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Nutritional quality and microbial density of sweet potato flour fortified with soybean and crayfish flours

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Abstract
Nutritional quality and microbial density of sweet potato based complementary food fortified with soybean and crayfish flours was investigated. Three different samples were produced from mixing sweet potato, soybean and crayfish at different formulation. Sample I, II, III are sweet potato: soybean: crayfish at ratio 80:15:5, 70:20:10 and 60:25:15 respectively. The formulated flours were analysed for proximate composition and microbial density. The result of proximate composition showed that the value of moisture content ranged between 6.50 - 8.50%, while ash content, crude protein crude fat, crude fibre, carbohydrate and energy value ranged from 5.50 – 9.50%, 25.10 – 28.50%, 4.20 – 6.20%, 0.13 – 0.27%, 47.73 – 56.27% and 363.42 – 370.48 Kcal/100g respectively. Its observed that as the level of inclusion of soybean and crayfish to sweet potato flour increases, there was increase in protein and crude fibre content but decrease in carbohydrate content. Also, the total bacteria count, coliform count, yeast and mould count ranged from 28-50 x 10^{-4}, 18-37 x 10^{-4} and 40-62 x 10^{-4} (CFU/g) respectively which are within the recommended limit value for microbial density in food. Therefore, sweet potato flour fortified with soybean and crayfish flour can be recommended as weaning food to reduce the incidence of malnutrition in infants.

Keywords: Flour, fortification, weaning food, malnutrition, infant, composition, quality

Introduction

In many developing countries including Nigeria, protein energy malnutrition (PEM) is endemic. PEM is found to be more among children because they are weaned abruptly into starchy foods. Hunger and malnutrition remain among the most devastating problems facing the majority of the world's population and continue to dominate the health of the world's poorest nations. Nearly 30% of infants and children in the developing world are currently suffering from one or more of the multiple forms of malnutrition [1]. The formulation and development of nutritious complementary foods from local and readily available raw materials has received considerable attention in many developing countries. The commercially standardized foods are generally very good and can help meet the nutritional requirements of young child in both developed and developing countries. However, the development of low-cost, high protein food supplements for weaning infants is a constant challenge for developing countries where traditional foods used during the weaning process are frequently characterized by low nutrient density and high bulk which can adversely affect infants health [2, 3].

In developing countries, 70% of weaning foods are supplied by cereals which are relatively poor source of protein [4]. Formulating and development of nutritious weaning foods from locally and readily available raw materials have received a lot of attention in many developing countries [5]. Apart from protein and energy, Infants diet need calcium, iron and trace elements which can be obtained by combining local staple presently available in the country. Traditional infant foods made of cereals or tubers are known for their high bulkiness and concentrations of fiber and inhibitors anti-nutrients which reduce their nutritional benefits [6, 7]. Cereals and legumes processed into dried products and reconstituted as porridge are widely promoted as complementary food in sub-Saharan Africa by researchers and health organizations. Such food mixes have improved protein and energy contents compared with cereal-only gruel [8].

Complementary foods based on either root or tuber crops have been shown to be significantly lower in phytate (3% to 20%) than cereal- and legume- based foods [9, 10]. A level of 0.01g/100g of phytate has been found in sweet potato [11]. The inhibitory effect of phytate has been shown to be dose-dependent [12], hence the use of sweet potato to process complementary food is likely to result in a product that would be low in phytate. Despite the nutritional benefits to be derived from processing the coloured variety of sweet potato into dried products that could be used as complementary foods for infants in Africa, only a few such formulation have been reported in the literature [12, 14].

Potato is a food crop with potential for partial replacement of cereal in complementary food. Potato flour prepared by low-cost solar dehydration technology has a long shelf life and high nutritional quality, which could be valuable in cereal-based human diets, including bread [15]. Sweet potato flour can serve as a source of energy and nutrients (carbohydrates, beta-carotene, and minerals) and can add natural sweetness, colour, flavor, and dietary fiber to processed food products [16]. Sweet potato (*Ipomoea batatas* (L.) Lam.) is cultivated throughout the tropics and warm temperate regions of the world for its starchy roots, which can provide nutrition, besides energy. The edible tuberous root is either long and tapered, ovoid or round with a skin colour ranging from white, brown, purple or red and the flesh colour ranging from white, pale cream, orange or purple. Besides, the plant is also much valued for its green tops, which are a concentrated source of many essential vitamins and minerals. Although China is the largest producer of sweet potatoes, accounting for more than 80% of the world supply, only 40% of the production is used for human consumption and industrial uses, while, the rest goes as animal feed. Sweet potatoes are considered as one of the most important food crops of man due to the health contributing principle in the tubers and leaves.

