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Nutritional Quality Assessment of Complementary Food from Plantain, Velvet Bean and Cray Fish

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Abstract
Complementary foods are needed to supplement breast milk with essential nutrients needed for general wellbeing of growing children. In developing countries these children still suffer from nutritional deficiencies which can be ameliorated by development of nutrient dense and acceptable complementary foods from locally available crops. Mixture design of design expert was used to obtain optimized flour blend from plantain, velvet beans and crayfish flours for the production of complementary food which was analyzed for its nutritional and sensory qualities. Result of proximate composition for moisture, crude protein, fat, fibre, ash and carbohydrate was 6.49 %, 12.18 %, 1.50 %, 0.35 %, 2.10 % and 82.93 % respectively. The complementary food had 64.80 % *in-vitro* protein, 21.80 % starch digestibility, gross energy of 4132.21 Cal, *in-vitro* total sugar content of 3.29g/100g and a total carbohydrate content of 50.87 %. The complementary food had sensory attributes comparable to commercial complementary foods, was nutrient dense and could be used as alternative to expensive complementary foods. There is therefore need to continue to formulate nutritionally dense and acceptable weaning food from local crops in order to ameliorate the nutritional deficiencies among infants and hence improve their general wellbeing.

Key words: Complementary foods, plantain flour, velvet beans, crayfish, nutritional quality

Introduction

Complementary food is any suitable food given to older infants and young children once breast milk or infant formula alone can no longer meet a growing child's nutritional needs corresponding to a healthy development (Ojinnaka *et al*., 2013). Developing countries possess lots of nutrient-dense, inexpensive and easily available plant food sources that can meet the nutritional requirements for infants and children when combined together in appropriate proportions (Olaleye *et al.,* 2020). Plantain (*Musa paradisiaca L.*) is a tropical fruit that constitute a staple food crop in Central and West Africa. In Nigeria and other parts of Africa and in many other places in the world, plantain (*Musa paradisiaca*) serves as a major staple food and is particularly desired for the variability in the stages of ripeness and in cooking methods (Oladele and Khokhar, 2011). The seeds of velvet bean (VB) (*Mucuna pruriens* (L.) merit a wider use as an alternative protein source in many tropical countries. The seed contain higher levels of proteins (25.4% to 29.6%), starch (31.2% to 39.5%), desirable amino acids, fatty acids and mineral composition with good nutritional properties (Vadivel and Janardhanan, 2005). Crayfish (*Procambarus clarkii*) sometime called crawfish, are fresh water crustacean resembling small lobsters. Crayfish are sea-foods that contain varying ranges of minerals and vitamins such as vitamin B_6 and B_{12}, vitamins A, D, E and K, phosphorus, zinc, iron, calcium, magnesium, sodium and other macronutrients that are essential for the growth of a child (Shane and Darren, 2007). There is a need to formulate nutritionally dense and acceptable weaning food from plantain, velvet bean, crayfish and dates in order to ameliorate the nutritional deficiencies among infants, hence, improving their wellness in the developing countries. This study is aimed at assessing the nutritional quality of complementary diet from plantain, velvet bean and crayfish flour blends.

Materials And Methods

Plantain bunches (*Musa spp*) and crayfish were purchased from Owode Market in Offa local Government Area of Kwara State while velvet beans (*Mucuna pruriens*) was obtained from a local farmer in Offa local government area of Kwara state. The method of Abimbola and Serah (2020) was utilized in preparation of plantain flour. The method of Duru *et al.* (2020) was used in the preparation of velvet beans flour. The crayfish flour was prepared according to the method of Umera *et al*. (2020). The flours produced were packaged in an airtight plastic container, labeled and kept in a freezer until needed for further use. D-optimal mixture design of Design Expert version 13.0 was used to obtain the optimal flour blend formulation of 68.30:21.70:10.00 for plantain, velvet bean and crayfish respectively, after which the flour samples were analyzed.

Nutritional Quality assessment of complementary diet flour blends

The complementary diet flour blends were evaluated for proximate composition (moisture, crude protein, crude fat, crude fibre, total ash and carbohydrate contents) as described by AOAC (2015); *in-vitro* protein and starch digestibility as described by Elkhalil *et al.* (2001) and total starch and total sugar contents as described by Akinsola (2017).

Determination of sensory evaluation

Optimized and coded prepared gruel samples were presented to twenty-one semi-trained nursing mothers and child-bearing mothers on the basis of sensory properties including colour, flavour, taste, texture, and overall acceptability using 9-point hedonic scale where 1 is dislike extremely and 9 liked extremely. Data obtained were statistically separated using Duncan multiple range test.

