

Complementary Food Formulation Extruded from Defatted Ground Paste for Infants between Six to Twenty-Four Months in Mubi Metropolitan Area of Adamawa State, Nigeria

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Abstract

Nowadays, food treatment technologies are constantly evolving due to increasing demand for healthier and tastier food with longer shelf lives. The transition from realistic breast feeding to formal foods referred to as complementary transient feeding of infants between 6-24 months of age, which is vulnerable. Kunun gyeda, is popular in the northern part of Nigeria as supplementary food. However, groundnut defatted groundnuts is very unpopular in this regard. Therefore, the aim of this study is to investigate the nutritional potentials embedded in this underutilized food in complementary feeding. Sorghum, sweet potatoes, defatted groundnut and tamarind were bought at Mubi market. The groundnuts was heated and blended into 3 ratios, later reduced to 10% moisture content. The normal kunun gyeda (porridge) was used as the control to the formulated blended which were analyzed using standard methods. The carbohydrate showed no significant difference with values 67.45, 65.79 and 63.79 for respective sample. The three samples were mixed in 3 different ratios of: 50%, 15% and 35% for sample 1: 50% 20% and 30% for sample 2 lastly 50%, 25%, and 25% as sample 3 that is for sorghum, sweet potatoes, and defatted groundnut cake respectively. Sensory evolution results, Proximate composition, Minerals analysis, extruded blend and the control all have shown significant differences. Based on the result, the use of defatted groundnut should be recommended and encouraged.

Keywords: Infants, Breast Feeding, *Kunun Gyeda*, Groundnuts, Food, Carbohydrate.

Introduction

Africans believe that breastfeeding facilitates a strong bond between a mother and her child. Some Africans have a strong belief in the power of the breast milk; that a woman is capable of blessing or casting a spell on a child with its power (Olabisi *et al*; 2021, WHO; 2001). Around the age of 6 months, an infant's need for energy and nutrients starts to exceed what is provided by breast milk, and complementary foods are necessary to meet those needs. An infant of this age is also developmentally ready for other foods. This transition is referred to as complementary feeding (Kathy, 2010). Infants should be

exclusively breastfed for the first six months of life to achieve optimal growth, development and health (WHO; 2001). Thereafter, to meet their evolving nutritional requirements, infants should receive nutritionally adequate and safe complementary foods while breastfeeding continues for up to two years of age or beyond (Difo, 2014, PAHO and WHO; 2003).

Presently, food treatment technologies are constantly evolving due to an increasing demand for healthier and tastier food with longer shelf lives (Viola *et al*; 2022). Human breast milk contains carbohydrates, protein, fat, vitamins, minerals, digestive enzymes and hormones. In addition to these nutrients (Gura, 2014). It is rich in immune cells, including macrophages, stem cells, and numerous other bio-active molecules (Walker, 2013) The first year of life is a period where infants undergo rapid growth and when good nutrition is crucial (WHO, 2001).

Nutrition in the early years of life is a major determinant of healthy growth and development throughout childhood. Breast milk is the ideal food for infants during the first six months of life (Likhar and Patil, 2022). This contains substances that cannot be reproduced artificially, and its overall nutrient composition is superior to any alternative. In spite of its superiority, breast milk cannot provide all of the nutrients and calories that allow infants to thrive after six months of life (Likhar and Patil, 2022).

Every infant should continue to receive breast milk for at least the first year, preferably for the second, when infants demand more nutritious foods to be added. Infants are gradually introduced to different types of semi-solid complementary foods, which helps in the transition from a diet centered on breast milk (Musalli *et al*; 2021). This period helps the children slowly become accustomed to eating adult-type foods and familiarizes them with a wide range of tastes. Usually, an infant begins the transition from liquid to solid foods with the introduction of infant cereals (Perkin *et al.*, 2015).

