Nutritional Assessment and Sensory Properties of Dried Pap Fortified with Soybean and Date Palm Fruit Flours

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KEYWORDS

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ABSTRACT

The nutritional inadequacy of exclusive breastfeeding becomes evident from six months onwards, highlighting the importance of introducing complementary foods to ensure optimal infant nutrition. This study evaluated the nutritional and sensory properties of dried pap fortified with soybean and date palm flours using face central Design. Maize grain was cleaned, washed, soaked in potable water for 72h, wet millet, sieved, dried in a cabinet dryer for 8h at 50 ^oC; the date palm fruit was washed deseeded, dehydrated at 50 ^oC for 30 min, ground and sieved with 1.19mm mesh. Soybean seed was washed soaked for 12h at 30 ^oC, dehulled, boiled for 2h at 80 ^oC, dried at 60 ^oC for 24h, milled and sieved using 600 µm mesh size. The moisture, ash, fat, protein, fibre and carbohydrate contents ranged from 6.20 – 7.06 %, 3.25 – 5.10%, 4.37 – 14.67%, 7.72 – 16.87 %, 12.49 – 21.97% and 35.22 – 65.48 %, respectively. Bulk density, swelling capacity and water absorption capacity ranged significantly from 0.07 – 0.79 g/c^3, 0.845 – 1.060 g/g and 0.898 – 0.955 g/g respectively. The sensory attributes of the pap samples varied significantly in terms of colour, odour, flavor and overall acceptability. It was 5 g date flour plus 5 g soybean flour was the most preferred besides the control samples. The finding of this study suggest that dried pap fortified with soybean and date palm flours has the potential to improve the nutrients and sensory quality of the product.

INTRODUCTION

Pap is a fermented cereal porridge from West Africa which can be produce from maize (*Zea mays*), guinea corn (*Srghum bicolor*) and millet (*Pennisetum typhodenum*). It is a staple food in most African countries with varying preparation methods and names. It is commonly used as weaning food for babies and also for young children and as a standard breakfast cereal in many homes. Pap usually has smooth texture and is boiled into porridge or cooked and turned into a stiff gel called "agidi" or "eko" prior to consumption (Steinkraus, 2019). The color of pap depends on the cereal used; slightly cream for white maize, cream for yellow maize, light brown for sorghum and greenish to grey for millet (Nakazato *et al*., 2020). It is produced generally by soaking maize grains in warm water for 2-3 days followed by wet milling and sieving through a screen mesh. The sieved material is allowed to sediment and ferment and is marketed as wet cakes wrapped in leaves (Jay, 2014). Nnanyelugo and Onofiok (2014) reported the use of pap as a weaning food in Southern Nigeria to supplement breastfeeding, because only breast feeding may be inadequate to meet the nutritional demands of the growing infant.

Maize is a versatile cereal grain cultivated globally, serving as a primary food source in many regions. It is rich in carbohydrates and provides a significant energy source. However, maize alone lacks some essential nutrients such as lysine, tryptophan, and micronutrients like iron and zinc, necessitating complementary processing or fortification to enhance its nutritional value (Klaenhammer and Fitgerald, 2014). In pap

production, maize serves as the base ingredient due to its starch-rich composition, which contributes to the creamy texture of the final product (Klaenhammer and Fitgerald, 2014).

Soybean (*Glycine max*) is a species of legume and one of the most important agricultural crops in the world. It is a versatile plant that provides food, feed, oil, and fiber and is widely cultivated in many countries, including the United States, Brazil, China, and India. Soybean is considered a key component of sustainable agriculture because of its high protein content, adaptability to various climates, soils and ability to fix atmospheric nitrogen, reducing the need for chemical fertilizers. In 2015, researchers conducted an analysis of studies to look at the effect of soy on people's cholesterol levels. They found that consuming soy significantly reduced levels of total cholesterol, triglycerides, and low density lipoprotein (LDL) cholesterol in the arteries. Soybean can also be helpful in managing obesity, reducing breast cancer risk, reducing osteoporosis and risk of type2 diabetes (Oluwabunmi *et al.*, 2015).

