CHEMICAL AND SENSORY ATTRIBUTES OF COMPLEMENTARY FOOD FROM PIGEON PEA (*Canjanus cajan*) AND RICE (*Oryza glaberrima*) BLENDS

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ABSTRACT

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The work was designed to develop complementary food from rice and pigeon pea flour blends. The proximate and vitamin content of the samples were determined using standard AOAC methods. Mineral elements were determined using wet-acid digestion method for multiple nutrients determination. Means and standard deviation were calculated and compared using student t-test. The result from proximate analysis shows that the crude protein obtained for Rice(R): Pigeon (P) pea (50:50) (37.6%) was higher than the crude protein obtained for R: P (80:20) (34.1%) and R:P (70:30) (26.2%). Crude fat and crude fiber obtained were low for all the blends. Crude fat ranged between 1.8 and 2.2 % while crude fiber ranged between 0.34 and 0.44%. All the blends were good sources of macrominerals but poor sources microminerals. The vitamin C of the blends ranged between 15.2and 28.8mg per100g. All the B-vitamins (niacin, thiamin and riboflavin) determined were low (0.20-0.38mg per100g, 0.10mg per100g, and 0.17-0.59mg/100g respectively). Alkaloid, saponin, and flavonoid were obtained in the blends in the following ranged, alkaloid (0.02-0.03mg per100g), saponin (0.01-0.1mg per100g) and flavonoid (0.01- 0.02mg per100g). The result showed that all the complementary food blends formulated were good sources of protein, vitamin C, macrominerals but poor sources of microminerals.

Keywords: *Complementary food, Oryza glaberrima, Cajanus cajan, infants*

INTRODUCTION

Adequate nutrition within the first two years of a life is pre-requisite for proper physical and mental development in infant and young children (Lutter and Dewey, 2003). In infants (0-6months), it has been shown that adequate nutrition can be achieved through exclusive breast feeding for the first six (6) months of life and complementation afterwards with nutrient-dense food (Uvere *et al*., 2009). Complementary food is defined as food given to infants when breast milk alone or infant milk is no longer sufficient to meet the nutritional need of the infant or the young child. These foods are needed to fill the gap between the total nutritional needs of the child and the amounts provided by breast milk (WHO, 2000). Traditional complementary foods in Nigeria majorly comprised blends made from cereals (maize, sorghum, millet, rice) and legume (groundnut, soybean, and cowpea), which may be enrich with palm oil or crayfish. In time past legume commonly used as complement were cheap sources of protein but high cost of living has increased food price including that of commonly consumed legume. It has therefore become imperative for researchers to look for an alternative source protein that can be used to mitigate the high prevalence of malnutrition of children in Nigeria.

Pigeon pea (*Cajanus cajan*) which was classified among the underutilized crop in Nigeria (Fasoyiro *et al*., 2010) has recently been identified as a legume with nutritional and medicinal potentials. Pigeon pea otherwise known as red grain (Ghadge *et al*., 2008) is commonly called "foi-foi" or "agbugbu" in South-eastern Nigeria (Ene-Obong, 1984). It is grown both as an annual crop or perennial plant in homestead (Sheldiake, 1984) and it is known as one of the most drought tolerant legume (Venezula and Smith, 2002). Though pigeon pea grows well in Nigeria its hard-to-cook characteristic limits its utilisation (El- Tabey, 1992; Fasoyiro *et al*., 2010). Record shows that pigeon pea can be utilized in the production of tempeh, noodles, and as snacks (Saxena *et al*., 2000). In Nigeria however, pigeon pea is either consumed alone or in combination with starchy staple such as cereal grains, tubers or roots (Ene- Obong, 1984). The objective of this study is to evaluate the effectiveness of rice and pigeon pea flour as complementary food for children.

MATERIAL AND METHODS

Collection of sample

The local rice sample was purchased from Ekeokwuru mini Market in Ohuhu Umuahia and the pigeon pea sample was purchased from local market in Onitsha, Anambra State. The sorghum (used as the control) was purchased from Ubani Market Umuahia, Abia State.

Cleaning/processing of rice and pigeon pea into flour

The rice was mixed with warm water (30 °C) and boiled for ten minutes. It was then washed with cold potable water and spread on a flat tray to dry under the sun. The tray was covered with net to keep away flies. The rice was dried for three days and then milled into flour using attrition milling machine (Thomas Wiley Model ED-5) to 5mm sieve size.The pigeon pea was soaked for six hours to facilitate dehulling and to reduce its beany off-flaour

(Uvere *et al*., 2009). It was spread in the sun to dry and subsequently roasted in a pan under moderate heat until it turns golden brown. The sample was milled into flour using attrition milling machine (Thomas Wiley Model ED-5) to 5mm sieve size.

