Quality Assessment of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date Palm Fruits

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Abstract

The research assessed the impact of micro-nutrient fortification on pulverized fermented yellow maize ogi with banana and date palm fruits flour blends with the view of boosting the chemical and sensory properties of ogi. The raw materials were processed into pulverized form and formulated into four (4) flour blends in the proportions of 90:5:5 (Sample B), 85:10:5 (Sample C), 80:15:5 (Sample D) and 75:20:5 (Sample E) of fermented yellow maize, banana and date palm fruit flours respectively while 100 % yellow maize flour served as the control (Sample A). The flour blends were analyzed for proximate, functional, sensory properties and amino acid profile using standard procedures. Result of the proximate analysis showed a significant (P<0.05) decrease in moisture, lipid, protein, and carbohydrate contents ranging from 3.83 to 2.98%, 1.00 to 0.88%, 9.02 to 4.37% and 84.00 to 82.75% respectively while the ash and fiber contents increased from 0.81 to 3.12% and 1.34 to 5.90% respectively with increased substitution with the banana and date palm fruits flour blends. Functional properties recorded significant (P<0.05) differences in swelling capacity, foaming capacity and gelatinization temperature but not in oil absorption capacity, while there was an increase in water absorption capacity and bulk density from 0.83 to 1.37 mg/g and 0.84 to 0.88 mg/g respectively resulting from increase in substitution level. Results of amino acid composition showed 19 amino acids with the first 9 being essential amino acids and the remaining 10 containing non–essential amino acids. The essential amino acids had highest values in Tryptophan and Lysine: 5.34 and 4.43 with total amino acid and total essential amino acids having highest values in sample A: 79.51 and 37.01. Total hydrophobic and total polar amino acids possessed highest values in Sample E having 51.23 and 51.48 respectively. Sensory properties showed no significant (P<0.05) difference among the samples with sample E having the highest scores for overall acceptability.
In conclusion, incorporating flour blends of banana and date palm fruits into pulverized fermented yellow maize ogi enhanced its nutrient level, improved quality as well as overall acceptability.

Keywords: *Fermented, pulverized, flour blends, banana, yellow maize ogi and date palm fruits*

1. INTRODUCTION

The verifiable beginning of Ogi, likewise known as akamu or pap (a Nigerian cornmeal skilly) can be followed back to the traditional food practices of various West African cultures (Franz *et al*., 2014). It has a rich history that goes back a few centuries and is profoundly imbued in the food culture of numerous Nigerians and other African ethnic gatherings (Cherniwchan, 2019).Yellow maize ogi is a conventional West African skilly produced using matured yellow cornmeal. Its preparation and consumption have been recorded among different ethnic gatherings in the area, including the Yoruba, Hausa, Igbo, and Fulani. Since making this meal was passed down from generation to generation, it is an important part of these communities' culinary heritage (Ogbonnaya, 2012).Historically, yellow maize, a variety of maize, was not native to West Africa. However, it was presented during the transoceanic slave exchange. It is accepted that this meal starting points can be connected to the impact of Portuguese merchants, who carried maize from America to West Africa in the eighteenth hundred years (Alpern, 1992). The presentation of maize significantly affected African cooking, and the adoption of this new harvest prompted the advancement of different recipes, including ogi (Klas, 2018). Fermentation is one of the customary processes for maize processing, which involves the breakdown of carbohydrates, proteins and other nutritive components present in the grain by microorganisms such as Lactic acid bacteria, among others. The probiotics resulting from fermentation process equally confer health benefits to the body when consumed in adequate amounts (Ekpa *et a*l, 2019). Food fermentation dates back to prehistoric times and are the oldest methods for producing new foods from existing substrates, and of prolonging the shelf-life of foods (Okpara and Mishra, 2017). Over the entire course of time, yellow maize ogi has been exceptionally esteemed for its nutritional advantages. Recently, due to its massive demand on consumption, versatility, nutritive impact, among others, researchers in the field of food science and its relations have viewed the need to incorporate techniques that help eliminate the burdensome and time consuming processes, yet maintaining its wholesomeness (Taiwo *et al*., 1997). This, has given rise to the strengthening of pulverized fermented maize ogi with various forticants (pulses, nuts, fruits, vegetables, etc) containing extra nutrients, for example, vitamins and minerals to upgrade its healthful content. Fermented pulverized maize ogi holds the vast majority of the wholesome benefits of customary ogi whose nutrients are lost from the grains during processing thereby adversely affecting nutritional quality (Amingo, 2004). Pulverized fermented maize ogi is a decent source of carbohydrates, giving energy and fuel for day-to-day deeds. It contains dietary fibre which helps with digestion, advances satiety and supports a solid stomach (Ashaolu *et al.,* 2024).It is likewise a well-known staple food among nursing moms, as it is accepted to upgrade breast milk production (Oke, *et al*., 2022).