Date palm fruit (*Phoenix dactylifera*) is a delicious fruit, with enormous nutritional value. It has been listed in Africa as a crop that plays a role in food security (Anon 2010; Ashraf and Hamidi-Esfahani, 2011). Date fruits are rich in dietary fibers, which are associated with low incidence of colon cancer, heart disease, diabetes and other diet-related diseases and disorders. Also, date fruit contains high amount of micronutrients and bioactive compounds known to be beneficial to health (Ashraf and Hamidi-Esfahani, 2011). It serves as a natural and healthy alternative to added refined sugars, which are known to be unsafe for consumption as they pose deleterious health issues (Sani *et al*., 2016). Since date palm fruits are regarded as safe and beneficial to human health, it may be a potential material in the enrichment of powdered pap. In view of the fact that it is important to make its nutrients available to consumers by ultimately utilizing the fruits, it is therefore imperative to evaluate the nutritional composition and acceptability of powdered *ogi* enriched with date palm fruits.

MATERIALS AND METHODS

Source of Material

The raw materials used in the study include yellow maize (*Zea mays*) date palm fruit and soybean. The materials were purchased from Eke- Awka, Awka South Local Government Area, Anambra, Nigeria. Reagents and equipment utilized in the study were obtained from the laboratory of Department of Food Science and Technology, Nnamdi Azikiwe University, Awka Anambra State, Nigeria.

Preparation of dried pap

The dried pap was prepared using the method described by Ojinnaka *et al.* (2013). Exactly 2.5kg of maize was sorted, washed, and steeped in water for 72h at room temperature. The steeping water was changed every 15h. The steeped maize was then wet milled with an attrition mill. The slurry was then sieved using muslin cloth. The slurry was allowed to settle overnight and the wet cake was recovered after decantation of the water (supernatant). The wet cake was later dried in a cabinet dryer at 50 ^{o}C for 8h. The dried meal cake was, milled using hammer mill, sieved (180 mm) and packaged in a cellophane and stored in a cool dry place until needed for product formulation.

Preparation of date palm fruit powder

The date palm fruit powder was produced using the method described by Ojinnaka *et al*. (2013). Exactly 1.0 kg of the date palm fruit was washed in a ruing tap, dried and cut to open. The deseeded fruit was dried using a dehydrator and ground into powder using a blender (Kitchen Aid Commercial 5-Quart). The ground date powder was sieved to fine flour using a 1.19 mm mesh. The fine powder obtained was stored in a clean air tight jar until needed.

Preparation of soybean flour

The soybean flour was prepared using the method described by Ihekoronye and Ngoddy (1985). About 200 g of the soybean seed was sorted, and washed with warm water. The seed was then soaked with sufficient water for 12h at room temperature. The soaked beans were dehulled and boiled for 2h at 80 ^{o}C. After boiling, it was drained to remove excess water. The drained soybean was dried in an oven at 60°C for 24h. It was then milled, sieved and packaged in air tight container.

Proximate Composition of dried pap

The moisture, ash, fat, protein, fibre, carbohydrate content in the composite flour were evaluated using the (AOAC, 2010) Method.

Functional properties of dried pap

The bulk density, swelling capacity and water absorption capacity in the dried pap were evaluated using the method described by Onwuka (2018).

Sensory evaluation

Twenty-member semi-trained panelists were used to evaluate the pap samples. The dried pap samples were mixed reconstituted properly with water to form thick slurry and heated to gelatinize using boiled water to form pap. Pap samples were served hot on a randomly code plates. The products were rated based on colour, aroma, flavor and overall acceptability on a 9-pont hedonic scale, where 1 represnts dislike extremely and 9 represents like extremely.