Soybeans is rich in protein (40%) and fats (20%) [17]. Soybeans contain moderate quantities of tryptophan and threonine. Soybeans have been used in human and animal nutrition because of their favourable agronomic characteristics, relatively low price, high quality and quantity of protein and oil [18] as well as their important functional properties for the development of different types of food for humans [19]. Crayfish is one of the cheapest sources of animal protein in Nigeria. Fish flesh generally contains mainly water, protein and fat with traces of carbohydrates, amino acids and other non-protein nitrogenous extractives various minerals and vitamins [20]. The fibers of crayfish are shorter than those of other meat, so are easier to digest. It has been observed that most of the complementary foods are supplied by cereals based-product, hence, this research work wants to produce weaning foods from root (sweet potatoes) fortified with soybean and crayfish which are locally available with little or no cost.

Materials and Methods

Samples Collection: The sweet potatoes, soybeans and crayfish used for this study were all purchased from Oja-Oba in Akure, Ondo State.

Processing of Sweet Potatoes

The sweet potatoes were washed to remove soil from the roots. They were then peeled and sliced into smaller pieces. The cubes were immediately immersed in a bath of 1% sodium meta-bisulphite for ten minutes to prevent non-enzymatic browning due to mallard reaction. It was drained and oven-dried at 60^{o}C in a cabinet dryer. It was then dry-milled into powder in a milling machine, sieved and packaged in polythene bag for analysis [21].

Processing of soybeans

Soybeans were sorted for stones, rot and other physical defects. The beans without defects were cleaned, soaked for 3hrs, dehulled and boiled for 15 minutes in order to reduce the anti-nutritional load of the seeds (Salma and Zaidah, 2005). It was then oven-dried at 60^{o}C until constant weight was obtained and milled into powder in a milling machine, sieved and packaged in polythene bag for analysis [22].

Processing of crayfish

Dry crayfish were sorted for stones and other unwanted particles. It was winnowed, washed, drained and oven-dried at 60^{o}C until constant weight was obtained. It was then milled and sieved into fine flour and kept in polythene bag for analysis.

Blend formulation

For the formulation, three different samples (I, II, and III) of sweet potatoes (80, 70, 60%), soybeans (15, 20, 25%) and crayfish (5, 10, 15%) were used.

Proximate composition

The recommended methods of the Association of Official Analytical Chemist (AOAC, 2006) were used for the determination of moisture, crude Fibre (CF), crude Fat (CFT), ash and total nitrogen contents. Crude Protein (CP) was estimated by calculation: (CP = % total N x 6.25) and carbohydrate was calculated by difference (100 - (% protein + % ash + % moisture + % fat + % crude fibre). The energy value was calculated by multiplying carbohydrate and protein by 4 and fat content by 9 and added together.

Microbial analysis

The methods of [23, 24] was used for this analysis. Serial dilutions were made from 1g of each formulated flour samples and dissolved in 9ml of distilled water. Pour plate method was used to estimate the total bacterial count, total coliform count and total mould/yeast count. 1ml of the formulated samples was withdrawn from an appropriate dilution and was placed in a sterile petri dish with the aid of a sterilized Pasteur pipette. The prepared nutrient agar, eosin methylene blue and potato dextrose agar were poured aseptically into each petri-dish by opening the lid of each at an angle of 45^{0}. The lid was closed promptly and swirled to allow even distribution of sample and discrete and distinguishable colonies. The mixture was allowed to set and subsequently incubated at 37 ^{0}C for 24 hours (for total bacteria and coliform count) and 28 ^{0}C for 72 hours.

Results and Discussion

The results of the proximate composition and microbial density of formulated complementary flours from sweet potato, soybean and crayfish are shown in table 1and 2 below.

Table 1: Proximate Composition (%) and Energy (Kcal/100g) Content of Formulated Diets

Diets	Moisture	Ash	Crude Protein	Crude Fat	Crude Fibre	Carbohydrate	Energy
I	$6.50^b \pm 0.34$	$5.50^b \pm 0.91$	$25.10^a \pm 1.30$	$5.00^a \pm 0.13$	$0.13^a \pm 0.01$	$56.27^a \pm 3.45$	$370.48^a \pm 21.14$
II	$8.50^a \pm 0.73$	$7.00^b \pm 0.34$	$26.75^a \pm 1.21$	$4.20^a \pm 0.22$	$0.19^a \pm 0.05$	$54.86^a \pm 0.58$	$364.24^a \pm 18.31$
III	$7.50^a \pm 0.45$	$9.50^c \pm 0.43$	$28.50^b \pm 1.59$	$6.50^b \pm 0.36$	$0.27^b \pm 0.13$	$47.73^b \pm 1.28$	$363.42^a \pm 19.11$