The sorghum grains (1kg) were cleaned by hand sorting and picking to select healthy seeds. The maize grains were then steeped in water for 24 hours, after which grains were washed and taken for milling using an attrition milling machine. The sorghum slurry was sieved using a muslin bag and left to sediment overnight after which, the water was decanted. The sorghum paste was pressed to ensure removal of water.

Formulation of blends from rice and pigeon pea flour for the production of complementary food

Blends were formulated based on the protein composition of processed flour (Nnam and Odigwe, 2007) in ratios of 70:30, 50:50 and 80:20 (protein basis) of rice and pigeon pea.

Preparation of gruel from rice and pigeon pea flour blends

Slurry was made by mixing two hundred gram of each of the blend with 400ml of water. The slurry was allowed to rest for 10minutes at room temperature (29 – 30 $^{\theta}$C) to allow for proper water absorption. The slurry was then gradually poured in a pot of boiling water (600ml) with continuous stirring until a thick paste was formed. Twenty gram of granulated sugar was added to each paste.

Preparation of gruel using sorghum (*Sorghum bicolor*)

The gruel was prepared using two hundred grams of the paste. About 120ml of clean water was added to the paste to prepare the slurry. The slurry was then added about 700ml of boiled water to make the pap. The prepared pap was stirred manually using a steel spoon to form a smooth paste. Twenty gram of granulated sugar was the added for taste.

Chemical analyses

The proximate compositions of the sample were determined using standard AOAC (2006) methods. Moisture content of the blend was determined gravimetrically. The crude protein content was determined by micro-Kjeldahl method, using 6.25 as the nitrogen conversion factor. The crude fat content was determined by Soxhlet extraction method using petroleum ether. The ash content was determined by incinerating the samples at 600 $^{\theta}$C in a muffle furnace. Carbohydrate was obtained by difference, while energy was calculated using the Atwater Conversion factors in KJ and Kcal (17KJ per 4Kcal, 17KJ per 4Kcal, and 37KJ per 9Kcal, for protein, carbohydrate and lipid respectively.

Mineral elements were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC. (2006). About 0.2g of the processed sample material was weighed into a 150ml Pyrex conical flask. Five (5.0) ml of the extracting mixture (H_2SO_4 – Sodium Salicylic acid) was added to the sample. The mixture was allowed to stand for 16 hours. The mixture was then placed on a hot plate set at 30 $^{\theta}$C and allowed to heat for about 2hours. Five (5.0) ml of concentrated perchloric acid was introduced to the sample and heated vigorously until the sample was digested to a clear solution. Twenty (20) milliliter of distilled H_2O was added and heated to mix thoroughly for about a minute. The digest was allowed to cool and was transferred into a 50ml volumetric flask and made up to the mark with distilled water. The digest was used for the determinations of calcium (Ca) and magnesium (Mg) by the ethylamine ditetra acetic acid (EDTA) Versanate complexiometric titration method. Potassium (K) and sodium (Na) were evaluated by flame photometry method and phosphorus (P) by the vanadomolybdate method using the spectrophotometer. The trace metals (zinc, iron, selenium) were determined using the atomic absorption spectrophotometer 969 instrument. The appropriate cathode lamp was fixed for each element. The sample was introduced to the atomizer and the value concentration of the element printed out as mgX per liter.

The β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (2006), while ascorbic acid was determined as described by AOAC (2006) using titration method. Gravimetric method (Harborne, 1973) was used to determine alkaloids. Saponin was determined by gravimetric oven drying method as described by the method of AOAC (2006). Tannin content of the sample was determined spectrophometrically as described by Kirk and Sawyer (1991). Phenol was determined by the folin-ciocatean spectrophotometry method (AOAC, 2006). Flavonoid was determined by gravimetric oven drying method as described by Harborne (1973).

Sensory evaluation

Sensory evaluation of the products was carried out by a group of 20 panelists made of nursing mothers. White sorghum (*Sorghum bicolor*) pap was used as the control. The evaluation was carried out in the food laboratory of the Department of Home economics. The judges evaluated the products using a seven point hedonic scale where 7 = like very much and 1 = dislike very much. Panelists scored the sample for four sensory attributes – colour, flavor, taste and over all acceptability. A cup of potable water was given to the panelist to rinse his/her mouth after each tasting.