The various West African cultures' traditional food practices, in which maize and millet were prominent crops, can be traced back to the origins of ogi (Abdul-Razaq, 2024). The region is home to these grains, which have been grown and eaten for centuries. Maize (*Zea mays*) is a versatile and vital crop with a rich history of cultivation and consumption worldwide. Yellow maize, a variety of maize among others possesses nutritional values, uses and health benefits which makes it an important ingredient in the diet of millions of people around the world and a key component of global food security and economic systems (Aguk, *et a*l., 2021). It is a good source of starch, dietary fibre, fundamental minerals, B-vitamins and pro-vitamin A (beta-carotene). Due to loss of nutrients and lack of standardization during its processing, there is the need for its fortification (Adeyemo *et al*., 2018). Banana and date palm fruits are a good source of micro-nutrients. These fruits have been utilized in the fortification of food products such as smoothies and shakes, baked goods, breakfast cereals, cereal bars, etc for the purpose of enhancing nutritional profile, flavour and sweetness, diversifying of nutrient intake, sustainability and locally sourced among others (Vayalil, 2012). Bananas (*Musa spp*) are a nutritious and delicious fruit with a rich history of cultivation and consumption believed to have originated from Asia (De Langhe *et a*l., 2010). They are rich in potassium, vitamin C, vitamin B_6 and dietary fibre. Whether eaten fresh as a snack or incorporated into various dishes, bananas provide essential nutrients and antioxidants that offer several health advantages (Khyati 2021). Date fruits (*Phoenix dactylifera*) on the other hand, are a valuable and nutritious fruit with a wide range of culinary and health benefits believed to be native to Africa (Pintaud 2011). They contain vitamins (such as vitamins A, B_6 and K), minerals (such as potassium, magnesium and iron), and dietary fibre. Their sweet and sticky flesh makes them a versatile ingredient in both sweet and savoury dishes. Food products resulting from integrating these food materials can provide essential nutrients and antioxidants that contribute to a balanced diet and overall health benefits (Ghnini; 2017; Aurore, 2009).

2. MATERIALS AND METHODS

2.1 Materials Procurement

Yellow maize grains, two (2) bunches of semi-ripe~~d~~ bananas and date palm fruits were bought from Akpan-Andem Market in Uyo Metropolis, Akwa Ibom State, Nigeria.

2.2 Samples Production

2.2.1 Production of Pulverized Fermented Yellow Maize Ogi

The grains were processed into pulverized fermented yellow maize ogi following the method described by (Awoyale *et. al.,* 2016). The maize grains (yellow variety) were first cleaned (sorting out debris and unwanted particles), washed, steeped for 48 hrs, wet-milled using disc attrition mill, wet-sieved via muslin cloth to separate pomace from the sievate, sedimented for 8hrs, decanted (separating the supernatant from the filtrate) and compressed in a jute bag using hydraulic jack to obtain ogi cake. The ogi cake was pulverized using a granulating machine, oven-dried at 50 ºC for 24 hrs, dry-milled, sieved via 0.5 mm mesh and packaged in a vacuum-sealed cellophane bag.

2.2.2 Production of Banana Flour

The method of Arisa *et. al*.~~,~~ (2013) was adopted in the production of banana flour. The bunches of partially-ripe bananas were de-fingered, washed under a running tap water, peeled, sliced to (approximately) 2 mm thickness with the aid of a stainless-steel knife, oven-dried at 50 ºC for 24 hrs, milled using a Power Tech, commercial heavy duty grinder, Model: HS - 206 and packed in a vacuum-sealed cellophane bag.