The formulated extruded product is an instant diet, useful in emergency situations and rural areas that will need nutrition intervention. The investigation normally used in the northern part of Nigeria as a complementary food is mostly Kunun-gyeda. However, the de-fated groundnut paste, Tunkunsa, is being used instead, along with fortified sweet potatoes, to add value to taste, aside from the other nutrient implications involved. The extrusion makes the diet an instant type, coupled with its ease and convenience both in preparation and transport (Camilia *et al.*, 2016)

High-temperature short-time (HTST) processes usually reduce microbial contamination and inactivate enzymes. Also, it facilitates the elimination of anti-nutritional factors in products that are in a dry state with typically low water activity and do not require refrigeration storage. In a typical region like Africa, these products are suitable for infrastructure because the cold supply chain is inadequate (Fill *et al.*, 2010).

Extrusion technology is central to value addition to agricultural commodities, especially cereals/legumes, to enhance food security and sustainable development. It is a powerful processing operation, which can produce products with unique textural properties having high and low density, as well as highly expanded and condensed products, depending on the processing condition. Extrusion is a process that combines several unit operations, including mixing, cooking, kneading, shearing, shaping, and forming (Kalep *et al* 2014). If developing economies are to eradicate poverty and achieve food and nutrition security, more effort is needed in harnessing extrusion technology for producing safe food utilizing locally grown legumes and cereal grains (Kalep *et al*; 2014).

Objectives

- i. To formulate three different combinations of extruded products.
- ii. To analyse the nutritive compositions of porridge (kunun gyada), which serves as the most popular native complementary cereal preparation.
- iii. To explore the nutritional composition of the underutilized defatted groundnut paste fortified with sweet potatoes in place as an alternative to the normal kunun gyeda.

Materials and Methods

Material

The material used in this study were red sorghum (*S. bicolor*), dehydrated groundnuts (*Arachis hypoges*), Orange flesh sweet potato floor (*Upomea batata*) and unripen matured crushed and dehydrated tamarind (*Tamarindus Indica*) were all purchased at the Mubi main market Adamawa state Nigeria.

Preparation of kunun gyada porridge which was made from sorghum floor groundnut paste and a quality of tamarind juice was prepared in the Nutrition and dietetics laboratory of the Federal Polytechnic, Mubi. This is locally and generally practiced in Northern part of Nigeria by means of cooking where fire woods were used as fuel.

Extrusion: the extrusion was carried out using a Twin Screw Extruder: SLG65 by Jimin Saitaino State Technology Development Company limited China.

Table 1. combination ratios of the extrude were:

The ratios of the extrude	Sorghum floor	Sweet potato floor	Defatted g/nut flour cake
1 st	50% (1000g)	15 % (300g)	35 % (700g)
2 nd	50% (1000g)	20 % (400g)	30 % (600g)
3 rd	50% (1000g)	25 % (500g)	25 % (500g)

Proximate analysis: The proximate analysis was carried out on the fresh sample. The analysis includes the moisture content, total ash, crude protein, fat, and crude fibre were determined by AOAC (1997), carbohydrate content was determined by simple difference ((Kingsely *et al*; 2019, Onimawo and Egbekun, 1998). Energy content was calculated using the AT-water formula. Vitamin C was determined by titrimetric method of AOAC (1990) and vitamin A by AOAC (1985).

Sensory evaluation: The formulated product and control were evaluated for colour, flavour, texture, taste, and general acceptability using the 9-point-Hedonic scale (Kortei *et al*; 2020, Ihekoronye and Ngody 1985).

Elemental analysis: Elements such as copper (Cu), iron (Fe) potassium (K), sodium (Na), magnesium (Mg), zinc (Zn) and calcium (Ca) were determined using the atomic absorption spectrophotometer (AAS).

Anti-Nutrient analysis: Some anti-nutrient factors such as oxalate, phytate and tannin were determined by Folin-Denis spectrophotometer described by Pearson 1976 for tannin, oxalate by method described by (Kingsely *et al*; 2019) and phytate by method described by Iwe (2003).

Statistical analysis: All results obtained from the analysis were subjected to the statistically package for social science (SPSS) version.

Results and Discussions

Table 1: Results of the sensory Evaluation of the extruded blend and the control.

