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FORTIFIED CORN-FLOUR FEED AS INFANT FORMULAE SUBSTITUTE

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The corn-flour feed varieties commonly consumed in Nigeria were fortified with dry white crayfish *(Pinnens notialis)*, red crayfish *(Macrobrachium macrobium)* and Tilapia. Eight different brands of popular infant formulae and the fortified corn meals were analysed for fats, protein, carbohydrates and nutritionally valuable minerals. Results obtained showed low fat, protein and carbohydrate values in the corn flour infant meal. However, on fortification, corn-flour meal - crayfish blends (4:1) compared favourable well with commercial infant formulae in terms of the fat, protein, carbohydrate and mineral elements. These results including the cost analysis of the fortified meal vis-a-vis the commercial infant feeds were discussed.

Key words.: Corn-flour, Infant, Fortified-meal, Crayfish, Tilapia.

Introduction

Infant formulae have become culturally acceptable as part of the diet [1]. In some developing countries of the world, however, most low income workers who cannot afford the high cost of commercial infant formula have resorted to the use of corn flour varieties as substitute. This is because the corn flour varieties are cheaper and readily available. The inadequacy of food for infants and children during the weaning period continues to be a major problem in developing countries. If growing children do not have sufficient protein in addition to sufficient energy intake, they may suffer growth restriction, protein energy malnutrition and mental retardation in severe cases [1].

In Nigeria, all mothers breast feed their babies at least for the first 3 months of life, unless there is circumstances which prevent this [2]. Some infants sustain excellent growth over the first 9-12 months of life despite breast milk being their source of nutrition [3,4].

Most infants however, fail to show satisfactory growth after 4-6 months unless flour intake is supplemented with other foods [5]. The infant formulae (milk) substitutes are very expensive and women from low income group in Nigeria tend to reduce the level of intake or neglect totally by shifting to very cheap alternatives.

Several liquid supplements have been prepared from soyabean *(Glycine max)* in Asia and have now been commercialized in the U.S.A. The most common infant formulae substitute among the low income group in Nigeria is corn-flour feeds prepared locally from cereals (maize and millet). This substitutes have been found to be deficient in a number of nutrients [6].

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Cowpea *(Vigna anguiculata)* are widely grown in Nigeria and their nutritional value has been well established [7,8]. Also there is low production of soybeans in Nigeria and their use in soy-milk and soy-beverage is limited and expensive.

In our earlier studies, corn-flour feeds were found to be unsatisfactory as supplements for infant feeds because of deficiency in certain nutrients [6]. The present investigation is aimed at the preparation of infant feeds using locally available, cost effective and nutritionally acceptable raw materials. Corn-flour meals have been fortified with different species of crayfish (white and red) and dried fish. A comparison of these feeds was made with commercially available feeds. It is hoped that this study could lead to the production of low cost infant feeds which majority of low income group in Nigeria can afford.

Materials and Methods

Eight brands of infant formulae were purchased from supermarkets in Nigeria for comparative analysis. The corn flour feeds were produced by the traditional wet milling process. The flours were dried thoroughly to sustain the textures. All the samples were preserved in the refrigerator at 4° prior to analysis. The crayfish and Tilapia samples were dried in an oven at 80° for 24 hrs and pulverised separately with a christy laboratory mill. The ground products were weighed and cost analysis was carried out per 100 g of the material.

Crude protein was determined by the semi-micro Kjedahls method. Fat was determined gravimetrically, after Soxhlet extraction with petroleum ether and subsequent evaporation to dryness on the stem bath [9]. Total carbohydrates were determined by the official methods of the AOAC [9] and the Clegg method [10].

The materials were determined by weighing 2 g of each of the sample in a clean dry silica crucible and redried at 104° for 16 hrs.

The residual white ash was dissolved in 5 cm^3 concentrated nitric acid. This was quantitatively transferred into 250 cm^3 volumetric flask, 5% w/v Lanthanum solution (10 cm^3) was then added to suppress interferences and the solution was made up to mark with distilled water. Absorption was taken on the SP - 9 atomic absorption spectrophotometer. Statistical analysis was carried out on the samples using the method described by Box *et al.* [11].

Results and Discussion

The results on fat, protein and carbohydrate contents in the formulae determined in the laboratory and the level given by the manufacturers are presented in Table 1, while those for the mineral levels are shown in Table 2.

The Laboratory results were in reasonable agreement with the levels given by the manufacturers for all the formulae. Statistical analysis indicated that there was no significant difference ($P>0.05$) between the two. The results indicate that the formulae are good sources of sodium, potassium and calcium. (Na, 1.1 – 3.6; K, 4.1 – 7.2 and Ca, 1.2 – 6.0 mg/g). The magnesium content is however low (0.5 – 0.7 mg/g).

