

## Comparative Study of the Nutrient Composition of Millet and Maize-Based Complementary Weaning Foods



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**ABSTRACT:** Children in the study area are mostly weaned on cereal gruel that is deficient in some essential nutrients. The current work compared the nutrient composition of millet (MLMX) and the (MZMX) based complementary food prepared from locally sourced food stuffs. MZMX was formulated from maize, soyabeans, groundnuts, crayfish and palm oil. MLMX contained millet in place of maize. Proximate composition of the two diets, were not significantly different ( $p > 0.05$ ) and compared well with frisocream. Mineral element composition of the two diets was significantly ( $p < 0.05$ ) different when compared. Amino acid compositions of the diets were comparable to that of frisocream. Antinutritional factors in the two diets were not significantly ( $p > 0.05$ ) different when compared.

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### INTRODUCTION

Hunger and malnutrition continue to cause enormous world wide human suffering. Malnutrition is one of the major cause of high infant mortality in developing countries especially sub-sahara Africa (Philomena and Cecile, 1981). The most complex period is after weaning and generally in children below the age of two years. Childhood malnutrition is the problem linked to the future of any nation.

The most serious nutritional deficiencies are various forms of Protein-Energy Malnutrition (PEM), particularly affecting infants (Walker, 1990). In sub-saharan Africa, malnutrition, as indicated in high rates of infant and child mortality and stunted growth (Walker, 1990).

A subject which deserves more attention in infant nutrition is the provision of adequately nourishing weaning foods until after sucking has been discontinued. A weaning food is usually a semi-solid food that is used in addition to breast milk and not one that is used to replace breast milk. In most countries, the introduction of weaning food is recommended from about the age of 4 months when extra sources of energy and other nutrients such as iron are required, in addition to those present in human milk (Walker, 1990). Weaning food should, therefore, have sufficient energy and protein to provide the infants' daily nutrient requirements (Berggren, 1984).

In many developing countries, particularly in the villages and rural areas, weaning foods consist of maize gruels or starchy preparation from roots and tubers (Walker, 1990). These traditional weaning foods provide mainly calories but are grossly inadequate in proteins and other nutrients (Fashakin and Ogunshola, 1982). This has led to widespread incidence of Protein-Energy Malnutrition (PEM) within the weaning age group. Hence, it is important to supply more available protein so as to improve the qualities of the traditional weaning food (Fashakin and Ogunshola, 1982).

Several methods of fortifying "corn" with protein-rich diets such as legumes have been recommended (Fashakin and Ogunshola, 1982; Ketiku and Smith, 1984). The Federal Institute of Industrial Research Oshodi (FIIRO) fortified corn by incorporating in it a full fat soya flour. The fortified preparation was named *soya-ogi* (Fashakin and Ogunshola, 1982). Other researchers have prepared locally, weaning foods that are fortified (Ketiku and Olusanya, 1984; Temple and Odewumi, 1989). The raw materials used in the preparation of these fortified weaning foods, although are in most cases rich in all the major macro and micro-nutrients, they are usually too expensive for most mothers especially those in the low socio-economic groups.

The aim of this study was therefore to:

- i. formulate nutritionally balanced supplementary food from locally available foodstuffs.
- ii. assess the proximate composition of the diets and compare them with friscocream, a commercially prepared weaning food.

### MATERIALS AND METHOD

Four different diets, were prepared using locally sourced foods stuffs. MLMX was made up of millet, groundnut, soya beans, crayfish and palm oil while MZMX contained maize in place of millet. The groundnut was lightly fried and blanched to remove “seed cover”, the soya beans was soaked in boiled water for about 20 minutes, it was subsequently fried and blanched. MLMX was prepared by mixing millet (60%), groundnut (16%), soya beans (16%) and cray fish (5%). The diet was ground using electric grinding machine and 3g/100g of palm oil was added. MZMX was prepared in the same way. The diets were compared with MLA which contain millet alone and MZA contain maize alone respectively. They were also ground using grinding machine. The MLA and MZA served as negative controls while *frisocream*, a commercially prepared weaning food was used as positive control diet.

The percentage moisture, crude protein, fat, fibre and ash were determined using the method of the Association of Official Analytical Chemists (AOAC, 1980).

Mineral element analysis of the experimental diets were analyzed by flame photometry and Atomic Absorption Spectrophotometry, while percentage amino acid composition in the diets was determined using the method of Spackman *et al.*, (1958). Cyanogenic glycosides were estimated by the methods of Conn (1969) while phytic acid and oxalate were estimated by the method of McCance and Widdonson (1975) and Dye, (1956) respectively.

Amino acid analysis of the experimental diet was done using automatic Technicon Sequential Multi Sample Amino acid Analyzer.