Ratios of extruded treatment	Colour	Flavour	Taste	Texture	General
1 st	1.91 ± 0.85 ^a	2.29 ± 1.38 ^a	2.40 ± 1.31 ^a	2.40 ± 1.19 ^a	1.97 ± 0.86 ^a
2 nd	2.14 ± 1.00 ^a	2.69 ± 1.30 ^{ab}	2.66 ± 1.13 ^a	2.83 ± 1.20 ^b	2.29 ± 1.06 ^a
3 rd	2.94 ± 1.28 ^b	3.23 ± 1.33 ^{bc}	3.09 ± 1.79	3.09 ± 1.22 ^{ab}	3.17 ± 1.47 ^b
control	2.43 ± 1.52 ^a	3.54 ± 1.80 ^c	4.06 ± 2.29 ^b	3.14 ± 1.54 ^b	3.54 ± 1.70 ^b

Mean along the column with different alphabetical superscript indicate significance difference ($p < 0.05$).

The sensory evaluation result of its statistical analysis for the extruded formulated blend was compared with control. In terms of the colour, the result has no much significant difference with (1.91, 2.14, and 2.43) to control as shown in Table 1. The result liked moderately covers the secure with only the 3rd extruded ratios produce 2.94 is significantly different. In the flavour result, the 1st and 2nd extruded blend product showed no significant difference (2.29 and 2.69 respectively) falling under the category liked against the 3rd extruded blend product

(3.23) and the control (3.54) which shows no significant different. The taste result showed that extruded blend product formulated showed a significant difference ($p < 0.05$) with control, where 1st 2nd and 3rd scores are 2.40, 2.66 and 3.09 respectively liked moderately for first two samples and liked slightly for the third formulated blend product. But the control falls under then category neither like or dislike. The texture results showed the first two formulated blend having 2.40 and 2.83 scores respectively falling under the category "like moderately" whereas the 3rd formulated blend product and the control with values 3.09 and 3.14 respectively fall under the category "like slightly". Generally, acceptability of the statistical analysis results for sensory evaluation showed significant differences between the extruded formulated blend product and the control. Acceptability of the sample was dependent on organoleptic feature of the complementary food such as appearance, taste, colour and texture (Birch 1998).

Table 2: Proximate composition results of the extruded blend and the control.

Ratios of extruded treatment	Carbon %	Moisture %	Ash %	Crude fibre %	Fat %	Crude protein %	Dry matter %
1 st	67.46 ±2.33 ^b	8.20 ± 0.57 ^a	3.32 ± 0.17 ^c	2.08 ± 0.17	5.28 ± 0.17 ^a	17.22 ± 1.99 ^a	52.80 ± 2.55 ^b
2 nd	66.79 ±4.54 ^b	8.25 ± 0.35 ^a	2.95 ± 0.07 ^b	2.09 ± 0.13	5.49 ± 0.37 ^a	17.30 ± 0.42 ^a	55.30 ± 4.69 ^b
3 rd	63.79 ±3.27 ^b	8.32 ± 1.11 ^a	2.93 ± 0.04 ^b	1.77 ± 0.68	5.74 ± 0.71 ^a	8.25 ± 0.74 ^b	21.10 ± 0.71
Control	45.71 ±6.21 ^a	70.90 ± 3.32 ^b	0.59 ± 0.58 ^a	0.09 ± 0.01	3.55 ± 0.92 ^b	8.25 ± 0.74 ^b	21.10 ± 0.71

Mean along the column with different alphabetical superscript indicate significance difference ($p < 0.05$).

In terms of protein, the result shows no significant difference between the formulated extruded blend but has significant difference compare with the control which has the least value of the difference could be attributed to the concentration of protein after fat extraction, thereby making the product, protein dense. This judicious combination of complementary foods from local staple, protein requirement for infant 9.191g/days for the first 6 months and 13.5g/day for the next few months (Lutz and Przyluski, 2008).

