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Improvement of Nutritive Value of Sorghum-Ogi Fortified with Pawpaw (*Carica papaya* L.)

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ABSTRACT

The utilization of pawpaw fruit as a constituent of sorghum-ogi was investigated by preparing mixtures of ogi with increasing level of pawpaw in 0, 20, 40, 60, 80 and 100% addition. The product, sorghum pawpaw-ogi was evaluated for proximate composition, titratable acidity, sugars and vitamins C. A taste panel evaluation was conducted to evaluate the acceptability of the products. The data obtained indicated an increase in protein ash and fat content while there was variation in the carbohydrate content. Vitamins C and sugar content were also found to increase in proportion with the increase in blending. There were no apparent effect of pawpaw addition on pH and titratable acidity in the mixtures. The taste panel evaluation and the amylograph pasting characteristics of the pawpaw-ogi blends concluded that blends with 40% pawpaw addition and beyond were acceptable in improving the nutritive value of ogi.

Keywords: acceptability, amylograph pasting, enriched food, human nutrition, proximate composition

INTRODUCTION

Malnutrition in neonates has been a source of concern to most countries, particulary the developing countries where there are shortages in nutritious foods for the young ones (Pierro and Eaton 2008). Incidentally, as a baby grows older, the demand for nutrient increases and breast milk alone becomes insufficient to sustain the baby. Alternatively, mothers begin the introduction of other foods such as fermented cereal food porridge made from the staple, whilst breast-feeding is progressively reduced. However, the watery porridge has very little nutritive value. Findings in rural Uganda revealed that in the second years of life, children who had been weaned received 60% fewer calories compared to those who were still being breast-fed (Nwasike *et al.* 1979). This defection in value was in spite of twice consumption of quantity of solids as compared to the period when the children are breast-fed. Hence it is imperative that the gruel should be freshly prepared each time and its nutritive value improved by supplementing with fresh cow's milk, pounded groundnuts, egg yolk, edible oil and fruits (AAP 2005). From recent findings, most diseases that neonates are predisposed to after weaning are mostly as a result of lack of appropriate nutrients that assist in the fortification of their immune system (Young and Drewett 2000; Monte and Giugliani 2004; Hay *et al.* 2004).

The use of pawpaw fruit (*Carica papaya* L.) for nutrient supplement in neonates foods has not been fully investigated. Pawpaw is a popular fruit plant grown all over the wet parts of West Africa, tropical and sub-tropical regions of the world. It is one of the cheapest, economically important fruit tree grown and consumed for its nutritional content (Baiyewu and Amusa 2005). Pawpaw belongs to the family Caricaceae with over 22 species and only one member of the genus *Carica* that is cultivated as a fruit tree while the other three genera (*Cyclicomorpha*, *Jarilla* and *Jacaratia*) are grown primarily as ornamentals (Burkhill 1966; OECD 2005; Carrasco *et al*. 2008). The Pawpaw fruit is melon-like, oval to nearly round, elongated club shaped, 15-50 cm long and 10-20 cm thick but fairly tough. When the fruit is immature (unripe), it is rich in white latex and the skin is green and hard. As it ripens, it becomes light or deep yellow externally and the thick wall of succulent flesh becomes aromatic yellow-orange or various shades of salmon or red. The fruit is then juicy, sweetish and some what like a cantaloupe (musk melon with orange flesh) in flavor but some types are quite musky (Morton 1987).

Pawpaw contains many biologically active compounds, these includes alkaloids, carpaine, pseudocarpaine, flavanols, butanoic acid, tannins, linanool, benzylglucosinolate, *cis*- and *trans*-linalool, terpenoids, alpha-linolenic acid, methyl butanoate, nicotine, lysozyme, malic-acid, oleic acid, carpasamine and palmitic acid, etc. *C. papaya* fruits consist mostly of water, carbohydrate, low in calories and rich in natural vitamins (A and C), minerals (potassium) (Chan and Tang 1979; Gebhardt and Thomas 2002; Oloyede 2005; Abdelkafi *et al.* 2009). In tropical folk medicine, pawpaw provides various culinary, medicinal, molluscicidal, biotechnological application and cosmetic properties (Nakamura *et al.* 2007; Jaiswal and Singh 2008; Cambon *et al.* 2008; Gurung and Salko-Basnet 2009). In view of the wide benefits that are available in pawpaw, authors seek to investigate supplementation of ogi with this fruit with intention to improve the nutritive value of the porridge used as food for infants in this part of the world where food supplies are limited. Furthermore, the aim of this present study is to prepare sorghum-ogi powder co-fermented with pawpaw; evaluate the nutritive composition and sensory acceptance of the mixture (**Table 1**).

MATERIALS AND METHODS

Materials

Fresh ripe pawpaw fruits and Sorghum grains (Brown Variety) were obtained from IITA, Ibadan, Nigeria

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Table 1 Nutrient content of ripe *Carica papaya* L.