Values with different superscripts in each column are significantly different ($p < 0.05$)
Key: I = Sweet potato: soybean: crayfish (80:15:5); II = Sweet potato: soybean: crayfish (70:20:10); III = Sweet potato: soybean: crayfish (60:25:15)

Table 2: Microbial Density of the Formulated Complementary foods

Sample	Total Bacteria Count (cfu/g)	Total Coliform Count (cfu/g)	Total Yeast and Mould Count (cfu/g)
I	28 x 10^{-4}	21 x 10^{-5}	57 x 10^{-4}
II	39 x 10^{-4}	37 x 10^{-5}	40 x 10^{-4}
III	50 x 10^{-4}	18 x 10^{-5}	62 x 10^{-4}

I = Sweet potato: soybean: crayfish (80:15:5); II = Sweet potato: soybean: crayfish (70:20:10); III = Sweet potato: soybean: crayfish (60:25:15)

The result obtained in Table 1 showed the proximate composition of the formulated complementary foods from sweet potato, soybean and crayfish flours at different ratios. The crude protein, ash, crude fibre, fat, moisture (dry basis), carbohydrates and energy ranged from 25.10 – 28.50%, 5.50 – 9.50%, 0.13 – 0.27%, 4.20 – 6.20%, 6.50 – 8.50%, 47.73 – 56.27% and 363.42 – 370.48 Kcal/100g respectively. The moisture contents are within FAO/WHO recommended value (5-10%) which is a safe limit. Moisture content of food is an important index of their susceptibility to microbial spoilage. When the moisture content is on the high side, it encourages the growth of microorganisms [25]. Moisture content would therefore indicate low growth of bacteria and fungi [25]. This thus predisposes such food to degradation and enhances its perishability.

Ash contents of all the formulated diets were high. World Health Organisation recommends (5%) ash content for weaning diets. Although ash content of all formulated diets was higher than recommended (5%) value by WHO except for sample II (sweet potato-soybean-crayfish) at ratio (70:20:10) which is slightly above the recommended range (5.50). This might be due to the inclusion of crayfish, an animal product in the diets and hence a high level of mineral elements in these diets.

The protein contents of the samples increased from 25.10 – 28.50% (Table 1) with the increase in the percentage of the soybean flour (15 – 25%) and crayfish flour (5 – 15%) (Table 1), rendering them valuable nutrient sources. The recommended protein content (grams of protein per 100 Kcal of food) for complementary foods is of 0.7g/100 Kcal, from 5 to 24 months. In most countries, the protein requirements of infants are met when the energy intake is appropriate except if there is a predominant intake of low-protein foods [26]. According to the Protein Advisory Group, guidelines for weaning foods should be 20% of proteins [27] but in this study, the formulated diets have higher protein than recommended value and diets with these high contents of protein can be useful not only for weaning children but also for children already suffering from protein energy malnutrition (PEM).

The crude fat value ranged from (4.20 – 6.50%) and this fall within the recommended range which is 10%. low fat content in the diets may be necessary to prolong its shelf life also by avoiding lipids peroxidation [28]. Lipids in complementary foods should provide approximately 30 to 45% of the total energy required [29] which is enough to guarantee the adequate intake of essential fatty acids, good energy intake and uptake of fat-soluble vitamins [26] The high percentage of crude fat could be attributed to the inclusion of oil-dense soybeans in the diet. This attribute tends to agree with the recommendations by FAO/WHO [30] that vegetable oils be included in foods meant for infants and children, which will not only increase the energy density, but also be a transport vehicle for fat-soluble vitamins [31].

The crude fibre contents of the samples (ranged from 0.13 – 0.27%) were generally low and these values were comparable with previous findings [32]. The low crude fibre contents of the samples make them digestible foods especially for children [33]. Low fibre content in food enhances nutrient availability. The carbohydrate contents (47.73 – 56.27%) of the samples decreased with increase in soybean and crayfish flours. Also, as the level of sweet potato inclusion reduce, the carbohydrate content reduces and sample III (sweet potato-soybean-crayfish at ratio 60:25:15) has the least carbohydrate content. It is important to have an easily or readily digested carbohydrate to avoid using proteins as source of energy [34].

