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EFFECTS OF PROCESSING METHODS ON THE QUALITY OF MAIZE-GROUNDNUT INFANT WEANING FOOD

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ABSTRACT

Five infant weaning foods were formulated from alternate mixtures of fermented maize-fermented groundnut (FMFG), fermented maize-roasted groundnut (FMRG), fermented maize-malted groundnut (FMMG), malted maize- malted groundnut (MMMG) and unprocessed maize-roasted groundnut (UMRG). The products were each complemented with skim milk since maize and groundnut are deficient in lysine and methionine. These mixtures were compared with Cerelac, a commercially available weaning food in Nigeria. The proximate compositions of alternate formulated mixtures compared favourably with Cerelac. Fermented maize-fermented groundnut had the highest protein and fat contents (15.1 and 10.5% respectively). Sensory evaluation studies showed significant differences in colour, aroma and consistency between the maize-groundnut infant formulations and Cerelac at $P<0.05$; but not in taste. The effect of variation of processing method on the nutritional quality indicated no significant difference ($P>0.05$) between rats fed with Cerelac and the four experimental based diets (FMFG, FMRG, FMMG AND UMRG) while the viscosities of all the diets and Cerelac fell within the accepted values for weaning foods. Also the variation of the processing methods showed similarity in the reconstitution time of the products. Rats fed with Cerelac and UMRG respectively differed significantly from those fed with MMMG. FMMG. PER and FER study showed that MMMG and FMMG had the highest values.

Keywords: Malting, fermentation, maize-groundnut weaning foods, nutritional quality.

INTRODUCTION

Weaning foods available in Nigerian range from the industrially manufactured brands to those traditionally processed in the homes. The severe economic problems in the country have made it difficult for most low and middle income nursing mothers to afford the industrially manufactured formulas which are adequate in calories and nutrients for babies. Thus Nigerian mothers resort to 'Ogi', a traditional weaning food of low nutritional value which is made from fermentation of cereals such as maize, sorghum and millet and which predisposes the child to nutritional disorders such as Kwashiokor, marasmus and pellagra.

Food scientists in Nigeria have been trying combinations of cereals, legumes and other staples in such a way that maximizes the efficiency of protein utilization for weaning foods (Ossai and Malomo, 1986). Accordingly, FIRRO (1973) developed 'Soy Ogi' by mixing 'Ogi', a traditionally fermented cereal product with soyabean, added in appropriate quantities. More recently, many indigenous legumes such as groundnuts are being mixed with cereals to raise the nutritional qualities of local weaning foods.

Modification of methods of processing have also been found useful in improving the nutritional status and quality of weaning foods (Wang and Fields, 1978; Uwaegbute and Nnayelugo, 1989). Fermentation and malting increase levels of amino acids, improve digestibility and reduce the level of anti-nutritional stress factors (Bandtzeag et al, 1981).

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Therefore, this study is ultimately aimed at comparing the various experimental methods on formulations for weaning foods in order to ascertain the most appropriate groundnuts mixtures, based on chemical analysis; sensory evaluations and animal feeding experiments.

MATERIALS AND METHODS

Unprocessed maize flour preparation

White maize (*Zea mays*), groundnut (*Arachis hypogea*), Skim milk (Carnco brand) and granulated sugar procured from Okigwe retail market, Imo State. Nigeria were used. Maize grains were sorted, cleaned and washed with water. They were later dried in a hot box oven (Gallenkamp) for 2 hours at 80°C. Thereafter, the grains were ground in the manual grinder (Corona, France) and sieved using mesh size of 120μm. The flour was packaged in high density polypropylene bags (0.5mm), and stored at room temperature in plastic container.

Roasted groundnut flour preparation

Cleaned and sorted groundnuts to remove contaminants were roasted in the oven at 100°C for 40 minutes. On cooling, the hulls of the nuts were manually rubbed off and winnowed. This was followed by milling and then packaging in high density polypropylene (0.5mm) bags.