Constituents	Approximate value
Water	89%
Calories	39 kcal
Protein	0.61 g
Fat	0.14 g
Carbohydrates	9.8 g
Calcium	24 mg
Iron	0.1 mg
Phosphorous	5 mg
Potassium	257 mg
Magnesium	10 g
Sodium	3 mg
Vitamin A	1094 IU
Vitamin E	0.73 mg

Source: USDA Nutrient Database for Standard Reference, Release 18 (2005).

Table 2 Various proportion of each component in each mixture blend (g).

Sample	A	B	C	D	E	F
Pawpaw (g)	0	20	40	60	80	100
Sorghum (g)	100	100	100	100	100	100

Preparation of sorghum ogi and pawpaw slurries

The sorghum grain was cleaned and 2 kg were steeped in 5 l of tap water for 2 days at room temperature (28 ± 2°C). The steeped grains were recovered by draining off the steeping water and then wet-milled on a premier mill. Excess water was added and stirred to make slurry and passed through a vibrating shaker with a 600 nm sieve. This was followed by souring for 12 hrs and decantation of the supernatant to obtain sorghum-ogi (a fermented sorghum meal) slurry. For the preparation of pawpaw slurry, the fruits were washed and cut into halves. The seeds were then removed, followed by peeling, slicing and blending in a Kenwood mixer.

Preparation of sorghum pawpaw-ogi meal

100 g of sorghum-ogi (dry basis) was mixed with 0, 20, 40, 60, 80 and 100 g of pawpaw slurries (dry basis) as shown in **Table 2**. The slurries were blended in a Hobart mixer for 5 minutes after adding 1 litre of the supernatant (souring water) earlier obtained from the ogi. After blending, the sorghum pawpaw ogi slurry was allowed to ferment for 2 days at room temperature, after which the supernatant was discarded and the slurry pressed to dryness. The cake so obtained was dried at 45-50°C for 24 hrs in a cabinet dryer, cooled, milled and packaged in thick polythene bags and labeled appropriately.

Experimental

Moisture content, ash content, crude fat and total nitrogen by the standard micro-Kjeldahl method were determined using the method of AOAC (1984, 1975). The percentage nitrogen was converted to crude protein by multiplying with a factor of 6.25. The carbohydrate was determined by difference. The pH of the sample blends were measured on a Unican model pH meter which had been previously standardized with buffer solutions of pH 4 and 9. Titratable acidity was determined by method of Banigo and Muller 1972. Diastatic activity was determined using Blish and Sandstedt method as described by Kent-Jones and Amos (1967). Sugar analysis was determined using the AOAC (1975) method. Vitamin C (ascorbic acid) was determined by the oxidation-reduction method based on the reduction of indophenol dye by an acid extract of the ascorbic acid. The bulk density of the samples was determined by method of Narayana and Narasinga-Rao (1984) while Water Absorption Capacity was calculated by method of Solsulski (1962). Pasting viscosity was determined on a brabender Amylograph by method described by Banigo *et al.* (1974) and Adeyemi (1983). Assessment by a 10-person panelist comprising of tasters who were familiar with the product was carried out on the ogi porridge prepared from the samples. Assessment was on a 7-point Hedonic scale for taste, appearance, texture, colour and acceptability. The data obtained were subjected to analysis of variance.

RESULTS AND DISCUSSION

Fortification with blended legumes has been utilized in enrichment processes for the cereal food (Osundahunsi *et al*. 2003). However, pretreatment of cereals utilized for porridge largely depended on the type of cereal, the desired product and the processes involved. Conversely, the processes are rigorous thus affecting the nutritional status of the desired product (Aminnigo and Akingbala 2004). The major drawback to the use of ogi as a staple food is its low nutritional value. Several attempts were made to improve the nutritional status of ogi, by fortifying it with protein rich substrates (Banigo 1972; Bamiro *et al.* 1994; Osungbaro 2009). A protein-enriched ogi containing 10% soya flour was developed by the Federal Institute of Industrial Research (FIIRO), Lagos, Nigeria (Akinrele 1970). The utilization of high lysine maize for the manufacture of ogi using improved processing system had also been attempted (Banigo *et al*. 1974; Adeniji and Potter 1978). The development of an ogi (dogit), having the therapeutic properties on the basis of its ability to control diarrhoea among infants has also been reported (Olukoya *et al*. 1994). In an attempt to improve the nutritive composition and sensory properties of ogi, Aminigo and Akingbala (2004) fortified maize ogi with okra seed meal. Okra seed fortification at 20% level using defatted and roasted meals increased crude protein content by 122 and 106%, respectively. These workers were also able to raise ash content by 2-5 fold and fat content was increased by 1.5-2.2%.