For carbohydrate content, in table 4 shows no significant difference between the 3 formulated sample of the extrude where formulated products thus meet the carbohydrate requirement for infants which is 60.9g/day (Lutz and Przyluski, 2008). There is a significant

difference when compared with the control which has the least value of 45.7 thereby falling below required standard.

Dry matter which speak of nutrient density shows no significant difference between extrude blends, 52.8, 55.3 and 54.1, while control has the least value of 21.1 with a wide significant difference to the formulated extruded blends. This could be attributed to the nutrient density of the formulated product. The defatted groundnut cake flour added to its nutrient density and the fortification much sweet potato also added to the nutrient density. These make up product is better in terms of dry matter compared to control.

In terms of moisture content, the formulated extrude blends of sorghum flour, defatted groundnut cake flour, tamarind, fortified with sweet potato flour, with values 8.20, 8.25 and 8.32 for the 1st, 2nd and 3rd sample respectively, showed no significant difference ($p < 0.05$) and all fall within the maximum allowable value for moisture content of food materials e.g. flour is 13% (Badamosi *et al.* 1996). The low moisture content of food product helps to extend the shelf life of those products and sustain the quality (Juliano, 1993). Formulated extruded blends products shows better than the control which has 70%, moisture content value, thus the formulated extruded blends show a better shelf-life stability that could be used in distant places with convenience, safety and ease when compared with the control. The crude fibre shows no significant difference among the formulated extrude but there exist a significant when compared with the control which has the least value of 0.09, while formulated extruded blends values are 2.08, 2.09, and 1.77 respectively which has meet findings of USDA-ASES, (1997) and states that the maximum accountable value of crude fibre in weaning foods is between 1.7% to 3.5%. The crude fibre is important in complementary food and keeps the infant healthy. This is achieved by adequate blending of local food which result in purpose nutrient intake and prevent malnutrition problem (Ogazi, 1996). The result obtained from the extruded blends is also similar to that found in Nestle Cerelac which is 2.3g.

Table 3: Minerals analysis results of the extruded blend and the control.

Ratios of extruded treatment	Sodium (Na) %	Calcium (Ca) %	Magnesium (Mg) %	Potassium (K) %	Phosphorus (P) %	Nitrogen (N) %	Zinc (Zn) %	Iron (Fe) %
1st	0.49 ± 0.15	2.00 ± 0.00	0.44 ± 0.09	1.03 ± 0.28	0.49 ± 0.16	2.2 ± 0.26 ^b	11.60 ± 0.59 ^a	75.20 ± 0.07 ^c
2nd	0.22 ± 0.05	2.21 ± 0.57	1.09 ± 0.55	0.62 ± 0.09	0.73 ± 0.04	4.05 ± 0.21 ^c	11.30 ± 1.56 ^a	21.42 ± 0.88 ^b
3rd	0.44 ± 0.01	1.50 ± 0.14	0.79 ± 0.26	0.55 ± 0.01	0.56 ± 0.29	2.56 ± 0.06 ^b	23.33 ± 1.17 ^c	22.29 ± 0.64 ^b
Control	0.49 ± 0.07	2.10 ± 0.14	0.61 ± 0.17	0.19 ± 0.00	0.39 ± 0.00	1.12 ± 0.19 ^a	14.95 ± 0.78 ^{ab}	10.60 ± 0.49 ^a

Mean along the column with different alphabetical superscript indicate significance difference ($p < 0.05$)

The minerals analysis result shows no statistical difference observed between the control the extruded blends products for Na, Ca, Mg, K, and P but there is significant difference ($p < 0.05$) for N, Zn, Fe and vitamin A, where the formulated extruded blends have higher values compared with the control. For example, the desire complementary food is 4mg (6-12 months) and 2.4mg (9-12 months) WHO, (2000). The extruded blends result showed higher value of 25.2, 21.42 and 22.29 respectively. This implies an adequate supply of the mineral to an infant with gastric capacity of 250g upon feeding in an amount sufficient to fill the gastric capacity of the infant.

Table 4: Vitamins analysis results of the extruded blend and the control.