Malted maize and Malted groundnut flours preparation

The maize grains and groundnuts were separately sorted and cleaned. They were later steeped separately in four volumes of water at room temperature for 18 hours. Washing of the grains was done at 6 hours interval to prevent fermentation. Steeped grains were spread on washed jute bags, watered and left to germinate in a dark cupboard at room temperature (28-30°C for two hours to reduce moisture content. The sprouts were removed and the grains ground to fine particles using a manual grinder (Corona, France). Afterwards, it was sieved with mesh of size, 120um to obtain malted maize flour.

The steeped groundnut grains followed the same processes as the maize except that after germination and washing, the grains were blanched at 100°C for five minutes to inactivate ant-nutritional factors before oven-drying at 80°C for two hours.

Fermented maize and groundnut flours preparation

Maize grains and blanched groundnut grains at (100°C for 5 minutes) were fermented separately at room temperature for 48hours using fermenting liquor of maize and groundnut flours mixture as a starter. The grains were

Table 1. Proximate composition of samples.

Samples	Moisture (%)	Ash (%)	Fat (%)	Crude fibre (%)	Crude Protein (%)	Carbohydrate (%)	Energy (kcal)
Fermented maize + Fermented groundnut (FMFG)	2.8	4.9	10.5	4.2	15.0	67.4	424.1
Fermented mazie+ Roasted groundnut (FMRG)	3.0	5.0	9.3	4.0	14.4	68.5	415.3
Fermented maize + Malted groundnut (FMMG)	2.9	4.6	8.8	4.1	14.2	70.0	416.0
Malted maize + Malted groundnut (MMMG)	3.5	4.2	7.1	4.8	12.0	70.3	393.1
Unprocessed maize + Roasted groundnut (UMRG)	2.0	6.3	9.4	4.7	12.7	71.0	439.4
Cerelac (Control)	2.5	3.3	9.0	2.3	15.5	69.7	421.8

drained, washed and oven-dried at 80°C for two hours. The hulls of the groundnut were rubbed off and winnowed. Finally, the fermented grains were ground using a manual grinder (Corona, France) and packaged separately in air tight polypropylene bags.

Formulation of infant feed mixtures

Groundnut flour, skim milk powder (SMP) and maize flour were blended in the ratio of 2:2:7 to produce infant weaning food. Prior to the addition of milk, groundnut – maize flour mixture was dried at 60°C for one hour to reduce the moisture content. To sweeten the infant formula, 5% of sugar by weight of the formula was thoroughly mixed with it. The blends were packaged in air-tight polypropylene bags and put in tin can container with a tight lid. The formulated mixtures were:

1. Fermented maize + Fermented groundnut + SMP (FMFG)
2. Fermented maize + Roasted groundnut + SMP (FMRG)
3. Fermented maize + Malted groundnut + SMP (FMMG)
4. Unprocessed maize + Roasted groundnut + SMP (UMRG)

Rat feeding experiment

The five maize-groundnut based weaning foods were evaluated with Cerelac as control by a feeding experiment using 24 weaning albino rats for 30 days. The rats were supplied by the Animal Science Unit, School of Agriculture, Imo State University, Owerri. Each group of four replicates was fed the five maize-groundnut weaning foods. The remaining experimental groups was fed with Cerelac (control), the industrially processed commercial weaning food. Equal weights of experimental diets and water were offered. The remaining food and spilled food were collected daily and weighed. The rats were weighed at every three days' interval and their weights recorded. The protein consumed was calculated from the total feed intake while the PER and FER were also calculated according to methods recommended by National Academy of Science/National Research Council (1963).

Proximate analysis

The moisture, fat, crude protein (N X 6.25), crude fibre and ash contents of the formulated products were determined according AOAC (1984). The energy content was determined by calculation using the Atwater factors (4x% protein; 9x% fat and 4x% carbohydrate).