2.2.3 Production of Date palm flour

Date palm flour was processed by sorting date palm fruits to eliminate debris and any unwanted particles. These fruits were manually de-pitted, cut into smaller sizes with the aid of a stainless steel knife, rinsed in distilled water and drained using a strainer. The chunks were oven-dried at 50 ºC for 24 hrs. The dried date palm fruits were subsequently milled using a Power Tech, commercial heavy duty grinder, Model: HS - 206. It was sieved through a 0.5 mm mesh to obtain fine homogeneous particles (Ikechukwu *et. al.*, 2017).

Pulverized fermented yellow maize ogi, banana and date palm flours were processed as shown in Fig 1, Fig 2, and Fig 3 respectively using standard methods.

Yellow maize grains

↓

Cleaning/Washing

↓

Steeping (for 48 hrs)

↓

Rinsing/Wet-milling (Disc attrition mill)

↓

Wet-sieving(Muslin cloth)

↓

Sedimentation (6 hrs)

↓

Decanting

↓

Compressing (Jute bag)

↓

Oven-drying (50^{o}c for 24rs)

↓

Sieving (0 5 mm mesh)

↓

Packaging

↓

Packaged pulverized fermented yellow maize ogi

Fig. 1: Flow chart for production of pulverized fermented yellow maize ogi (Modified)
Source: Awoyale *et. al.* (2016)

Partially-riped Banana
↓
Washing
↓
Peeling
↓
Slicing (approx. 2 mm thick)
↓
Oven-drying (50 °C for 24 hrs)
↓
Milling
↓
Packaging
↓
Packaged banana flour

Fig. 2: Flow chart for the production of Banana flour (Modified)
Source: Arisa *et. al*. (2013)

↓

Date palm fruits
↓
De-pitting
↓
Washing
↓
Oven-drying (50 °C for 24 hrs)
↓
Milling
↓
Sieving (0 5 mm mesh)
↓
Packaging
↓
Packaged date palm flour

Fig. 3: Flow chart for the production of Date palm fruit flour (Modified)
Source: Ikechukwu *et. al.* (2017)

2.2.4 Formulation of Pulverized fermented yellow maize ogi - banana and date palm fruit flour blends

The formulation ratios used for the present study for the purpose of enhancing nutritional and sensory attributes of the samples are as shown in table 3.1 . The 100% pulverized fermented yellow maize (A) served as the control sample. A Power Tech, commercial heavy duty grinder, Model: HS - 206 and an electric weighing balance were used for mixing and weighing of the flour blends respectively.

Table 2.1: Blending ratio of the flour blends

Sample	Pulverized fermented yellow maize ogi	Banana flour	Date palm fruit flour
A	100	0	0
B	90	10	5
C	85	15	5
D	80	10	5
E	75	20	5

2.2.5 Preparation of Ogi (Skilly)

Five different ogi samples were produced from the formulated samples. Each sample was reconstituted with room temperature distilled water of 100ml, followed by addition of water (100ºC) with consistent stirring till a homogeneous mixture was achieved.

3. METHODS OF ANALYSIS

3.1 Proximate Composition Determination

The moisture content, crude ash, lipid and crude protein were determined using the method as described by AOAC (2010), crude fibre was determined using the method as described by Onwuka (2005), and carbohydrate content was determined using the method as described by AOAC (2012).

3.2 Total Energy Determination

Atwater factor as described by Osborne and Voogt, (1978) was used to calculate the total energy (caloric) value using the formula below:
Total energy value = (Protein x 4) + (Fat x 9) + (Carbohydrate x 4)

3.3 Functional Properties Determination

The water absorption capacity, oil absorption capacity, foaming capacity and bulk density were determined using the procedure as described by Uzoukwu (2015). Gelatinization temperature was determined using the procedure as described by Sosulsk (1962), while swelling capacity was determined using procedure as described by Suresh (2014).

3.4 Amino Acid Determination

Amino acids were determined using High Performance Liquid Chromatography (HPLC) as described by the method of AOAC (2016).

3.5 Sensory Evaluation

Twenty semi-trained panelists drawn from the University Community, University of Uyo, Uyo, Nigeria were used. All panelists were regular consumers of ogi. These judges evaluated the sensory characteristics of the coded ogi for the following sensory attributes: appearance, aroma, taste, consistency and overall acceptability. A nine-point Hedonic rating scale was applied, which ranged from 1 (disliked extremely) to 9 (liked extremely) (Ihekoronye and Ngoddy, 1985). Questionnaires for entering scores and portable water for mouth-wash between tasting intervals were made available to the panel of judges. To determine the level of overall acceptability, data collected were statistically analyzed.