The energy contents of all formulated diets were adequate. The recommended energy intake of complementary foods varied according to the age of the infants, and depends on how much breast milk, and the frequency at which they are fed with complementary foods [35]. According to [36], weaning foods must have high energy content, low viscosity, balanced protein (containing all essential amino acids, vitamins (particularly A, D and B group), minerals, iron, folic acid, calcium), pleasant taste and with no anti-nutritional components.

Table 2 showed the total microbial load of infant flours produced from sweet potato-soybean-crayfish at different levels of formulation. The total bacteria count ranged between 28 – 50 x 10^{-4}cfu/g in which sample III has the highest (50 x 10^{-4}cfu/g) and sample I has the lowest (28 x 10^{-4}cfu/g). The total coliform count ranged between 18 – 37 x 10^{-5}cfu/g). Sample II has the highest value (37 x 10^{-5}cfu/g) followed by sample I (21 x 10^{-5}cfu/g) and sample III has the lowest value of 18 x 10^{-5}cfu/g.

The total yeast and mould count ranged between (40 – 62 x 10^{-4}cfu/g) in which sample III has the highest value (62 x 10^{-4}cfu/g) followed by sample I (57 x 10^{-4}cfu/g) and sample II has the value of (40 x 10^{-4}cfu/g). In this research work, high counts were obtained for mould and yeast but a food product for consumption should have microbial count below 10^5cfu/g. The international microbiological standard recommends a bacteria contaminants limit of less than 10^6cfu/g for food [37]. The presence of coliform count could be of public health risk to the consumers even at the low count. The high microbial density of most products can be accounted for due to poor and unhygienic processing environment, poor running water for washing and dilution.

Conclusion

Roots and tubers though very poor in some major nutrients are potentials crops for the formulation of adequate weaning foods. It is important to begin to explore the possibility of their use in weaning food formulation because the commercial weaning food is gradually getting out of the reach of the average people in most developing countries. This study showed that sweet potato, soybean and crayfish flour blends have good nutritional quality. The nutritional composition data showed that the various blends are suitable for use as complementary infant flour and a potential weaning food of good nutritional quality. However, the microbial density of the samples show that it was still within the acceptable limit according to the standard recommended by the International Commission for Microbiological Specification of flour.