Viscosity and Reconstitution time measurement

The Viscosity of the various mixtures of maize-groundnut gruel and Ceralac was measured following the method of Mosha and Svanberg (1983). Reconstitution time was

Table 2. Viscosity and Reconstitution time of weaning foods

Samples	Viscosity (cps)	Reconstitution Time (Seconds)
Fermented maize + Fermented groundnut (FMFG)	2485	474
Fermented maize + Roasted groundnut (FMRG)	2556	478
Fermented maize + Malted groundnut (FMMG)	2520	477
Malted maize + Malted groundnut (MMMG)	2374	475
Unprocessed maize + Roasted groundnut (UMRG)	2800	479
Cerelac (Control)	2755	472

with that of Cerelac (Table 2)

measured by placing a spoonful of each sample on the surface of 25ml cold distilled water contained in a 200ml beaker. The time for each sample to become completely wet and dissolve without stirring was recorded as reconstitution time.

Sensory evaluation

Sensory evaluation test was carried out on the five new products and Ceralc (control) by a 10 experienced panelists using a nine point hedonic scale ranging from 9 like extremely to 1 dislike extremely (1FT sensory Evaluation Division, 1981). The following quality attributes – colour, taste, aroma and consistency were evaluated.

Statistical Analysis

The sensory evaluation and the percentage weight gain experiments were respectively carried out at six levels (FMFG, FMRG, FMMG, MMMG, UMRG and Control) and each of the percentage weight gain quadruplicated four times. Results of the sensory analysis method and the percentage weight analysis were evaluated for significance using the one-way analysis of variance (ANOVA) and the least significant different (LSD) method (Steel and Torrie, 1981).

RESULTS AND DISCUSSION

Proximate analysis of the weaning foods

The proximate analysis values for fat, protein and carbohydrates for the five maize-groundnut infant weaning formulations compared favourably with Cerelac, the popular commercial weaning food in Nigeria (Table 1).

The crude fibre content of malted maize-malted groundnut (MMMG) was high but protein contents and energy values of MMMG were found to be the lowest. Crude fibre has been reported to increase slightly with germination (Akpapunam and Achinewhu, 1985; Youcef et al, 1987). Beevers and Guernsey (1966) recorded that the nitrogen content of the cotyledon of groundnut declined rapidly when it is germinated. The low energy value of MMMG was as a result of decrease in protein and fat content of this sample. Fermentation increases the nutrient composition of grains (Ezeji and Oji-Melukwe, 1993) as fermented maize-fermented groundnut (FMFG) was observed to have the highest fat and protein contents. The energy values of all the products were above 383 Kcal which is the recommended daily allowance for babies between 4-11months (FAO/WHO/UNU, 1985).

Viscosity and Reconstitution time of the products

The gruel of all the samples fell within the required viscosity (1000-3000cps) recommended for weaning foods (Mosha and Svanberg, 1983) (Table 2).

Sample MMMG had the lowest viscosity as a result of malting. Malting had been implicated to reduce bulk density (Uwaegbute and

Table 3. Weight gain, Protein Efficiency Ratio and Feed Efficiency Ratio for rats fed with weaning maize-groundnut mixture and Cerelac

Samples	Weight gain (%)	PER value	FER value
Fermented maize+ Fermented groundnut (FMFG	199.6[ab]	1.9	4.4
Fermented maize + Roasted groundnut (FMRG)	237.9[ab]	1.8	4.3
Fermented maize+ Malted groundnut (FMMG)	246.0[ab]	2.2	4.6
Malted maize + Malted groundnut (MMMG)	163.7[b]	2.3	5.0
Unprocessed maize + Roasted groundnut (UMRG)	271.9[a]	1.7	4.1
Cerelac (Control)	274.1[a]	2.4	4.6

a,b: Mean values with different letters as superscripts are significantly different from one another (P<0.05)

Nnayelugo, 1983). Likewise, fermentation reduced the bulk density of FMFG (Mbugua, 1987). Formation of low viscous gel by the four malted and fermented samples (FMFG, FMRG, FMMG and MMMG) indicated that the question of over-dilution as are the cases with gel may not arise. Over-dilution tends to lower the energy intake in relation to volume.