3.6 Statistical Analysis

To determine for significant difference ($P < 0.05$), data obtained were subjected to a one way analysis of variance (ANOVA). Duncan's Multiple Range Test was used to separate means following the Statistical Package for Social Sciences (SPSS, Inc., Chicago, USA) version 20.0 software.

4. RESULTS AND DISCUSSION

4.1. Proximate Composition and Energy Value of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits

Moisture content is an index of water activity of many foods. It is therefore essential to determine the moisture content of a food sample as it helps in the understanding of its physical characteristics such as appearance, freshness, shelf-life, weight and relationship with micro-organisms (Jayasekara, 2013). Proximate composition and energy value of dried yellow maize ogi fortified with flour blends of banana and date palm is shown in Table 4.1. The moisture content of sample E was 2.98%, significantly different ($p < 0.05$) when compared to the control sample A which had a value of 3.83%. The moisture content decreased with the inclusion of flour blends (banana and date palm). This may be due to the fact that the standard moisture content of banana and date palm fruits are lower than that of the dried ogi which conferred lower moisture content with inclusion of the fortified food products. The moisture contents for all the formulated blends meets the recommended level for safe keeping of samples by the Standards Organization of Nigeria (SON) and shows that they will have better keeping quality. This is because moisture content exceeding 14% in flours has greater danger of microbial activity which produces undesirable changes in the flour (Ihekoronye and Ngoddy, 1985)). Low moisture content guarantees better shelf life and denser nutrient composition (Muyanja *et al*., 2012; Zakpaa *et al*., 2010; Kikafunda *et al*., 2006), thus, enhancing the storage stability of the flour.

For ingredient optimization which ultimately ensures food samples quality and safety, it is of necessity to determine the ash content of a food sample (Kim, 2018). The ash content of the samples were significantly ($p < 0.05$) different. It increased from 0.81 - 3.12 % with increasing level of fortification of flour blends of banana and date palm. Similarly, Alagbe *et al*. (2020)

reported ash content of 2.7 - 2.8% on soluble sugars and nutritional content of banana. The ash content of a food material could be used as an index of mineral constituents of the food (Fusuan *et al.,* 2017; Udoh, 2017).

Lipid (fat) determination is of essence as it is an essential component of tissues as well as a veritable source of fat soluble vitamins (A, D, E and K). Fat has the ability to supply thrice the amount of energy required by the body (Cosso *et al*., 2010). The lipid content of the samples showed significant ($p<0.05$) difference with increase in levels of fortification. This is an indication that both banana and date palm fruits are low in fat. The findings agreed with Onwuka *et al*. (2015).on evaluation of varieties of cooking banana. Jamal *et al.* (2016) had similar report on some selected Pakistan rice.

It is important to determine dietary fibre in food samples as it helps to burn fat and maintain proper peristaltic movement of the intestinal tract to prevent constipation. Fibre significantly enhances weight loss, ameliorates gastrointestinal disorders, provides bulk in diet and boost immune system. The lowest value for crude fibre was registered in sample A (1.34%) while sample E (5.90%) registered the highest value. This can largely be attributed to the addition of banana flour. This result is in agreement with previous studies carried out by Asouzu (2020) on cooking banana and yellow maize composite flour. The values obtained for crude fibre are relatively higher than the values reported by Oladopo *et al*. (2017) for selected varieties of maize flour and Olurin *et al*. (2021) for breakfast blends of sorghum, bambaranut and date palm.

The significant essence of protein determination results from its ability to build and repair worn out tissues in the body. The substitution of flour blends of banana and date palm in samples B-E resulted in lower protein value (4.37-6.35%) compared to control (9.02%). The high protein content of the control indicates that yellow maize is a better source of protein than both banana and date palm fruits. The result is in agreement with previous studies carried out by Asif-ul-alam (2014) on the drying effect of green banana flour and baked products, and Ilori (2022) on powdered ogi enriched with date palm fruit. According to Bonazzi and Dumoulin (2010), the biological value of dried protein vary with the drying procedure.

Carbohydrates are known as sources of readily available energy in food samples. The result registered high values of carbohydrate contents for all samples with the control being the highest. This is an indication that the three food components (yellow maize, banana and date palm fruits) are excellent sources of carbohydrate.