Statistical analysis

Analyzes were carried out in triplicates and the data obtained were subjected to Analysis of variance (ANOVA), using Statistical Package for Social Sciences (SPSS) version 20.0. The means were separated using Duncan's New Multiple Range Test at 0.05.

RESULTS AND DISCUSSION

Proximate composition of dried pap fortified with soybean and date palm flour

Moisture content was in the ranged of 6.20 – 7.06 % against the control sample which had 6.56 %. The various formulations showed no significant ($p>0.05$) differences. Sample PS3 and PS6 had the highest and lowest values, respectively. The obtained values are within the Recommended Daily Allowance (10-15%) suggested for pap products. In a similar report by Oguntona and Oguntona (2003), the values reported (10-20%) are line with the obtained findings. The ash content ranged from 4.06 – 5.10 % against the control sample (0.25%). These values are in consonant with the Recommended Daily Allowance values (2-4g/100g) for infant foods and suggested value for pap (Oguntona and Oguntona, 2003). Comparably, the values obtained in this study is slightly higher than the findings (2.11-2.91%) by Adeniyi and Oyewole (2017) in ogi fortified with Bambara nut flour. Fat contents ranged from 7.25 – 14.67 % against the control 4.37 %; with PS5 and PS6 having the highest and least values, respectively. Recommended Daily Allowance is expected to be 30-40% (WHO, 2007). Adebowale *et al*. (2011) suggested 3-4% fat for pa. These values are in contrast to the reported values 0.60 -1.50 % by Ayo *et al*. (2021) in pap samples from different maize varieties. The addition of soybean and date palm fruit to dried pap resulted in an increase in the fat content of the products. While this may be beneficial to some individuals, it is important to consider the potential health impact on the overall dietary fat intake of consumers. The protein content varied between 7.72 % in the control to 16.87 % in sample PS5, which contained 12.5g date flour and 12.5 g soybean flour. Fortification with soybean and date palm fruit significantly increased the protein content compared to the control sample ($p<0.05$) RDA is 15-20 % of total energy intake (WHO, 2007). This study is similar to the findings conducted by Aladesanmi *et al*. (2018) who reported a protein content ranged of 6.81 to 8.51 g/100g in different pap samples. However, these values are below par compared to the suggested values (15-20 g/100g) for pap by Adebowale *et al*. (2011). Fibre content ranged from 18.05 – 21.97% against the control 12.49 %. Sample CNT (Control) had the least fibre content while PS5 had the highest. A study by Adjuyitan *et al*. (2010) reported fiber contents of 5.73 g/100g in pap made from maize and sorghum blends, while another study by Oladele and Aina (2016) reported a fiber content of 3.29 g/100g for pap made from maize. These reported values are lower compared to the obtained values in this study. Fiber content plays a significant role in the digestive system and helps to reduce the risk of various chronic diseases such as cardiovascular disease and diabetes. The carbohydrate content ranged from 39.97 – 54.38 % against the control sample (65.48%). This indicates that the samples are rich in carbohydrates, which is expected as pap is primarily made from starchy grains. The carbohydrate contents of pap in this study agreed to the reported values 57.11 – 64.93 % by Ayo *et al*. (2011) in millet-egg-soybean hull composite flour. The decrease in carbohydrate content trend in the pap with increasing protein agreed with the findings of Adeyemo and Onilude (2013) in production of maize gruel.

Table 1: Proximate composition of dried pap fortified with soybean and date palm fruit (%)