Effect of pawpaw addition on the proximate composition of ogi

The result of the proximate composition of the sorghum/pawpaw ogi blends is presented in **Table 3**. The moisture content of the samples did not show any definite trend but were in the range of 8 and 11%. At this moisture range, the samples might be kept for at least 6 months if properly stored. The fat content of the sorghum grain, as expected, was higher than that of the ogi samples because of removal, through wet sieving, of the germ where most of the fats are concentrated. It could be inferred from the results obtained that additions of pawpaw might not have any significant effect on the fat content of ogi. There was an increase in the ash content with increasing level of pawpaw addition. This was expected since one of the most important contributions of fruits to human diet is the provision of minerals. However, the ash content obtained for sorghum grain was higher than that of pure ogi sample due to removal of most of the minerals which are concentrated in the bran and germ by the wet-sieving process. The protein content did also increased significantly with pawpaw addition in the blends. The starch content in all the ogi samples were higher than the starch content of the whole sorghum grain as the wet-sieving process must have removed the major part of the

Table 3 Proximate composition of pawpaw-ogi blends.

Sample	Moisture (%)	Fat (%)	Ash (%)	Protein (%)	Carbohydrate (%)
A	11.10 ± 0.10	0.36 ± 0.01	0.10 ± 0.03	4.10 ± 0.18	84.50 ± 5.21
B	9.10 ± 0.90	0.49 ± 0.02	0.63 ± 0.27	4.89 ± 0.33	84.91 ± 4.54
C	10.65 ± 0.10	0.76 ± 0.21	0.86 ± 0.16	6.67 ± 0.06	80.93 ± 5.26
D	8.50 ± 0.90	0.99 ± 0.01	0.92 ± 0.27	7.10 ± 0.01	82.40 ± 3.80
E	11.60 ± 0.29	1.67 ± 0.11	1.14 ± 0.25	8.26 ± 0.25	77.90 ± 3.12
F	8.24 ± 0.70	1.69 ± 0.16	1.78 ± 0.55	8.96 ± 0.46	78.21 ± 4.10

Table 4 Ascobic acid and sugar content of pawpaw-ogi blends.

Sample	Ascorbic acid (mg/100 g)	Reducing sugar (mg/maltose/100 g)	Non-reducing sugar (mg/sucrose/100 g)	Total sugar (mg/100 g)
A	0.28 ± 0.26	0.20 ± 0.004	0.12 ± 0.001	0.33 ± 0.22
B	1.18 ± 0.77	0.30 ± 0.001	0.26 ± 0.076	0.56 ± 0.01
C	1.10 ± 0.42	0.36 ± 0.001	0.29 ± 0.002	0.62 ± 0.55
D	1.20 ± 0.16	0.42 ± 0.002	0.31 ± 0.001	0.66 ± 0.68
E	1.30 ± 0.23	0.46 ± 0.001	0.36 ± 0.002	0.75 ± 0.32
F	1.46 ± 0.93	0.52 ± 0.001	0.40 ± 0.002	1.25 ± 0.04

Table 5 The pH, titratable acidity, diastatic activity, water absorption capacity and bulk density of pawpaw-ogi blends.

Sample	pH	Titratable acidity (mg of NaOH/100 ml of filterate)	Diastatic activity (mg maltose/100 g)	Water absorption capacity (ml)	Bulk density (g/ml)
A	3.52 ± 0.02	3.02 ± 0.01	21.8 ± 2.02	81.00 ± 2.01	0.728 ± 0.002
B	3.90 ± 0.01	3.15 ± 0.03	48.9 ± 4.02	70.00 ± 3.26	1.810 ± 0.013
C	4.11 ± 0.01	3.43 ± 0.09	51.2 ± 2.03	61.00 ± 2.12	0.852 ± 0.012
D	4.10 ± 0.02	3.62 ± 0.29	78.5 ± 3.01	59.00 ± 2.29	0.885 ± 0.012
E	4.19 ± 0.03	3.53 ± 0.11	98.5 ± 1.06	49.00 ± 3.42	0.945 ± 0.011
F	4.25 ± 0.03	3.72 ± 0.41	110.8 ± 2.04	45.20 ± 3.25	0.910 ± 0.027

Table 6 Results of analysis of taste panel scores.

Quality attributes	A	B	C	D	E	F	LSD	"F" Value
Taste	4.7 a	4.0 d	4.1 c	4.6 b	4.7 b	5.6 a	1.57	3.52
Colour	6.2 a	6.0 a	5.4 a	5.7 a	5.7 a	5.8 a	0.80	0.67
Texture	4.7 a	4.1 b	3.2 bc	4.2 c	3.2 d	3.4 e	2.28	2.50
Flavour	3.5 d	4.1 c	4.4 c	5.2 b	5.6 a	5.9 a	1.87	8.55
Sourness	4.0 a	5.0 b	5.8 ab	4.4 c	3.5 d	3.3 e	1.31	6.50
Appearance (dry sample)	5.2 a	5.3 a	5.3 a	5.2 a	5.2 a	5.3 a	0.63	2.10

Table 7 Amylograph pasting characteristics of pawpaw-ogi blends.