Energy (caloric) value refers to the amount of energy provided by the food consumed when metabolized by the body (Hall *et al*, 2011). It is useful as it helps maintain balanced diet and manage good health. The highest lipid content in sample A (control) exhibited the highest energy value while sample E with the lowest energy value indicated the least energy value. The findings from this study agrees with the 386.28 - 395.01 Kcal/g recorded by Adeoti (2017) for Maize-*Moringa oleifera* seed flour The energy values were calculated with carbohydrate, fat and protein as constituents. Carbohydrate and protein contributed 4 Kcal/g, while fat contributed majorly by 9 Kcal/g. This therefore explains why sample A (control) has the highest energy value.

Table 4.1: Proximate Composition and Energy Value of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits .

Sample	Moisture Content (%)	Ash (%)	Lipid (%)	Crude Fibre (%)	Protein (%)	Carbo-hydrates (%)	Energy (Kcal/100g)
A	3.83[a] ± 1.35	0.81[e] ± 0.10	1.00[a] ± 0.08	1.34[e] ± 0.08	9.02[a] ± 0.09	84.00[a] ± 0.10	381.08[a] ± 0.41
B	3.55[b] ± 2.12	1.37[d] ± 0.06	0.98[b] ± 0.04	4.16[d] ± 0.04	6.35[b] ± 0.12	83.59[b] ± 0.03	368.58[b] ± 0.56
C	3.38[c] ± 1.00	2.22[c] ± 0.00	0.93[bc] ± 0.06	4.63[c] ± 0.06	5.43[c] ± 0.05	83.51[c] ± 0.04	364.13[c] ± 0.72
D	3.17[d] ± 1.05	2.84[b] ± 0.03	0.91[c] ± 0.07	5.29[b] ± 0.07	4.51[d] ± 0.03	83.28[d] ± 0.07	359.35[d] ± 0.30
E	2.98[e] ± 0.05	3.12[a] ± 1.05	0.88[d] ± 0.05	5.90[a] ± 0.05	4.37[e] ± 1.08	82.75[e] ± 0.05	356.40[e] ± 0.18

Blending ratio**:** A = 100:0 (Control); B = 95:05; C = 90:10; D = 85:15; E = 80:20 of pulverized fermented yellow maize, banana and date palm flour blends.

4.2. Functional Properties of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits.

Table 4.2 shows the functional properties of pulverized yellow maize ogi fortified with blends of banana and date palm. Water Absorption Capacity (WAC) is the ability of a food sample to absorb water within its structural matrix and swell (Udoh*, et al.,* 2023). It is a crucial functional trait that influences taste profile, consistency and overall quality of the food product (Yeh, 2008). Understanding the WAC of a food sample is essential in food formulation, processing and product development, as it can affect mouthfeel, textural and cooking behaviour as well as shelf-life stability of the final food product (Sandhu, 2009). WAC showed an increasing trend from the control to the samples with higher levels of flour blends of banana and date palm fruits fortification. These results contradicted the previous work carried out by Suleiman (2022) on composite flour blends of maize, melon seed, carrot and crayfish. This increase can be attributed to the fibrous nature of banana allowing for water interaction through hydrogen bonding.

Oil Absorption Capacity (OAC) is the ability of a food sample to absorb oil in its structural matrix and retain it. It is often expressed as the amount of oil (in grams) that can be absorbed by a definite weight of the food sample (usually in grams) under specific conditions (Akpapunam, 2015). Understanding the OAC of a food sample is of importance in product development and recipe formulation. It allows food manufacturers and scientists to tailor formulations to achieve desired characteristics such as texture, oil and flavour retention

(Gomez-Estaca, 2018). OAC showed significant ($p<0.05$) difference from sample A (control) to samples B-E with proportional increase in the levels of flour blends of banana and date palm fruits fortification. Low OAC of the food samples indicates that banana and date palm fruits flours have minute quantities of oil. This therefore, suggests that they may be useful in recipe formulations in foods that require re-constitutions such as custard, beverages, etc (Agama-Acevedo, 2019; Sajib, 2014).