Statistical Analysis

All determinations were done in duplicates. The data generated were entered into the computer and analyzed using Statistical Package for Social Sciences (SPSS version 16.0) Means and standard deviations obtained from the chemical analysis were calculated. Level of significance was at $p<0.05$. Analysis of variance (ANOVA) was used to compare the values obtained for sensory evaluation.

RESULT AND DISCUSSION

Proximate composition of complementary foods developed from Rice and pigeon pea blends and that sorghum pap

The energy and proximate composition of the complementary food formulated from rice and pigeon pea and sorghum pap as control is shown on Table 1. Moisture ranged between 16.0% and 86.82% with white sorghum pap having the highest moisture value (86.82%) and R: P (80:20) having the lowest moisture value (16.0 %.). The moisture composition of any food is an index of its shelf-life (Appiah *et al*., 2011). This implies that R: P (80:20) may have a longer shelf-life than the other products. The crude protein value obtained for the blends (26.2 – 37.6%) were significantly (p<0.05) higher than the crude protein value obtained for white sorghum pap (3.05%). The relatively higher crude protein value found in blends than in the sorghum pap could be attributed to the fact that they contained pigeon pea; pigeon pea like other legume is a rich source of plant protein (Stadlmaryr *et al*., 2012).

Table 1: Proximate composition of complementary foods developed from rice and pigeon pea blends and that sorghum pap

Nutrients	R:P(70:30)	R:P(50:50)	R:P(80:20)	White sorghum pap (control)
Moisture (%)	23.2b±0.01	21.5c±0.01	16.0d±0.01	86.82a± 0.02
Protein (%)	26.2c±0.01	37.6a±0.01	34.1b±0.01	3.05d ±0.01
Fat (%)	1.8c±0.01	1.9b±0.01	2.2a±0.01	0.18d ±0.00
Fiber (%)	0.34c±0.00	0.37b±0.01	0.44a±0.01	0.09d ±0.01
Ash (%)	0.30c±0.01	0.44a±0.01	0.40b±0.01	0.21d± 0.00
Carbohydrate (%)	48.1a±0.00	38.1c±0.01	46.7b±0.01	10.94d
Energy (Kcal)/(KJ)	313/1330c	319/1357b	343/1450a	49. 58d

Means with similar superscripts in the same column are not significantly (p<0.09) different. R: P- Rice: Pigeon pea

The daily protein need of children between the ages of 1-3years is 13gper day (Wardlaw and Hampl, 2007); this implies that intake of 50g each of the blend can supply the daily protein need of children of that age group. Crude fat and crude fiber obtained in the study were generally low; but the fat (1.8 and 2.2 % respectively) and fiber (0.34 and 0.44% respectively) contents of the blends were significantly (p<0.05) higher than those of the control (0.18 and 0.09% respectively). These results were not surprising because the pigeon pea as a component of the formulated blend is rich in fat (Stadlmaryr *et al*., 2012); and even though sorghum is rich source of fiber processing (sieving) must have reduced its fiber content. Low fiber obtained in all the blends is desirable because high fiber diet lowers glucose absorbance in-vivo (which is not desirable in this age group). The carbohydrate content of the blends ranged between 46.1 and 48.1%, energy ranged between 313 and 344 kcal with R: P (80:20) have the highest energy value (344kcal). The carbohydrate (38.1 and 48.1g per100g) and energy (313 and 343kcal) of the blends were significantly higher than those of the sorghum pap (10.94g per 100g and 49.58kcal). Higher energy and values obtained in blends as compared to the energy value of sorghum pap was expected because the energy value of any food is known to be the function of its composition, and the blend contained a higher carbohydrate, fat and protein values than the sorghum pap. Energy obtained in the blends (313 and 343 kcal) was higher than the ones reported for some traditional complementary foods (maize pap 39.77kcal, sorghum pap 35.15kcal, pap with roasted groundnut powder 81.55kcal and pap with soybean flour 56.57kcal) produced in Nigeria (Ogbonnaya *et al*., 2011). High energy obtained in the blends has positive nutritional implication for children; intake of watery and low energy complementary foods has been identified as some of the factors responsible for malnutrition in Nigerian children (Anigo *et al*., 2010). According to UNICEF, (2001), the energy needs from complementary for an infant with average breast milk intake in developing countries should be approximately 200kcal per day at 6-8months of age, 300kcal per day at 9-11 months and 550kcal per day at 12-23 months of age this implies that blends can be recommended for infants within the age brackets of 9-11 months in terms of energy.