### RESULT AND DISCUSSION

Millet and maize which are common staple foods in the study are served as the major sources of carbohydrate in MLMX and MZMX diets respectively. Crayfish and soyabeans served as source of mineral and vegetable protein respectively in both diets. Groundnut serves as supplementary source of vegetable protein and lipid, while red palm oil serves as source of  $\beta$  carotene (a provitamina A).

**Table 1:** Proximate composition of the millet and maize complementary weaning diets.

Parameters	MLMX	MZMX	MLA	MZA	PC
Moisture (%)	10.83±0.085 <sup>a</sup>	9.67±0.350 <sup>a</sup>	7.2±0.2 <sup>b</sup>	7.3±0.2 <sup>b</sup>	2
Ash (%)	5.713±0.245 <sup>a</sup>	6.17±0.269 <sup>a</sup>	1.583±0.076 <sup>b</sup>	2.62±0.166 <sup>b</sup>	-
Crude protein (%)	14.23±0.097 <sup>a</sup>	14.68±0.085 <sup>a</sup>	8.49±0.051 <sup>b</sup>	8.71±0.026 <sup>b</sup>	15.3
Crude fibre (%)	5.323±0.100 <sup>a</sup>	7.386±0.311 <sup>a</sup>	2.00±0.100 <sup>b</sup>	2.433±0.25 <sup>c</sup>	8
Crude Lipid (%)	10.90±0.100 <sup>a</sup>	8.32±0.300 <sup>a</sup>	3.856±0.115 <sup>b</sup>	3.523±0.414 <sup>c</sup>	7.2
CHO (%)	52.99±0.251 <sup>a</sup>	52.79±0.474 <sup>a</sup>	76.87±0.190 <sup>b</sup>	75.42±0.565 <sup>b</sup>	71.5
Energy (kcal/100g)	366.98	344.76	376.14	368.22	410.00

Results are mean±SD of 3 different determinations

a,b and c: values bearing different superscripts in the same row differ significantly (P<0.05).

MLA = Millet alone diet, MZA = Maize alone diet, MLMX = Millet mixture diet, MZMX = Maize mixture diet, PC = Friscocream diet

As indicated in Table 1, the protein content of MLMX and MZMX (14.23±0.09%, 14.68±0.08%) were significantly higher (P<0.05) than the respective MLA (8.49±0.04%) and MZA (8.71±0.04%). However, the protein content of the MLMX and MZMX were

comparable to that of the positive control, friscocream (15.3%). MLMX and MZMX are about 71 and 73% respectively. Of the 20% protein recommendation by Protein Advisory Group New York (PAG)(1982). Ketiku and Smith, (1984) reported that some locally

produced weaning food contain 17.76% protein while commercially prepared weaning food contain between 10 and 15% protein (Fashakin and Ogunshola, 1982; Kaituku and Smith 1984; Keitku and Olusanya, 1984). The recommended composition of the Third world weaning food adopted from Royal Tropical Institute, Amsterdam (1987) is 13% protein. The result of the diets in the current work MLMX (14.68%) is comparable to the recommended values. Stordy *et al.*, (1994) reported a weaning food to have a protein content of 14%. The protein contents of MLMX and MZMX were found to be significantly ( $P < 0.05$ ) greater than the respective negative control diets. The results of the current work are indicative of the fact that supplementing either millet or maize with sources of both vegetable and animal proteins improves the protein contents of the diets.

The lipid content of MLMS and MZMX of the diet as shown in Table 1 are  $10.90 \pm 0.17\%$  and  $48.32 \pm 0.17\%$  respectively. The values were significantly higher ( $P < 0.05$ ) than the values obtained for the positive control diets (7.3%). The MLMX diet is in accordance with 10% fat recommended by the PAG (1982) for weaning foods. Stordy *et al.* (1994) reported a comparable 8% lipid content. According to the Royal Tropical Institute (1987), the fat content of weaning gruel should be 20 – 26%. The values obtained for MLA and MZA diets which were

( $3.85 \pm 0.17\%$ ) and ( $3.52 \pm 0.17\%$ ) respectively are significantly ( $P < 0.05$ ) lower than the respective mixtures.

The carbohydrate content of MLMX and MZMX were  $52.99 \pm 0.23\%$  and  $52.79 \pm 0.23\%$  respectively, while that of friscocream diet was 71.5%. The amount of carbohydrate in the MLMX and MZMX diets was about 87% of the 61% of the recommended values of the Royal Tropical Institute (Amsterdam (1987)). The negative control diet (MLA and MZA) contain 76.87% and 75.42% of carbohydrate respectively, which were significantly ( $P < 0.05$ ) higher than the corresponding mixture diets. This may largely be due to the low contents of protein and fats in the negative control diets.