Sample Code	Moisture	Ash	Fat	Protein	Fiber	Carbohydrate
PS1	$6.40^{de} \pm 0.20$	$4.77^{g} \pm 0.02$	$14.35^{b} \pm 0.04$	$16.32^{c} \pm 0.01$	$18.18^{e} \pm 0.01$	$39.97^{g} \pm 0.25$
PS2	$6.64^{de} \pm 0.34$	$4.13^{h} \pm 0.03$	$9.09^{de} \pm 1.16$	$14.59^{e} \pm 0.04$	$18.23^{e} \pm 0.25$	$46.88^{cd} \pm 0.24$
PS3	$7.06^{abc} \pm 0.11$	$5.03^{de} \pm 0.02$	$9.39^{d} \pm 0.04$	$12.93^{h} \pm 0.00$	$18.75^{d} \pm 0.01$	$46.82^{cd} \pm 0.06$
PS4	$6.46^{de} \pm 0.30$	$5.10^{c} \pm 0.01$	$8.69^{e} \pm 0.03$	$12.62^{i} \pm 0.02$	$21.96^{b} \pm 0.02$	$45.15^{f} \pm 0.35$
PS5	$6.40^{de} \pm 0.34$	$4.85^{f} \pm 0.01$	$14.67^{b} \pm 0.01$	$16.87^{b} \pm 0.00$	$21.97^{b} \pm 0.00$	$35.22^{de} \pm 0.34$
PS6	$6.20^{e} \pm 0.20$	$4.06^{i} \pm 0.01$	$7.25^{g} \pm 0.04$	$10.04^{j} \pm 0.03$	$18.05^{e} \pm 0.00$	$54.38^{b} \pm 0.21$
CNT	$6.56^{cde} \pm 0.11$	$3.25^{j} \pm 0.07$	$4.37^{h} \pm 0.11$	$7.72^{k} \pm 0.07$	$12.49^{f} \pm 0.44$	$65.48^{a} \pm 0.02$

PS1: 5g date flour + 20g soybean flour; PS2: 5g date flour + 12.5 g soybean; PS3: 12.5g date flour + 12.5 g Soybean; PS4: 20g date flour + 5 g soybean flour; PS5: 12.5 g date flour + 12.5 g soybean flour; PS6: 5g date flour + 5 g soybean flour, CNT: Control

Functional properties of dried pap fortified with soybean and date palm fruit

The bulk density ranged from 0.70 – 0.79 g/cm^3 against the CNT (0.74 g/cm^3) sample fortified with 5 g date flour and 12.5 g soybean (P52) had the highest BD while PS6 had the least BD. The results showed that BD of the samples varied significantly ($p<0.05$). These results are in consonant with the study by Adebowale and Lawal (2002) who reported BD ranged from 0.70 – 0.94 g/cm^3 for paps fortified with cowpea and pigeon pea. A higher BD indicates a more compact and less porous, values obtained are closely in agreement with the recommended range (0.4 – 0.6 g/cm^3) reported by Adebowale *et al*. (2011). Swelling capacity ranged from 0.845 – 1.060 g/g against the CNT (1.004 g/g), with PS6 and PS1 having the highest and lowest SC, respectively. Comparably with a study by Ade-Omowaye *et al*. (2008) who reported a range of 5.15 – 10.50 g/g for pap fortified with cassava flour and soyflour; these results are similar to the values obtained in this study suggest that the addition of soybean and date palm fruit to dried pap improved its swelling capacity, which could lead to a better WAC and increased volume. The water absorption capacity was in a range of 0.891 – 0.960 g/g against the control (0.926 g/g); with PS2 (5g date palm flour and 12.5 g soybean) having the highest WAC while PS4 (20 g date flour and 5 g soybean flour) had the lowest WAC. These values are relatively close to the recommended values (2.00 – 4.00 g/g) reported by (Falade and Ogunwolu, 2014). In a related study, Akinoso and Raji, (2011) evaluated the WAC of yam flour substituted with pigeon pea flour and found that it ranged from 1.76 – 1.94 g/g. These values are in agreement with those obtained for the pap samples in the current study. Pap fortified with soybean and date palm flour can improve texture and hydration properties (Oguntona and Oguntona, 2003).