Similar elements are also present in the corn-flour infant feed which is presented in Table 3 except that the values are much lower. (Na, 0.3–0.4; K, 0.3–0.5; Ca, 0.2 and Mg, 0.2–0.3 mg/g). Statistical analysis at $P>0.05$ indicated that the corn flour infant feed significantly differed from the commercial infant feeds. The fat content of the corn-flour feed ranged from 4.0-5.6%, while protein accounted for 7.5-8.28%. These values are also lower than that for the commercial infant feeds. The carbohydrate content is however higher (82.0–84.6%).

The analytical data of Tilapia and crayfish is presented in Table 4. The result indicate moderate levels of fat (7.5-10.5%), low carbohydrate (21.9-30.0%) and high protein (50.75-53.64%) compared with either infant formulae or corn flours. Similarly mineral elements were also higher (Na, 13.0-18.4; K, 12.5–16.0; Ca, 27.8–44.0 and Mg, 1.12–2.0 mg/g).

The results of the analysis of fortified corn-flour is presented in Table 5. All the fortified samples compared well with the commercial samples. The sample with ratio 4:1 (corn flour white crayfish) gave the closest and most acceptable results compared with infant formulae.

There was marked improvement in the protein value (17.10%) compared to corn flour (8.0%) and average infant formulae (11.6%). The fat content in the mixture was lower than the average value for infant formulae. However, a higher carbohydrate value (70.82%) was obtained in the mixture compared with the average infant formulae (61.3%).

TABLE 1. FAT, PROTEIN AND CARBOHYDRATE CONTENTS IN INFANT FORMULAE COMPARISON OF SURVEY RESULTS AND MANUFACTURER'S LEVEL (% BY WEIGHT).

Brand	Laboratory results			Manufacturer's level		
	Fat	Protein	Carbo-hydrate	Fat	Protein	Carbo-hydrate
SMA	22.0	10.23	61.1	27.70	11.9	55.4
Similac	22.5	10.20	52.4	27.40	11.4	55.8
Frisolac	17.5	9.26	60.1	–	10.8	–
My-boy	26.5	10.06	50.0	29.0	11.70	54.2
Babeena	8.5 1	2.85	60.1	9.5	17.0	66.0
Nutrient	9.5 1	4.22	68.0	9.0	16.0	64.0
Cerelac	9.5 1	3.14	69.0	9.0	15.8	67.4
Friso cream	14.5	12.87	70.0	–	15.8	64.0
Overall Mean	16.3	11.6	61.3	18.6	13.7	60.1

TABLE 2. Na, K, Ca, Mg CONTENTS IN INFANT FORMULAE: COMPARISON OF SURVEY RESULTS AND MANUFACTURER'S LEVELS (mg CONSTITUENTS/g FORMULAE).

Brand	Laboratory results				Manufacturer's level			
	Na	K	Ca	Mg	Na	K	Ca	Mg
SMA	3.2	5.8	1.2	0.6	2.0	7.4	5.6	0.4
Similac	3.0	7.2	4.0	0.5	1.8	6.1	4.2	0.3
Frisolac	1.8	4.3	3.0	0.7	1.1	4.2	3.5	0.4
My-Boy	3.1	4.1	4.6	0.6	2.4	7.7	7.5	0.6
Babeena	3.6	7.2	6.0	0.6	–	–	–	–
Nutriend	1.6	6.8	5.2	0.5	1.6	5.8	3.1	–
Cerelac	1.9	6.7	6.0	0.4	1.7	6.5	5.4	–
Frisocream	1.1	3.2	2.8	0.5	–	–	–	–
Overall mean	2.4	5.7	4.1	0.5	1.8	6.3	4.8	0.4

TABLE 3. FAT, PROTEIN, CARBOHYDRATES AND MINERAL CONTENTS OF CORN FLOURS (DRY WEIGHT).

Flour	Percentage by weight			mg Constituents/g flour			
	Fat	Protein	Carbo-hydrate	Na	K	Ca	Mg
Millet	4.5	7.5	82.0	0.4	0.5	0.2	0.3
Corn	6.5	8.28	84.0	0.3	0.3	0.2	0.2
Overall Mean	6.0	8.0	83.0	0.4	0.4	0.2	0.2

TABLE 4. FAT, PROTEIN, CARBOHYDRATES AND MINERAL CONTENTS OF DRIED TILAPIA, WHITE AND RED CRAYFISH (DRY WEIGHT).

Fish samples	Percentage by weight			mg Constituents/g flour			
	Fat	Protein	Carbo-hydrate	Na	K	Ca	Mg
Tilapia	7.5	59.8	30.0	12.0	16.0	27.8	1.1
White crayfish	10.5	52.4	22.0	14.5	15.0	37.0	1.6
Red crayfish	8.0	53.6	21.9	18.4	12.5	44.0	2.0
Overall Mean	9.0	52.0	25.0	15.0	14.0	36.0	1.5

The composition of mineral elements for corn flour - crayfish mixture 4:1 is also similar to that of the infant formulae, except that the calcium level was higher for the mixture (7.6 mg/g) compared to 4.1 mg/g in the infant formulae. This may serve an advantage in bone building.

The recommended dietary allowance (RDA) in USA for calcium is 360 mg for infant, while that of magnesium is 50 mg[1].