Mineral Composition (mg per 100g) of the complementary food developed from Rice and pigeon pea blends and that sorghum pap

The result of the mineral composition of the blends is shown on Table 2. All the blends are rich in macrominerals but low in microminerals. When compared with sorghum pap (control), calcium (405 and 505mg per 100g), magnesium (115 and 175mg per 100g), potassium (555 and 575mg per 100g), sodium (305 and 475mg per 100g) and phosphorus (405 and 985mg per 100g) were significantly higher in the blends while iron (0.85mg per 100g) and zinc (0.16mg/100g) were significantly higher in sorghum pap.

Calcium ranged between 405 and 505mg per100g with calcium value of R: P (50:50) and that of R: P (80:20) (505mg 100g) been significantly (p<0.05) higher than the calcium obtained for R: P (70:30) (405mg per 100g). The daily calcium daily need of children between the ages of 1-3years is 500mg per d (Wardlaw and Hampl, 2007): this implies that consumption of 100g of either R: P (50:50) or R: P (80:20) will meet the daily calcium need of children within that age group. Calcium is an important element in the formation and development of

bone. The magnesium obtained for R: P (70:30) and R: P (80:20) was similar (175mg per 100g) but significantly different from the Mg obtained for R: P(50:50) (115mg per 100g). Magnesium is needed in the body for proper nerve and heart function as well as insulin release from pancreas. The K obtained for R: P (50:50) and R: P (80:20) (575mg per 100g) was significantly higher than the K obtained in R: P (70:30) (555mg per 100g); also the sodium found in this study varied significantly from each other. Sodium obtained for R: P (70:30) was 475mg per 100g, R:P (50:50) (225mg per 100g) and R:P(80:20) (305mg per 100g). Sodium, potassium and calcium are important elements needed for the transmission of nerve impulse in the body (Oh and Williams, 2006). As noted earlier the blends are generally poor sources of microminerals. The iron ranged between 0.02-0.03mg per 100g and selenium ranged between 0.02-0.04mg per 100g. Though rice and pigeon pea are naturally poor sources of micronutrients (Stadlmaryr *et al.*, 2012), effect of processing also may have decreased the micronutrients further.
Vitamin composition of the complementary food developed from rice and pigeon pea blends and that sorghum pap

Table 2: Mineral Composition (mg per 100g) of the complementary food developed from Rice and pigeon pea blends and that sorghum pap

Nutrient	R:P (70:30)	R:P (50:50)	R:P (80:20)	white sorghum pap
Calcium	405b±0.01	505a±0.01	505a±0.01	152.77c± 0.07
Magnesium	175 a ±0.01	115 b ±0.01	175 a ±0.01	68.77c ±0.04
Potassium	555 a ±0.01	575 a ±0.01	575 a ±0.01	174.08b±0.04
Sodium	475 a ±0.01	225c±0.01	305 b ±0.01	149.61d ±0.02
Phosphorus	585 b ±0.01	405 c ±0.01	985 a ±0.01	318.22d ±0.40
Iron	0.02^{b} ±0.01	0.02^{b} ±0.01	0.03^{b}±0.01	0.85a± 0.01
Zinc	0.0^{b} ±0.01	0.0^{b} ±0.01	0.0^{b}±0.01	0.16a±0.04
Selenium (µg/100g)	0.02^{b}±0.01	0.04^{a} ±0.01	0.04^{a} ±0.01	0.02^{b}±0.00

Means with similar superscripts in the same column are not significantly (p<0.09) different. R: P- Rice: Pigeon pea

The vitamin composition of the bends is on Table 3. The vitamin C contents of the products ranged between 1.74 and 28.8 mg per 100g. Sample R: P (80:20) had the highest vitamin C content (28.8 mg per 100g) while, sorghum pap had the lowest vitamin C value (1.74 mg per 100g). It is interesting to note that the vitamin C obtained for each blend in this study is capable of meeting the daily vitamin C need (15 mg per d) of children between the ages of 1-3 years. Vitamin C is of great importance in meals as it enhances the absorption of plant iron in-vivo. The niacin, thiamin and riboflavin (0.20 and 0.38, 0.10 and 0.17 and 0.59 mg per 100g respectively) were significantly (p<0.05) higher than values (0.02, 0.02 and 0.06mg per 100g respectively) obtained for sorghum pap.

Table 3: Vitamin composition of the complementary food developed from rice and pigeon pea blends and that sorghum pap (mg per 100g).