Results And Discussion

Table 1 presents the results for the proximate composition of optimized weaning food mixture from plantain, velvet bean and crayfish flour. The moisture content was observed to be 6.49%. This is in agreement with the recommended level of moisture permissible for moisture contents of flour based food products 10 – 14% (FAO, 2004). These results are lower than 8.15 – 9.58% reported for moisture contents of weaning foods from sorghum-mung beans-orange fleshed sweet potato blends by Olaleye *et al.* (2020); but higher than 4.78-5.31% reported for maize-pea-anchote complementary flour blends. Moisture content is an indicator of storage, shelf stability and safety of food products; hence the weaning food will have less microbial proliferation due to low moisture content. The crude protein content was 12.18%. This is almost close to FAO/WHO Codex Alimentarius Standards for weaning foods at 14.52 – 37.70 g/100 g for optimum balance between proteins of lower and higher biological value for meeting the appropriate demand for growth (Young, 2001). Crude protein content of this study is slightly in conformity with (14.00 – 18.04%) reported by Olaleye *et al*. (2020) for weaning foods from sorghum-mung bean-orange fleshed sweet potato blends but lower than (15.00 – 28.09%) reported for complementary food from cereal, oilseed and animal protein by Fasuan *et al.* (2017) and (23.85%–28.84%) obtained by Ijarotimi and Keshinro (2012) for complementary food from fermented and germinated popcorn.

The crude fat content of the weaning food diet was 1.50%. This is lower than the recommended fat content (10 – 25%) for complementary diets by WHO/FAO (2004). The result of this study is lower than (4.68 – 21.56%) reported for fat contents of weaning food diets from millet-sesame-Moringa flour blends by Disseka *et al.* (2018). Eboagu *et al.* (2020) also reported 8.00 – 11.00 % for fat contents of fonio millets-soybean flour blends weaning food diet which is higher than those obtained in the current report. The low fat contents of the weaning food diet in the current study is advantageous as it will be less prone to oxidative deterioration which could result in rancidification and spoilage. Dietary fiber assists to fill the stomach for extended time, improves blood sugar and cholesterol levels and helps in ameliorating diseases including bowel cancer, diabetes and heart disease (Iwanegbe *et al.*, 2019). The crude fibre content of the weaning food diet was observed to be 0.35%. This is in consonance with the codex standard (1991) regulation for crude fibre of (<5%) in complementary diets.

Ash is the inorganic residue after water and organic matter have been eliminated through burning food sample (Iwanegbe *et al.*, 2019). The ash content of the weaning food diet was observed to be 2.10%. This is close to the WHO/FAO (2004) and codex standard (1991) for crude ash contents (3 – 5%) of complementary diets. Gemede *et al.* (2020) reported (1.98 – 2.99%) for complementary diets from maize-

pea-anchote flour blends which are in conformity with the findings of the current study. The weaning food in the current report may be rich in mineral elements due to its sufficient ash contents. The carbohydrate content of the weaning food diet was found to be 82.93%. This is higher than the carbohydrate content (60 – 75%) recommended by the Codex standard (1991) for infants foods. Values of 68.02-73.62 % and 63.7-77 % were reported for weaning food from sorghum, mung beans and orange fleshed sweet potato blends and sorghum-cowpea complementary foods by Olaleye *et al* (2020) and Elemo *et al.* (2011) respectively. Carbohydrates are the most important and readily available source of energy. They are also important in brain, heart, nervous, digestive functions and immune system (World Health Organization (WHO), 2008). Therefore, the weaning food in this study is capable of producing the required energy needed for work due to its high level of carbohydrates (Ijeh *et al*., 2010).

Table 1: Proximate composition of optimized complementary food

Proximate Composition (%)	Values	Recommended value
Moisture	6.49	10 – 15% (FAO, 2004)
Crude protein	12.18	15% (Codex standard, 1991)
Crude fat	1.50	10 – 25% (WHO/FAO, 2004)
Crude fibre	0.35	<5% (Codex standard, 1991)
Total ash	2.10	<3 – 5 % (WHO/FAO, 2004; Codex standard, 1991)
Carbohydrate	82.93	60 – 75% (Codex standard, 1991)