References

1. ACC/SCN. Second Report on the World Nutrition Situation, 1997, 234-249.
2. Aworth OC. Exploration and Exploitation of Indigenous Technology for the growth of the Food and Beverage Industry - An overview paper presented at the 17th Annual Conference of the Nigerian Institute of Food Science and Technology, Ilorin, 1993.
3. FAO. Sorghum and Millet in Human Nutrition. FAO, Food and Nutrition Series Rome, Italy. 1995; 27:1.
4. Glover DV. Improvement of protein quality in maize, In: Wilke HL, Ed improving the nutrient quality of cereals. Washington, DC: AID, 1976, 69-97.
5. Plahar WA, Annan NT, Development of balanced protein-energy weaning foods based on local legumes and cereals Report submitted to the Association of African Universities by Food Research Institute. Accra, Ghana, 1994.
6. Morgam R, Mirtzner N, Scrimshaw N. Improving the nutritional status of children during weaning period, HOVIPREP (Home-and Village-Prepared Weaning Foods). Massachusetts Institute of Technology, Cambridge, MA, USA, 1984.
7. Montemayor NR, Notario JN. Development of food products using soybean and root crop flours. CMU Journal of Agriculture and Food Nutrition. 1992; 4(3):274-288.
8. Golder PC, Hossain MA, Altaluri S, Ilangantileke S. Home scale processing of sweet potato. In: 2nd International symposium on sweet potato and cassava, Kuala Lumpur, Malaysia, 2005, 165-166.
9. Gibson RS, Anderson VP. A review of interventions based on dietary diversification or modification strategies with the potential to enhance intakes of total and absorbable zinc. Food Nutrition Bull. 2009; 30:5108-43.
10. Lukmanji Z, Hertzmark E, Mlingi N, Assey V, Ndossi G, Fawzi W. Tanzania food composition tables, 1st ed. Dares Salaam: Muhimbili University of Health and Allied Science/Tanzania Food and Nutrition Centre/Harvard School of Public Health, 2008.
11. Ukom A, Ojimelukwe P, Okpero D. Nutrient composition of select sweet potato [(*Ipomoea batatas* (L. law)] varieties as influences by different level of nitrogen fertilizer application. Pakistan J Nutrit. 2009; 8(11):1791-1795.
12. Iwe MO. effects of extrusion cooking on functional properties of mixtures of full – fat soy and sweet potato. Plant Foods Hum Nutr. 1998; 53:37-46.
13. Iwe MO, Zuilichen DJ, Stolp W, Ngoddy PO. Effect of extrusion cooking of soy-sweet potato mixtures on available lysine content and browning index of extrudates. Journal of Food Engineering. 2004; 62(2):143-150.
14. Kabira JN, Imungi JK. Possibility of incorporating potato flour into the traditional Kenya foods, African Study Monographs. 1991; 12(4):211-217.
15. Idolo I, Sensory and nutritional quality of Madiya produced from composite flour of wheat and sweet potato, Pakistan Journal of Nutrition. 2011; 10(11):1004-1007.
16. Ibironke SI, Fashakin JB, Badmus OA. Nutritional Evaluation of Complementary Food Developed from plant and animal protein sources. Nutrition and Food Science. 2012; 42:2:111-120.
17. Liu K. Expanding soybean food utilization, Journal of Food Technology. 2000; 54(7):46-58.
18. Ossai G, Malomo O. Nutritional and sensory evaluation of a new cereal/legume weaning food. Nig. Food J. 1988; 6:23-29.
19. Van-Oirschort Q, Rees D, Aked J. Sensory characteristics of five sweet potato cultivars and their changes during storage under tropical condition. Food Qual. Prefer. 2003; 14:673-680.
20. Ahmed M, Akter S, Eun J. Peeling, drying temperatures, and sulphate-treatment affect physicochemical properties and nutritional quality of sweet potato flour. Food Chem. 2010; 121:112-118.
21. Salma O, Zaidah I. Sweet potato for the production of nutritious food products. In: 2nd International Symposium on sweet potato and cassava, Kuala Lumpur, Malaysia, 2005, 223-224.
22. Egounlety M. Production of legume-fortified weaning foods. Food Res. Inter. 2002; 35:233-237.
23. AOAC. Association of Official Analytical Chemists Official Methods of Analysis Association of Official Analytical Chemist, 18th ed. Washington D.C, 2006.
24. Cheesbrough M. Medical laboratory manual tropical, edition Dodington, Cambridgeshire England, 2003; 146-216.
25. Temple VJ, Badamos EJ, Ladeji O, Solomoro M. Proximate and chemical composition of three locally formulated complementary foods, West Africa. J Biol Sci. 1996; 5:134-143.
26. WHO/UNICEF. Complementary feeding of young children in developing countries: a review of current scientific knowledge. Geneva: World Health Organization, WHO/NUT/. 1998; 98:1.
27. FAO/WHO. Preparation and use of Food-Based Dietary Guidelines: Report of Joint FAO/WHO Consultation technical report series 880. Geneva, FAO/WHO/UNICEF Protein Advisory Group, 1998.

28. FAO/WHO/UNU. Preparation and use of Food-Based Dietary Guidelines. Report of a Joint, 2002.
29. Eka BE, Abbey BW. Akaninwor JO. Nutritional Evaluation of some traditional weaning foods from Akwa Ibom State, Nigeria. Nigerian Journal of Biochemistry and Molecular Biology. 2010; 25(1):65-72.
30. Nandutu A, Howell N. Nutritional and rheological properties of sweet potato based infant food and its preservation using antioxidants; African. J. Food Agricult. Nutrit. Develop. 2009; 9(4):1076-1090.
31. Kikafunda FK, Walker FA, Abeyasekera S. Optimising viscosity and energy density of maize porridges for child weaning in developing countries. Int. J Food Sci. Nutr. 1997; 48:401-409.
32. Low JW, Arimond M, Osman N, Conguara B, Zano F, Tschirley D. A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and Serum Retinol Concentrations in Young Children in Rural Mozambique. American Soc. Nutrit. 2008; 137:1320-1327.
33. Ohiokpehai O. Food processing and nutrition: A vital link in agricultural development. Pak. J Nutr. 2003; 2:204-207.
34. Amagloh FK, Hardacre A, Mutukumira AN, Weber IJ, Brough L, Coad J. Sweet potato-based complementary food for infants in low-income countries. Food Nutrit. Bull. 2012; 33(1):3-10.
35. Annan NT, Plahar WA. Development and quality evaluation of a soy-fortified Ghanaian weaning food. Food Nutr, Bull. 1995; 16:263-269.
36. Chellammal S, Prema L. Feasibility of developing extruded food products based on cassava and sweet potato. In: Kurup G.T, Palaniswami, M.S, Potty, V.P, Padmaja, G, Kabeerathumma S, Pillai, S.V (Eds), 1996.
37. Nandutu AM. Biochemical, physic-chemical and nutritional properties of sweet potato (*Ipomoea batatas*) and its processing into an infant weaning food. Ph. D. Thesis, University of Surrey UKm, 2004.