Table 2: Functional properties of dried pap fortified with soybean and date palm fruit

Sample Code	Bulk density (g/cm^3)	Swelling capacity (g/g)	Water Absorption capacity (g/g)
PS1	$0.74^{ef} \pm 0.00$	$0.845^{k} \pm 0.01$	$0.955^{a} \pm 0.00$
PS2	$0.79^{b} \pm 0.00$	$0.960^{h} \pm 0.02$	$0.960^{a} \pm 2.88$
PS3	$0.76^{c} \pm 0.00$	$0.976^{f} \pm 0.02$	$0.89^{ef} \pm 0.12$
PS4	$0.76^{c} \pm 0.00$	$1.007^{c} \pm 0.01$	$0.891^{f} \pm 0.01$
PS5	$0.78^{b} \pm 0.01$	$0.927^{j} \pm 0.01$	$0.928^{cd} \pm 0.01$
PS6	$0.70^{g} \pm 0.01$	$1.060^{a} \pm 0.02$	$0.952^{ab} \pm 0.01$
CNT	$0.74^{de} \pm 0.00$	$1.004^{d} \pm 0.36$	$0.926^{d} \pm 0.07$

PS1: 5g date flour + 20g soybean flour; PS2: 5g date flour + 12.5 g soybean; PS3: 12.5g date flour + 12.5 g Soybean; PS4: 20g date flour + 5 g soybean flour; PS5: 12.5 g date flour + 12.5 g soybean flour; PS6: 5g date flour + 5 g soybean flour, CNT: Control

Sensory evaluation of dried pap fortified with soybean and date palm fruit

The mean score colour ranged from 4.84 – 6.08 against the CNT (7.16). The results indicated that the samples had lower scores in terms of colour when compared to the control sample. Aroma ranged from 4.36 – 6.84 with PS6 and PS4 having the highest and least mean score, respectively. For overall acceptability, the values, ranged from 5.28 – 5.84 against the control (6.64). Sample PS6 was preferred above all other samples when compared with the CNT which had a value slightly higher than PS6.

Table 3: Sensory evaluation of dried pap fortified with soybean and date palm fruit

Sample Code	Colour	Aroma	Flavour	Overall acceptability
PS1	$5.60^{b} \pm 1.83$	$5.84^{abc} \pm 2.19$	$5.60^{b} \pm 2.45$	$5.84^{b} \pm 2.37$
PS2	$5.00^{b} \pm 1.91$	$4.96^{bcd} \pm 2.47$	$5.28^{b} \pm 2.81$	$5.28^{abc} \pm 2.48$
PS3	$4.84^{b} \pm 2.10$	$4.88^{cd} \pm 2.39$	$5.04^{b} \pm 2.19$	$5.04^{bc} \pm 2.17$
PS4	$5.28^{b} \pm 2.30$	$4.36^{c} \pm 2.46$	$5.16^{b} \pm 2.70$	$5.64^{abc} \pm 2.82$
PS5	$6.00^{ab} \pm 2.42$	$5.88^{abc} \pm 2.44$	$5.68^{b} \pm 2.41$	$5.56^{abc} \pm 2.38$
PS6	$6.08^{ab} \pm 2.02$	$6.84^{a} \pm 1.53$	$6.00^{ab} \pm 2.22$	$5.84^{abc} \pm 1.77$
CNT	$7.16^{a} \pm 1.21$	$6.48^{a} \pm 1.12$	$7.08^{a} \pm 1.12$	$6.64^{a} \pm 1.22$

PS1: 5g date flour + 20g soybean flour; PS2: 5g date flour + 12.5 g soybean; PS3: 12.5g date flour + 12.5 g Soybean; PS4: 20g date flour + 5 g soybean flour; PS5: 12.5 g date flour + 12.5 g soybean flour; PS6: 5g date flour + 5 g soybean flour, CNT: Control

CONCLUSION

The nutrient contents of the acceptable pap product has been proved with the addition of soybean, and date palm fruit. The low moisture content in the preferred product confers long shelf-life relative to the recommended moisture of flours (<12%). On the basis of sensory evaluation, it was revealed that pap sample PS6 (5g date flour plus 5 g soybean flour) was the best.

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