Swelling Capacity (SC) refers to the maximum amount of liquid that a food sample can absorb and retain resulting to an increase. This feature affects the texture, viscosity and overall quality of a food material. The result showed significant ($p<0.05$) difference with sample A recording the highest value (11.96mL/g) and sample E, the lowest value (7.54mL/g). This reduction is accompanied by fortification of the flour blends of banana and date palm fruits. This result has lower values but yet is in agreement with the previous studies by Abioye, (2015) on properties of soy-plantain flour. This could be as a result of preference with consistency.

Foaming Capacity (FC) of a food sample refers to its ability to form stable foam or bubbles when agitated or aerated. It can be influenced by various factors, including the protein and fat content, pH, temperature and the presence of emulsifiers or stabilizers (Doyen, 2015). Understanding the FC of a food product is crucial in recipe formulation and product development, as it can impact the sensory characteristics, appearance, mouthfeel, and overall quality of the final food sample. FC measurements are typically performed in the food industry to optimize formulations, and ensure consistent and desirable foam properties in various food applications (Nadeem, 2015). The result for FC showed significant ($p<0.05$) difference with levels of fortification of flour blends of banana and date palm fruits. The values obtained in this study are lower than those of the previous studies as recorded by Odimegwu (2019) on breakfast cereals made from flour blends of maize and jackfruit seed.

Bulk Density (BD) is an important physical property that can provide information about the flow properties, handling characteristics and storage requirements of a food sample (Ersoy, 2017). The results obtained for BD showed considerable increase with increase in level of fortification. The BD values obtained in this study are comparable to the values of 0.70-0.84 g/cm^3 as reported by Oluwamukomi, (2005) on soy supplementation effect on ogi quality.

Gelatinization Temperature (GT) refers to the temperature at which a gelatinous substance undergoes a phase transition from a liquid or sol state to a gel or solid state. It determines the formation and stability of gels in food products. It is often influenced by factors such as the composition of the gelatinous substance, concentration of gelling agents, pH and processing conditions (Karim, 2000). The result of this study showed significant ($p<0.05$) decrease with increase in fortification levels. The values obtained are higher than the values 71.00 - 88.50ºC as recorded in a previous study by Ukom (2019) on yellow maize ogi enriched with orange-fleshed sweet potato and African yam been seed flours for infants.

Table 4.2: Functional Properties of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits.

Sample	WAC (%)	OAC (%)	SC (%)	FC (%)	BD (%)	GT (^{0}C)
A	$0.83^e \pm 0.1$	$1.00^a \pm 1.6$	$11.96^a \pm 1.03$	$8.66^a \pm 1.08$	$0.74^e \pm 0.01$	$74.67^a \pm 2.13$
B	$1.07^d \pm 1.1$	$0.97^b \pm 1.27$	$11.51^b \pm 1.98$	$7.58^b \pm 1.01$	$0.79^d \pm 1.50$	$73.67^b \pm 1.19$
C	$1.23^c \pm 1.2$	$0.77^c \pm 1.63$	$10.85^c \pm 1.65$	$6.75^c \pm 1.14$	$0.82^c \pm 0.64$	$70.67^c \pm 1.13$
D	$1.26^b \pm 1.1$	$0.63^d \pm 1.54$	$9.53^d \pm 1.62$	$5.69^d \pm 1.1$	$0.86^b \pm 1.51$	$70.00^d \pm 1.19$
E	$1.37^a \pm 0.6$	$0.47^e \pm 1.51$	$7.54^e \pm 1.13$	$2.34^e \pm 1.4$	$0.88^a \pm 0.97$	$68.33^e \pm 0.64$

Blending ratio**:** A = 100:0 (Control); B = 95:05; C = 90:10; D = 85:15; E = 80:20 of pulverized fermented yellow maize , banana and date palm flour blends.