Sample	Tp (min)	Mg (min)	Tvp (^{0}C)	Vp (B.U)	Mn (min)	Vi (B.U)	Vr (B.U)	Ve (B.U)	Mn-Mg (B.U)	Vp-Vr (B.U)	Ve-Vp (B.U)	Ve-Vr (B.U)
A	81	32	89	320	36	280	210	830	4	110	510	620
B	84	33	93	290	34	265	210	840	1	80	550	630
C	86	32	96	285	34	340	230	810	2	55	525	580
D	85	34	96	310	36	270	200	910	2	110	600	710
E	83	30	93	315	32	255	220	890	2	95	575	670
F	82	29	91	270	36	210	190	700	7	80	430	510

Tp = Pasting Temperature; Mg = Gelatinazation time; Tvp = Temperature at peak viscosity; Vp = Peak viscosity during heading; Mn = Time to reach peak viscosity; Vi = viscosity at 95°C; Vr = viscosity after 30min holding at 95°C; Ve = Viscosity on cooling to 50°C; Mn – Mg = Ease of cooling; Vp – Vr = Stability of the starch; Ve – Vp = Set back value; Ve – Vr = Galetinization index; B.U = Bradender unit

bran and germ leaving mainly the starch fraction.

The results of the ascobic acid and sugar content of blended samples are presented in **Table 4**. The addition of pawpaw significantly increased the vitamin C content of ogi. Hence, it could be inferred that the incorporation of pawpaw to sorghum-ogi could improve the vitamin C content of the ogi. The total sugar, the summation of both the reducing and non-reducing sugar, increased with an increase in the level of added pawpaw having highest value of 1.25 ± 0.04 mg/100 g in 100% blend.

The pH and titratable acidity of ogi samples were found to range between 3.52 and 4.25, and 3.02 and 3.72 mg NaOH/100 ml of filtrate, respectively (**Table 5**). There was no apparent effect of pawpaw addition on the pH and titratable acidity of ogi. Changes in diastatic activity of ogi samples were observed with increasing level of pawpaw addition, with values of 21.8 ± 2.02 to 110.8 ± 2.04 mg maltose/100 g respectively for sorghum ogi at 0% level of substitution and sorghum pawpaw-ogi at 100% level of blending. The bulk density of the samples obtained are nearer to each other in the range of 0.698 and 0.950 g/ml, with 0% blend having the smallest bulk density, which implies that it will occupy the smallest space (**Table 5**). The water absorption capacity of pawpaw-ogi blends also decreased with increasing additional level of pawpaw.

Taste panel assessment of pawpaw-ogi blends

The taste panel assessment of the blends is shown in **Table 6** for quality attribute of all the samples. The results were treated with the analysis of variance method. For sourness, 0% and 20% blends were found to be significantly different from the other samples at 5% confidence level and 0% only was significantly difference from other samples for texture. Also, 0 and 100% blends were significantly different from the other samples for taste while 100 and 80% blends were significantly different for flavour. For colour and appearance, there was no significant difference in all the samples.

Amylograph pasting viscosity of pawpaw-ogi blends

Amylograph pasting viscosity data of the samples is presented in **Table 7**. The peak viscosity (Vp) ranged between 70 and 320 BU; indicating that addition of pawpaw did not significantly alter the swelling property of ogi. Stability value of the starch (Vp – Vr) decreased from 110 BU to 51 BU at 60% level of pawpaw addition, which would appear to indicate that pawpaw tends to improve stability of sorghum-ogi. Set back values (Ve – Vp) ranged between 430 and 600 BU while the gelatinization index (Ve – Vr) ranged between 510 and 710 BU. Therefore, it could be inferred that the pasting characteristics of sorghum pawpaw-ogi are not significantly different from the normal sorghum-ogi. The factors that can affect the pasting viscosity of sorghum-ogi include grain variety, processing conditions and manufacturing methods in accordance with the reports of Banigo *et al*. (1974).

CONCLUDING REMARKS

Pawpaw, like other fruits, is not accorded with the importance it deserves in the diets. This is probably because of ignorance of its nutritive value and the difficulty in storage and utilization. This work has revealed the utilization of pawpaw fruit as a constituent of traditional weaning meal and as an enriched adult food (ogi). An indication from this study is that pawpaw fruits, which are valuable nutritionally because of the vitamins and minerals, which they contain, as well as for their bulkiness and laxative properties could be beneficial as constituent of a staple diet thereby enhancing its use in food industry.

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