The reconstitution time for the maize-groundnut based weaning foods was similar

Nutritional quality of the weaning foods

There was not significant different ($P<0.05$) in weights between the rats fed with the control diet (Cerelac) and those fed with four of maize-groundnut based diets (FMFG, FMRG, FMMG and UMRG). There was however significant difference in weight gained by rats fed with Cerelac and UMRG respectively and those fed with MMMG as seen in Table 3.

The first stage in the malting of seeds involves the breakdown of seed reserves and their utilization by the plumule and radicle of the seeds (Ihekoronye and Ngoddy, 1985). This breakdown led to low carbohydrate and fat contents of MMMG. The lower percentage weight gained by the rats fed with this diet could have been caused by the lower carbohydrate, fat and energy values. The weight gain alone is not an accurate index of the quality of foods. Other nutritional indices such as PER and FER ratios exhibited by rats fed with MMMG showed that malting may enhance the nutritional quality of maize-groundnut infant weaning food. The PER ratios of 2.3 and 2.2 for MMMG and FMMG are little above the recommended minimum PER ratio of 2.1 for weaning foods (FAO/WHO, 1970). Bau and Derby (1979) Showed that germination improved the nutritional quality of protein as measured by PER. On the other hand, roasting appeared to decrease significantly the PER ($P<0.05$) of the formulations as exemplified by PER ratio of UMRG (1.7) and FMRG (1.8) and this is in line with the work of Geervani and Theophilus (1980) on green grain.

The PER ratio of the maize-groundnut based weaning foods was also improved by malting more than any other method of processing used in this study. MMMG and FMMG recorded the highest PER ratios of 5.0 and 4.6 respectively.
Fermentation did not increase the FER ratios as much as malting. Roasting seem to decrease the PER ratios more than other methods of processing used I this study.

Sensory Evaluation

Processing methods have no effect on the taste of all the maize-groundnut

Table **Sensory Evaluation scores of the weaning maize-groundnut infant formulations**

Samples	Colour	Taste	Aroma	Consistency
Fermented maize + Fermented groundnut (FMFG)	5.7[bcd]	5.7[a]	5.2[cde]	5.7[cde]
Fermented maize + Roasted groundnut (FMRG)	7.0[ab]	5.4[a]	6.1[bc]	6.2[bc]
Fermented maize + Malted groundnut (FMMG)	4.1[e]	4.7[a]	5.6[bcd]	4.9[cde]
Malted maize + Malted groundnut (MMMG)	5.5[cde]	5.4[a]	6.2[b]	6.1[bcd]
Unprocessed maize + Roasted groundnut (UMRG)	6.5[bc]	5.5[a]	5.1[bcde]	7.1[ab]
Cerelac (Control)	8.1[a]	8.6[a]	8.3[a]	8.5[a]

A,b,c,d,e: Mean values in the same column followed by the same letter are not significantly different at 5% level.

weaning formulations. Table 4 showed that there was no significant difference (P<0.05) in taste between the maize-groundnut infant weaning foods and Cerelac.

Malting produced poor coloured products from maize-groundnut infant mixture. The appearance of MMMG and FMMG were very poor. Malting however, seemed to enhance the aroma of weaning formulations when compared with other methods of processing. The aroma of Cerelac differed significantly with those of the new products. In terms of consistency almost all the products were significantly inferior to Cerelac with the exception of unprocessed maize-roasted groundnut (UMRG). The organoleptic properties of these weaning foods can be improved to compare favourably with that of Cerelac by addition of artificial or natural colourings, flavourings and binders.

CONCLUSION

Processing methods were found to affect the nutritional quality, viscosity, reconstitution time and organoleptic properties of the alternate mixtures. Malting and fermentation improved PER value. This index of nutritional quality was decreased by roasting.

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