4.3 Amino Acid Composition of Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits

The amino-acid profile is an important food parameter that displays the essential and non-essential amino-acids present in a food material. Amino acid content of fruit and fruit-derived foods is intensely studied because of their contribution to nutritional value, aroma, taste and health-promoting effects and their possible use as markers of origin and authenticity (Mandrioli *et al*, 2013). It further showcases amino acids that readily interact with water molecule and other polar liquids. It is worthy to note that all amino acids play different roles that helps the body to grow and function properly. However, essential amino acids are not synthesized in the body, thus, must be supplied through diets. Tryptophan and Lysine are the essential amino acids lacking in maize grains when considered as a whole but fairly present in Sulphur-constraining amino acid (Ihekoronye and Ngoddy, 1985). Wang, (2017) recorded low level of lysine and tryptophan in cereals and legumes (plant-based protein sources). Amino acid composition of pulverized fermented yellow maize ogi fortified with flour blends of banana and date palm is indicated in Table 4.3. The result for amino acid composition of dried yellow maize ogi fortified with flour blends of banana and date palm fruits showed significant ($p<0.05$) increase in the essential amino acids with increase in the addition of banana and date palm flours for tryptophan and lysine ranging from 0.56 - 5.34 and 1.17 - 4.43 respectively. Glycine, a hydrophobic amino acid recorded the highest values ranging from 3.32 - 8.41 followed by tryptophan, then Glutamate, a polar amino acid ranging from 1.15 - 5.01 respectively. The amino acids with least values were Isoleucine, a hydrophobic amino acid significantly ($p<0.05$) decreasing from 4.97 - 1.15, Cysteine, Histidine and Threomine, polar amino acids decreasing ($p<0.05$) significantly from 4.71 - 1.67, 3.23 - 1.70 and 3.57 - 2.54 respectively. Adetiya, (2020) on banana-cassava flour similarly reported higher values of total essential amino acids in banana flour (35.37%) in comparison to cassava flour (29.95%). The result from table 4.3 implied that consumers of food products with banana and date palm fruits would consume more of lysine and tryptophan than 100% of yellow maize products.

Table 4.3: Amino acid Composition of Pulverized Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm

ESSENTIAL AMINO – ACIDS	A	B	C	D	E
Tryptophan	0.56 ± 0.12	1.34 ± 0.00	2.73 ± 0.08	4.99 ± 0.05	5.34 ± 0.03
Histidine	3.23 ± 0.08	3.01 ± 0.08	2.85 ± 0.01	2.27 ± 0.07	1.70 ± 0.10
Leucine	4.71 ± 0.01	4.32 ± 0.10	3.76 ± 0.06	3.12 ± 0.00	2.54 ± 0.14
Isoleucine	4.97 ± 0.01	4.32 ± 0.10	3.91 ± 0.00	2.63 ± 0.12	1.75 ± 0.14
Phenylalanine	7.04 ± 0.10	6.54 ± 0.00	5.13 ± 0.11	3.22 ± 0.00	2.56 ± 0.11
Valine	5.74 ± 0.00	4.28 ± 0.05	3.89 ± 0.10	3.03 ± 0.10	2.73 ± 0.05
Lysine	1.17 ± 0.03	1.19 ± 0.04	2.65 ± 0.00	3.94 ± 0.03	4.43 ± 0.00
Methionine	6.11 ± 0.07	5.83 ± 0.08	4.97 ± 0.04	4.18 ± 0.00	3.34 ± 0.10
Threomine	3.57 ± 0.02	3.32 ± 0.00	3.14 ± 0.10	2.07 ± 0.05	2.54 ± 0.08
NON – ESSENTIAL AMINO ACIDS					
Asparagine	5.96 ± 0.02	5.21 ± 0.05	4.65 ± 0.06	3.29 ± 0.04	2.77 ± 0.06
Arginine	3.78 ± 0.02	3.63 ± 0.05	3.22 ± 0.07	2.45 ± 0.08	2.37 ± 0.06
Alanine	4.97 ± 0.01	4.27 ± 0.05	3.86 ± 0.07	3.31 ± 0.03	2.66 ± 0.03
Aspartate	6.65 ± 0.06	6.19 ± 0.05	5.74 ± 0.03	5.23 ± 0.10	4.24 ± 0.02
Glutamate	1.15 ± 0.07	2.21 ± 0.06	3.82 ± 0.02	4.24 ± 0.04	5.01 ± 0.06
Glycine	3.32 ± 0.03	4.54 ± 0.06	5.71 ± 0.05	7.16 ± 0.05	8.41 ± 0.07
Tyrosine	5.47 ± 0.03	4.83 ± 0.05	4.12 ± 0.03	3.63 ± 0.01	2.73 ± 0.00
Cysteine	4.71 ± 0.10	4.39 ± 0.05	3.45 ± 0.00	2.51 ± 0.01	1.61 ± 0.06
Proline	1.28 ± 0.08	2.97 ± 0.02	3.22 ± 0.05	4.80 ± 0.00	5.22 ± 0.02
Serine	5.12 ± 0.07	4.86 ± 0.08	4.14 ± 0.00	3.78 ± 0.07	2.64 ± 0.01
Total Amino acid (TAA)	79.51	77.88	74.96	69.84	64.05
Essential Amino acids (TEAA)	37.01	34.03	33.03	29.45	26.33
Total Hydrophobic Amino acid (THAA)	21.95	36.65	42.06	46.62	51.23

