesame seeds flour. Also, non-enzymic reaction between the reducing sugars and the amino acids during the heating process (Gałkowska *et al*., 2022)). Darkening which results in significant decrease in L value of pasta colours has been reported with wheat composite pasta samples (Arribas *et al*., 2020).

CONCLUSION

This study has revealed enhanced amino acid status of pasta produced from the substitution of whole wheat with defatted sesame seeds flour 20 % inclusion of defatted sesame seeds flour. Increase in defatted sesame seeds flour addition resulted in deeper colour intensity. Since pasta are mainly consumed by children in this part of the world, this product could provide a more nutritious food and help mitigate malnutrition. Further work can be carried out on the sensory and cooking characteristics of the pasta.

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