The moisture content of MLMX and MZMX were  $10.83 \pm 0.44\%$  and  $9.67 \pm 0.44\%$  and both were significantly ( $P < 0.05$ ) higher than the values obtained for the positive control diets whose content was 2%.

The iron content of the MLMX ( $16.3 \pm 0.46\text{mg}\%$ ) and MZMX ( $12.36 \pm 0.46\text{mg}\%$ ) as shown in Table 2 were significantly ( $P < 0.05$ ) higher than the positive control diet (2mg%). The current work recorded a difference of iron content of 0.8% over the negative control diet. The respective values of mixtures were higher than those of the millet or maize alone.

**Table 2:** Mineral element composition of the basal and complementary diets (mg/g).

Mineral element	MLMX	MZMX	MLA	MZA
Na	$28.25 \pm 0.15^a$	$19.70 \pm 0.13^b$	$8.21 \pm 0.07^c$	$1.76 \pm 0.401^d$
K	$66.28 \pm 0.07^a$	$42.28 \pm 0.16^b$	$27.76 \pm 0.11^c$	$16.36 \pm 0.05^d$
Ca	$66.26 \pm 0.33^a$	$52.57 \pm 0.42^b$	$3.06 \pm 0.16^c$	ND
Mg	$148 \pm 3.21^a$	$105 \pm 2.08^b$	$70 \pm 0.15^c$	$59 \pm 0.01^d$
Zn	$43 \pm 0.05^a$	$2.9 \pm 0.01^b$	$3.3 \pm 0.2^b$	$1.7 \pm 11^c$
Cu	$1.1 \pm 0.05^a$	$0.74 \pm 0.01^b$	$0.44 \pm 0.01^c$	$0.56 \pm 0.11^c$
Fe	$16.3 \pm 0.49^a$	$12.36 \pm 0.25^b$	$15.44 \pm 0.02^a$	$5.46 \pm 0.11$

ND = not detectable

Results are mean  $\pm$  SD of 3 different determinations

a, b and c: values bearing different superscripts in the same row differ significantly ( $P < 0.05$ ).

MLA = Millet alone diet, MZA = Maize alone diet, MLMX = Millet mixture diet, MZMX = Maize mixture diet.

Iron is essential for the formation of haemoglobin of the red blood cell and other cellular activities (Ihekorenye and Ngoddy, 1985). Royal Tropical Institute, Amsterdam (1987) recommends 100mg of iron per day.

The magnesium content of MLMX and MZMX diets as indicated in table 2 were  $148 \pm 0.86\text{mg}\%$  and  $105 \pm 0.86\text{mg}\%$  and are significantly ( $P < 0.05$ ) higher than the positive control diet whose content was  $44\text{mg}\%$ . The level of Mg and Zn of MLMX and MZMX diets were recorded to be higher than values reported for some commercial and locally prepared weaning foods (Chandra and Puri, 1986). The bioavailability of the element is not only a function of the quantity present in a diet, but also depends on the chemical form in which they are present in foods and on other innumerable dietary interactions in the gastrointestinal tract with other food components that can displace the original ligands and strongly influence its bioavailability (Chandra and Puri, 1986). The phytates, oxalates and tannin content of foods can adversely affect the bioavailability of magnesium, zinc and most trace elements (McDonald *et al.*, 1987).

It is presumed that the essential amino acid pattern should reflect the relative performances of the formulated diets. This assumption is reflected in MLMX and MZMX but contrary by the amino acid composition of MLA and particularly MZA diets, which show low amount of lysine. Ihekorenye and Ngoddy (1985) reported that maize contain low amount of protein (zein) which is deficient in lysine and tryptophan.

The current work shows MZMX diet to comprise  $2.26\text{g}\%$  and MZA  $2.10\text{g}\%$  lysine, while MLMX contain  $2.84\text{g}\%$  lysine and that the positive control diets to have  $3.39\text{g}\%$  lysine.

The level of some antinutritional factors in the diets such as cyanogenic glycosides, phytic acid,

tannins and oxalate are presented in Table 4. The level of cyanogenic glycoside of MLMX and MZMX diets were  $2.50 \pm 0.03\text{mg}\%$  and  $2.13 \pm 0.03\text{mg}\%$  respectively. These level are higher ( $P < 0.05$ ) than in the negative control diets ( $0.19 \pm 0.03\text{mg}$ ) and ( $0.15 \pm 0.03\text{mg}$ ). This may be due to presence of legumes in the mixture diets.