No RDA's are established for sodium and potassium but authorities have recommended that potassium intake should equal sodium intake to counteract the effect of sodium in raising blood pressure. Also the National Research Council has suggested a daily intake of 1.8-5.6 g as safe and adequate [12]. The determined levels seem to be within the recommended guidelines for infant formulae and the forified corn flour. In addition, the fortified corn flour has an advantage of balanced Na:K ratio (3.2 : 3.1 mg/g) over the averaged infant formulae (2.4 :5.7 mg/g).

The result of comparative analysis of the fortified corn flour with some commercial infant formulae is depicted in Fig. 1. The analysis of the corn flour - Tilapia blends in several ratio is presented in Table 4. Apart from the fat content being too low (3.1-4.1%), the Na, K ratio is not as favourable as corn flour crayfish blend. Furthermore, processing of Tilapia is more tedious compared to crayfish. Therefore, in view of these, corn flour - crayfish blend (4:1) could serve as good substitute to commercial infant formulae.

The cost analysis of the fortified infant feed and the commercial infant feed (per 100g basis) indicated that corn flour crayfish cost N10.10 while corn flour - tilapia, N10.75. However, Babeena cost N30.50 and Nutrient, N32.65. Therefore, the value of the mixture was 30 - 35% the cost of the commercial infant formulae.

Work is in progress on feeding trials with fortified infant formulae using some selected infants in some parts of the country. The result of which will be communicated shortly.

Conclusion

The study has shown that the corn flour feeds are high in carbohydrate and low fat and protein values. It has equally been demonstrated that corn flour feed is deficient in mineral elements and are therfore not good substitute for infant formulae.

An addition of crayfish and tilapia to corn flour resulted in high percentage of protein and mineral elements with reasonable amount of fats and carbohydrates.

Mixtures of corn flour with crayfish at different ratios gave good complementation. Laboratory results of corn flour - crayfish (4:1) were in reasonable agreement with the levels given by the infant formulae. More advantageously, the balanced ratio of Na:K in the corn flour mixture will prevent the chance of blood pressure in infants. The corn flour - tilapia blends has a low fat content and Na:K ratio is also unfavourable.

The low cost of the corn flour - crayfish blend (30-35% of the cost of infant formulae) has a great advantage for low income mothers to feed their infants on equally good quality food at much less price.

TABLE 5. FAT, PROTEIN, CARBOHYDRATES AND MINERAL CONTENTS OF FORTIFIED CORN FLOUR

(a) CORN FLOUR AND CRAYFISH (DRY WEIGHT).

Corn flour crayfish	Percentage by weight			mg/g Mixture			
	Fat	Protein	Carbo-hydrate	Na	K	Ca	Mg
1:1	8.0	30.1	54.0	7.2	7.1	18.2	0.7
2:1	7.5	22.6	59.7	5.4	5.4	13.4	0.5
3:1	7.3	18.9	67.9	4.1	4.3	10.1	0.4
4:1	7.0	17.1	70.8	3.2	3.1	7.6	0.3

(b) CORN FLOUR AND TILAPIA (DRY WEIGHT).

Corn flour/ Tilapia	Percentage by weight			mg/g Mixture			
	Fat	Protein	Carbo-hydrate	Na	K	Ca	Mg
1:1	4.1	32.4	50.9	6.5	7.0	13.6	0.5
2:1	3.8	24.5	60.2	7.4	6.6	10.4	0.4
3:1	3.4	20.4	68.6	4.8	5.2	8.6	0.4
4:1	3.1	18.7	71.2	4.2	5.0	5.8	0.2

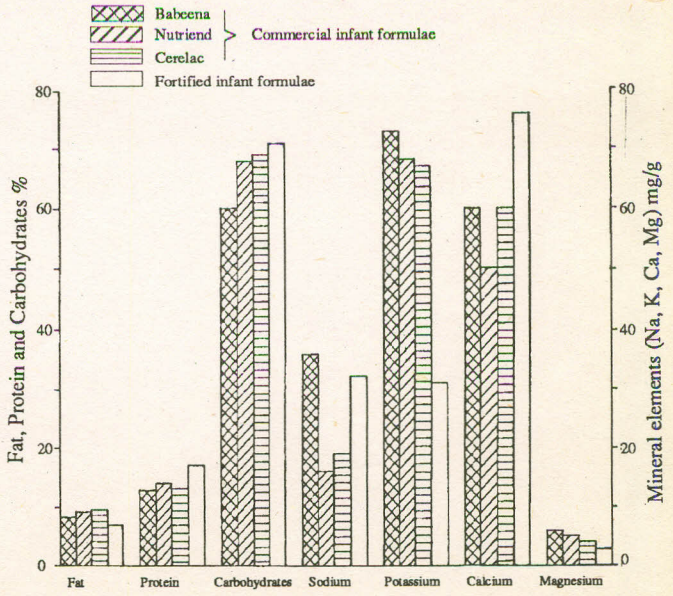

Fig. 1. Comparative analysis of the fortified infant formulae with some commercial ones.

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