Ratios of extruded treatment	Vitamin C, mg/100g	Vitamin A, mg/100g
1 st	18.20 ± 0.85 ^{ab}	15.48 ± 0.45 ^{ab}
2 nd	15.55 ± 2.11 ^b	23.45 ± 1.63 ^{bc}
3 rd	14.68 ± 1.64 ^b	24.15 ± 6.08 ^{bc}
Control	14.96 ± 2.49 ^b	1.93 ± 2.65 ^a

Mean along the column with different alphabetical superscript indicate significance difference ($p < 0.05$).

Values for vitamin A is found higher (15.48, 23.45, and 24.15) for 1st, 2nd and 3rd formulated extruded blends respectively when compared to control which was 1.93. The higher values obtained could be attributed to the fortification of the diet with sweet potato flour, implying adequate supply of the vitamin to an infant upon an adequate feeding in an amount enough to fill the gastric capacity of the infant. The vitamin requirement for the infant 6-8 months old is 5mg and 9-12 months old is 9mg (WHO, 2000).

The desired calcium density of complementary foods is 125mg for a 6-8 months and 75mg for 9-12months old infant (WHO, 2000). The results for both control and extrude blends products falls below the infant requirement.

Table 5: Anti-Nutrient composition of the extruded blend and the control.

Ratios of extruded treatment	Tannin mg/100g	Phytate mg/100g	Oxalate mg/100g
1 st	0.16 ± 0.12	0.14 ± 0.02	0.33 ± 0.00
2 nd	0.16 ± 0.16	0.09 ± 0.01	0.33 ± 0.09
3 rd	0.10 ± 0.09	0.15 ± 0.06	0.26 ± 0.21
Control	0.02 ± 0.00	0.19 ± 0.16	0.33 ± 0.26

Mean along the column with different alphabetical superscript indicate significance difference ($p < 0.05$).

There was no significant difference for the anti-nutrient (phytate, tannin and oxalate) between control and extruded blends as shown in Table 5. This implies that the products are has a good bio-availability for the infant.

Conclusion

This study, titled; Complementary Food Formulation Extruded from defatted ground paste for infants between six to twenty-four months in Mubi Metropolitan, Adamawa State - Nigeria. Has been carried out successfully. The sensory evaluation result of its statistical analysis for the extruded formulated blend was compared with control. In terms of the colour, the result has no much significant difference with (1.91, 2.14, and 2.43) to control as shown in Table 1 Table 2 revealed the importance of crude fibre formulated extruded blends values were 2.08, 2.09, and 1.77 respectively, as reported in literature that the maximum accountable value of crude fibre in weaning foods is between 1.7% to 3.5%. Values for vitamin A is found higher table 3, (15.48, 23.45, and 24.15) for 1st, 2nd and 3rd formulated extruded blends respectively when compared to control which was 1.93. The higher values obtained could be attributed to the fortification of the diet with sweet potato flour, implying adequate supply of the vitamin to an infant upon an adequate feeding in an amount enough to fill the gastric capacity of the infant. While, the extruded blends result in table 4, showed higher value of 25.2, 21.42 and 22.29 of Vitamins. The results show no significant difference in terms of carbohydrate with values 67.45, 65.79 and 63.79 for respective sample. The three samples were mixed in 3 different ratios of: 50%, 15% and 35% for sample 1: 50% 20% and 30% for sample 2 lastly 50%, 25%, and 25% as sample 3 that is for sorghum, sweet potatoes, and defatted groundnut cake respectively. Sensory evolution results have shown significant differences to control (table 1). Proximate composition results of the extruded blend and the control also have shown significant differences (table 2). Minerals analysis results of the extruded blend and the control shown significant difference (table 3) and based on the result, the use of defatted groundnut should be encouraged.

Recommendations

- Infant breast feeding mothers should alternate to a formulated extruded ground nut paste.
- The Nutritionist Dietetics of Nigeria should make awareness to infant breast feeding mothers
- The use of defatted groundnut should be encouraged

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Conflict of Interest

Authors declare no conflict of interest.

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