Total Polar Amino acid (TPAA)	16.93	29.28	32.58	42.88	51.48

Blending ratio**:** A = 100:0 (Control); B = 95:05; C = 90:10; D = 85:15; E = 80:20 of pulverized fermented yellow maize , banana and date palm flour blends

Essential Amino acids (TEAA): Tryptophan, Histidine, Leucine, Isoleucine, Phenylanine, Valine, Lysine, Methionine and Threomine

Total Hydrophobic Amino acids (THAA): Tryptophan, Leucine, Isoleucine, Phenylalanine,

Valine, Methionine, Alanine, Glycine and Proline.

Total Polar Amino acids (TPAA): Histidine, Lysine, Threomine, Asparagine, Arginine, Aspartate, Glutamate, Tyrosine, Cysteine and Serine.

4.4 Sensory Properties of Ogi (Skilly) made from Pulverized Fermented Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits

Sensory properties of ogi made from pulverized yellow maize ogi fortified with flour blends of banana and date palm fruits is shown in Table 4.4. The mean score range for appearance was 5.90 - 8.25, significantly ($p<0.05$) different among the samples. Similarly, aroma, taste and consistency ranged from 5.40 - 7.56, 5.00 - 7.40 and 6.60 - 7.45 respectively. Sample E had the highest values in appearance, aroma and taste with the exception of consistency. The low consistency score with addition of banana and date palm flours could be attributed to their biological nature. The overall acceptability ranged from 5.77 -7.65. This can be attributed to the panelists preference on sensory properties with respect to appearance, aroma and taste. These results compared duely with the results of Inyang (2020) for pasting properties of acha-green banana composite flour fortified with cowpea flour.

Table 4.4: Sensory Properties of Pulverized Yellow Maize Ogi Fortified with Flour Blends of Banana and Date palm Fruits

Sample	Appearance	Aroma	Taste	Consistency	Overall acceptability
A	$5.90^{b}\pm2.13$	$5.40^{c}\pm1.51$	$5.00^{c}\pm1.13$	$6.60^{ab}\pm1.19$	$5.77^{c}\pm1.75$
B	$6.45^{b}\pm1.19$	$6.45^{bc}\pm1.54$	$6.55^{ab}\pm1.98$	$6.95^{ab}\pm1.37$	$6.70^{b}\pm1.50$
C	$6.30^{b}\pm1.13$	$6.05^{b}\pm1.23$	$6.10^{bc}\pm1.45$	$6.35^{b}\pm1.42$	$6.05^{bc}\pm0.64$
D	$7.55^{a}\pm1.19$	$6.90^{ab}\pm1.37$	$6.35^{b}\pm1.62$	$7.45^{a}\pm1.35$	$7.25^{b}\pm1.51$
E	$8.25^{a}\pm0.64$	$7.56^{a}\pm1.50$	$7.40^{a}\pm1.13$	$7.00^{ab}\pm1.38$	$7.65^{a}\pm0.97$

Blending ratio**:** A = 100:0 (Control); B = 95:05; C = 90:10; D = 85:15; E = 80:20 of pulverized fermented yellow maize , banana and date palm flour blends.

CONCLUSION

In conclusion, the research study has shown that incorporating different substitution levels of flour blends of banana and date palm fruits into pulverized fermented yellow maize ogi enhanced nutrient level, boost health benefits, improved quality, overall acceptability and enhanced shelf life properties of the pulverized blends for pap. This fortification therefore, increases the biological level of the pap thereby reducing the excessive dependence on artificial additives and its associated challenges.

RECOMMENDATION

i. Fortification of other cereal grains with banana and date palm fruits should be employed to reduce health challenges resulting from artificial additives.

ii. Studies on ways to increase quantities of pulverized fermented yellow maize ogi with banana and date palm fruits to meet the growing population and food crisis in Nigeria, due to its present economy should be taken into due consideration.

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