Sample	Vitamin C	Niacin	Thiamin	Riboflavin
R:P (70:30)	17.6^{b}±0.09	0.38^{a}±0.31	0.10^{a}±0.01	0.17^{b}±0.01
R:P (50:50)	15.2^{c}±0.01	0.20^{c}±0.01	0.10^{a}±0.01	0.18^{b}±0.01
R:P (80:30)	28.8^{a}±0.01	0.24^{b}±0.01	0.10^{a}±0.01	0.59^{a}±0.01
White sorghum Pap (control)	1.64^{d} ±0.01	0.02^{d}±± 0.00	0.02^{d}± 0.00^{b}	0.06^{d}± 0.00^{c}

Means with similar superscripts in the same column are not significantly (p<0.09) different. R: P- Rice: Pigeon pea

It is interesting to note that the niacin, thiamin and riboflavin obtained in the blends were several folds higher than RDI (Recommended Intakes for Individuals) for infants and children (DRIs, 1998). The B-vitamins are needed in the body for energy metabolism (Wardlaw and Hampl, 2007). Phytochemical composition of complementary developed from Rice and Pigeon pea blends and that sorghum pap The phytochemical composition of the blends is shown on Table 4. Phytochemicals are plant chemicals known for their protective activities in both plants and man. Alkaloid, saponin, and flavonoid were obtained in the blends in the following ranges alkaloid (0.02 and 0.03mg per100g), saponin (0.01and 0.1 mg per 100g) and flavonoid (0.01 and 0.02 mg per 100g).
The presence of alkaloid, saponin and flavonoid in the blends is an indication that consumption of the blends will impact some health benefits (Heim *et al.*, 2002; Shi *et al.*, 2004). Flavonoids are a class of secondary plant metabolites that are believed to exert beneficial health effects through their antioxidant and chelating properties (Heim *et al.*, 2002); also phenols are one of the major groups of non-nutritive dietary components that have been associated with the inhibition of cancer, atherosclerosis, as well as for age-related degenerative brain disorder (Chang *et al.*, 2006). Tannin and oxalate were not detected in the blends. Phenol was found only in sample R: P (80:20) (0.03mg per 100g). The absence of tannin and oxalate in the blend is an indication that the products are safe for consumption.

Sensory attributes of complementary developed from Rice and Pigeon and those of traditional pap (*Sorghum bicolor* pap)

The sensory attributes of the formulated complementary food is on Table 5. Score of the colour ranged between 3.4 and 5.6, with R: P (70:30) having the highest score for colour acceptability, while traditional pap (sorghum pap) had the lowest score for colour (3.4).

Table 4: Phytochemical composition of complementary developed from rice and pigeon pea blends (mg per 100g).

Phytochemical	R:P(70:30)	R:P(50:50)	R:P(80:20)	White sorghum pap (control)
Alkaloids	0.02b±0.01	0.03a±0.01	0.03a±0.01	0.02b±0.01
Flavonoids	0.02b±0.01	0.02b±0.01	0.02b±0.01	0.02b±0.01
Phenols	0.00b±0.01	0.00b±0.01	0.03a±0.01	0.00b±0.01
Tannins	0.00 a ±0.01	0.00 a ±0.01	0.00 a ±0.01	0.07 a ±0.01
Saponins	5.1a ±0.01	0.01b ±0.01	0.00c ±0.01	0.09b ±0.01
Oxalate	0.00b ±0.01	0.00b±0.01	0.00b±0.01	0.01a ±0.01

Means with similar superscripts in the same column are not significantly ($p<0.09$) different. R:P-Rice: Pigeon pea

Table 5: Sensory attributes of complementary developed from rice and pigeon and those of traditional pap (*Sorghum bicolor* pap)

Sample	Colour	Flavour	Taste	General Acceptability
R:P(70:30)	5.6a± 2.87	4.9a± 2.62	7.9a ±2.00	7.9a± 1.99
R:P(50:50)	4.6ab ±2.28	4.6a ±2.13	6.6b ±1.64	7.0a ±1.38
R:P(80:20)	4.8ab ±2.16	4.7a ±2.00	6.4b ±1.23	7.0a ±1.45
Traditional pap	3.4b ±1.82	3.5b ±1.93	5.0c± 2.16	5.4b ±1.98

Means with similar superscripts in the same column are not significantly ($p<0.09$) different. R: P- Rice: Pigeon pea

The bright cream colour of the formulated foods must have enhanced their acceptability in terms of colour. The score obtained for taste varies significantly ($p<0.05$) in all the products except for samples R:P (50:50) vs R:P(80:20) whose attribute for taste were not significantly different from each other (6.6 vs 6.4). The mean results on flavor and general acceptability show that the formulated products were more acceptable than the traditional pap made from sorghum.

CONCLUSION

The result showed that all the complementary food blends formulated were good sources of protein, vitamin C, macrominerals and vitamins particularly the B-vitamins but poor sources of microminerals.

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