Cyanide, a product of hydrolysis of cyanogenic glycosides is highly cytotoxic because of its ability to inhibit the cytochrome oxidase of the electron transport chain and its ability to interfere with oxygen transport by haemoglobin (McDonald *et al.*, 1987).

The phytic acid content of MLMX and MZMX were  $0.26 \pm 0.007\text{mg}\%$  and  $0.22 \pm 0.007\text{mg}\%$  respectively (Table 4). The MLMX and MZMX have significantly ( $P < 0.05$ ) higher phytate content than the respective negative controls. Antinutritional properties of phytate is associated with its ability to lower the bioavailability of essential mineral elements and forms complexes with protein thereby inhibiting enzymatic digestion of ingested proteins.

The values obtained for tannin in MLMX and MZMX diets (Table 4) were  $0.37 \pm 0.08\text{mg}\%$  and  $0.33 \pm 0.08\text{mg}\%$  respectively. The corresponding mixture diets contain significantly higher ( $P < 0.05$ ) amounts than the negative controls. Tannins have a distinctive property due to its ability to inhibit the activities of digestive enzymes, thereby decreasing food digestibility and palatability. The values obtained for oxalate in MLMX and MZMX diet were  $4.73 \pm 0.13\text{mg}\%$  and  $4.36 \pm 0.13\text{mg}\%$ . (Table 4). Both were significantly ( $P < 0.05$ ) higher than in the corresponding negative control (Table 4).

High moisture content of vegetables reduces the toxicity of oxalic acid (Dommgang *et al.*, 1980). The antinutritional factor (ANF) can be removed or destroyed by boiling, cooking or heating at high temperature.

**Table 3:** Amino acid composition (g/100g of protein) of basal and complementary diets.

Amino acid	Frisocream	MLMX	MZMX	MLA	MZA
Valine	3.02	3.60	3.31	3.16	1.28
Threonine	2.77	3.16	2.33	1.55	1.23
Phenylalanine	4.22	4.56	4.05	3.96	2.29
Methionine	2.75	2.03	1.54	1.39	0.83
Lysine	3.59	2.84	2.26	2.21	2.10
Isoleucine	3.34	3.03	3.15	3.11	2.51
Leucine	7.13	8.07	9.27	4.64	3.10
Histidine	2.82	2.00	1.94	1.88	1.40
Arginine	5.10	4.08	3.74	3.10	3.04
Aspartic acid	6.23	7.10	5.17	3.99	2.41
Serine	4.02	3.12	2.02	1.20	1.10
Glutamic acid	13.55	15.19	7.75	6.25	4.14
Proline	4.25	5.09	1.48	1.27	1.08
Glycine	3.25	2.27	2.43	1.37	2.37
Alanine	3.08	4.16	2.08	1.40	1.25
Cystine	2.51	1.58	1.19	1.05	1.01
Tyrosine	3.22	3.06	3.22	2.23	1.43

**Table 4:** Some anti-nutritional factors content of basal used complementary diets (mg/g)

Diets	Cynogenic glycoside	Phytic acid	Tanins	Total oxalate
MLMX	2.50±0.1 <sup>a</sup>	0.26±0.01 <sup>a</sup>	0.37±0.015 <sup>a</sup>	4.73±0.25 <sup>a</sup>
MZMX	2.13±0.05 <sup>a</sup>	0.22±0.02 <sup>a</sup>	0.33±0.02 <sup>a</sup>	4.36±0.35 <sup>a</sup>
MLA	0.193±0.015 <sup>a</sup>	0.14±0.01 <sup>b</sup>	0.15±0.01 <sup>b</sup>	0.86±0.05 <sup>b</sup>
MZA	0.15±0.01 <sup>c</sup>	0.11±0.01 <sup>b</sup>	0.12±0.01 <sup>b</sup>	2.33±0.11 <sup>b</sup>

Values are mean±SD of different determinations

a, b, c and d: values bearing different superscripts in the same column differ significantly (P<0.05).

MLA = Millet alone diet, MZA = Maize alone diet, MLMX = Millet mixture diet, MZMX = Maize mixture diet, PC = Frisocream diet

## CONCLUSION

The result of the current work indicated that the nutrient composition of MLMX and MZMX were comparable and superior to millet or maize alone respectively. The nutrient composition of the mixture (MLMX and MZMX) is also comparable to one of the commercially prepared diet frisocream. It can than be indicated that the mixture (MLMX and MZMX) may be as good as frisocream in maintaining proper growth and development in infant/children supplementary diets.

## RECOMMENDATION

The most vulnerable period of life is weaning period especially when resources are limited. Research effort should be concentrated on how best people in our environs should utilize their available food stuffs so as to formulate weaning food which are cheap and easy to prepare and fit into traditional culinary and child feeding practice.

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