Nutritional Quality of complementary Food

The result of the nutritional quality of the complementary diet is as shown in Table 2. Nutritionists have utilized the *in-vitro* method to gain an understanding of how feeds or food are processed or digested by attempting to replicate, with varying degrees of accuracy, the compartments and working conditions found in the digestive tract of the target species (Moyano *et al*., 2015). The *in-vitro* protein digestibility of the complementary diet was 64.80%. This is lower than the values of 84.35 – 87.36 % by Ekwere *et al.* (2017) for *in vitro* protein digestibility of infant food from African yam bean-Bambara groundnut flour blends but closer to 65.4 – 83.8% for weaning foods from rice, soybean, carrot and egg. High *in- vitro* protein presence of food is a good indicator of quality protein (Duru *et al.*, 2020). The *in-vitro* starch digestibility of the weaning diet was 21.80%. This is higher than those obtained by Odenigbo *et al.* (2013) for in vitro starch digestibility of unripe banana (8.3 – 8.7%) and cooking banana (13.89 – 14.3%) respectively but lower than (89.30 – 94.95%) reported by Souilah *et al.* (2014) for *in vitro* starch digestibility of sorghum flours. The relatively high *in vitro* starch digestibility of the weaning diet would be highly beneficial to weaned infants for improved vitality. The gross energy of the weaning food diet was 413.2 Kcal. This conforms to the recommended energy intake (0.6 – 1 kCal) for infants especially at 6 – 8 months and 12 – 13 months respectively (Achidi *et al.*, 2016). However, our value is higher than (344.3 – 368 kCal) reported for weaning foods from rice-legumes flour blends by Lotfy *et al.* (2019), (343.06 – 396.91 kCal/100g) for from cereal-legume-tuber-vegetable-cray fish by Achidi *et al.* (2016) and (1528.18 – 1658 kCal) reported by Famakin *et al.* (2016) for plantain-based functional dough meals supplemented with soybean cake. Variation in values could be attributed to the energy reduction capability of velvet bean used in the current study (Moses and Adebola, 2017; Abioye *et al.*, 2011; Adekunle and Mayowa, 2018). When breast milk intake is lower or the infants have a growth delay, energy intake should be higher, ranging from 0.8 to 1.2 kcal/g (WHO/UNICEF, 1998).

Table 2: Nutritional quality of complementary food

Parameter	Value
In vitro protein digestibility (%)	64.80
In vitro starch digestibility (%)	21.80
Gross energy (Cal)	4132.21
Total sugar (g/100g)	3.29

Total carbohydrate (%)	50.87

The total sugar content was (3.29 g/100g) which was lower than (15.96 g/100g) in weaning food from cowpea-peanut - banana and (34.37 – 38.76 mg/g) for maize-*acha*-sorghum *ogi* fermented for 48 hrs (Bassey *et al.*2013; Malomo *et al*. 2021). However, this result is similar to (1.64 – 5.98%) for germinated brown rice flour Singh *et al.* (2018). Sugars provide a quick, simple source of energy but it does not contain the nutrients such as vitamins and minerals (Malomo *et al.*, 2021). The total carbohydrate content of diet was (50.87%). This is lower than the recommended daily intake for infants (60%) by Food and Agricultural Organization (FAO) (1990) and 65.41 – 71.90% total carbohydrate contents of weaning food prepared from sweet potato and soybean by Haque *et al.* (2013). Although plantain flour is a good source of carbohydrate (78.48%) (Adegunwa *et al.*, 2019), the low total carbohydrate content evident in the weaning diet of this study could be attributed to the inherently higher protein content in the velvet bean (23 – 35%) which is capable of reducing the total carbohydrate content of the blend (Rajiv and Chandrashekharaiah, 2017; Ezeagu *et al*., 2003).

Sensory evaluation of complementary food diet

The sensory properties result for the optimized complementary food and a commercial food brand are presented in Table 3. The commercial brand had the best sensory ratings with respect to all sensory attributes of colour, appearance, taste, mouth feel, viscosity, flavour and overall acceptability. This could be due to the fact that assessors were accustomed to the commercial brands. However, the formulated diet compared favourably to the commercial diet for all sensory attributes giving an indication that acceptable complementary weaning food could be formulated from plantain, velvet bean and crayfish.

Table 3: Sensory evaluation of complementary diet with commercial brand

Sensory attributes	Commercial brand	Formulated diet
Colour	8.50	6.60
Appearance	8.30	6.60
Taste	8.30	7.10
Mouth feel	8.10	6.90
Viscosity	7.60	6.60
Flavor	7.80	7.60
Overall acceptability	8.60	7.50

Conclusion

This study used an optimized flour blend formulation from plantain, velvet beans and crayfish to produce a nutrient-dense complementary diet that met the minimum nutritional standards of macro-nutrients required for infants using simple and adaptable technology. Nutritionally, the complementary flour blend was comparable to established standards. The percent *in-vitro* protein and starch digestibility of the weaning food were similar to some previously formulated complementary foods from indigenous local food crops. The sensory attributes of the formulated diet compared well with the commercial complementary brand and could be exploited to improve the nutritional quality of traditional complementary foods given to infants and growing children in developing countries.

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