Gezira J. of Agric. Sci. 2(**1**): **106**-1**16** (2004)

Weaning Food Formulation from Different Blends of Cereals and Legumes

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ABSTRACT

Six weaning food formulations F_1—F_6 composed of wheat (50-55 %) de-hulled broad beans (15-35 %), sesame (5-10 %), fenugreek (0-I5 %), skim milk (0-8 %), sugar (4 %), ground nut oil (1.5 %) and vitamins/salt mixture (l .5 %); were selected for calculated amino acid scores and energy values. They were processed using the roller drum-drying technique. Protein content of processed formulations F_l-F_6 was found in the range of 17.4 to 18.5% and energy value from 346 to 372 Kcal/100g. Viscosity at 12.5 % guel concentration ranged from 2600 to 8350 cp for F_5 and F3 respectively. The high viscosity ofF_3 can be related to its fenugreek content (15 %). Weaning food formulations including wheat, de-hulled broad beans and sesame with fenugreek at zero and 5% level showed acceptable characteristics and high nutritive value.

INTRODUCTION

The majority of the people in sub-Sahara Africa depend mainly on cereal grains as their staple food owing to the limited supply of animal foods. Maize, wheat and rice, provide over one half of the total calories and protein for the aforementioned people (Hanson, 1974). Acid porridges prepared cereals are still eaten in varying amounts in different parts of the world particularly in developing countries, where they represent the basic diet. Merrisa, (Sudan) and Uji (Kenya); Koko (Ghana); and Ogi (Nigeria) are examples of these porridges prepared by the fermentation of sorghum, maize and millet or cassava (Dirar, 1993).

Traditional, homemade cereal porridges from sorghum or millet flour; form an important part of the weaning diet in Sudan. To improve the nutritive value, an investigation is needed to formulate and produce weaning food for children from locally available food materials.

MATERIALS AND METHODS

The seeds of four crops were obtained from retail markets in Mysore and Ooti (India), in October 1998. Wheat seeds were cleaned by hand and using an aspirator. De-husking was done in a polisher after conditioning the moisture level to approximately 16%, using water mixer for few minutes. De-husked grains were then dried at 60^0C, for 3 h before milling into fine flour of approximately 80 % extraction.

Broad bean seeds were first hand cleaned and winnowed to remove dirt, dust, stones and foreign materials. Moisture level was increased to a level suitable for de-husking, before using the de-husking machine twice to ensure satisfactory de-husking. Husks were separated by hand winnowing and the de-husked seeds were milled into fine flour. Fenugreek seeds were cleaned and milled into whole flour. Sesame seeds were cleaned both by hand and using a vibrating grader. Dehusking was carried out using the weak lye solution method. The separated husks were drained off and the seeds were dried in a hot air tray dryer at 40^0C for 16 h. The de-husked seeds were then stored in a tightly closed container in a cold room, ready for use.

Formulation of cereal-legume blend

Formulae of weaning foods were calculated according to the method described by Jansen and Harper (1985). A large number of formulae were worked out in which various combinations of the raw materials were put together. Only six formulae were selected taking in consideration reasonably high amino acid score >65 %; protein content as well as other essential factors. The percent composition of the six weaning food formulations selected (designated as F_l,F_2, F_3‘ F_4, F_5 and F_6). is given in Table 1.

Processing of weaning foods by roller drying technique

The slurry of each formulation was subjected to simultaneous cooking and drying in Escher Wyes double drum drier. Vitamins and minerals in the amounts recommended (Harper and Jansen, 1985) were then added to the final product.

Proximate composition

Moisture, protein, fat and total ash were determined according to AOAC (1984). Dietary fibre, determined by the rapid enzymatic method (Asp *et al.*, 1983). Carbohydrate content, calculated by difference and the total energy content (K cal) was calculated by multiplying the protein and carbohydrate content by a factor of 4 and the fat content by a factor of 9. The quantitative determination of protein was carried out in Buchi apparatus (Buchi 425 Digester and Buchi 321 Distillation Unit).

Bulk density

The method described by Wang and Kinsella (1976) was used. Bulk density was expressed as g/ml .

Water retention capacity

The method described by *Cegla et al.* (1977) was followed.

Apparent viscosity

The method described by Quinn and Beuchat (1975) was followed، with some modifications. 5, 7.5, 10 and 12.5 g of the weaning food material were suspended in water at 60^0C to complete the volume to 100 ml. They were cooled to room temperature and viscosity was measured by a Brookfield Synchro electric Viscometer using RVT spindle No.4 (or different spindles depending on the viscosity of the slurry) at constant speed of 100 rpm. The value was multiplied by the factor specified for the spindle in Brookfield instrument manual supplied with instrument and gruel viscosity expressed in centipoise (CP) units.

Pasting characteristics

Rapid visco analyser (RVA) was used to determine the weaning food characteristics by the standard International Cereal Chemists (ICC) method No. 162 (1966), using test profile STD 2. The RVA profilogram was analysed for peak viscosity (PVA), hot paste viscosity (HPVA), cold paste viscosity (CPV), area total set back (CPV-HPV) and break down (PV-HPV).

Orgnoleptic evaluation

The six processed weaning foods were subjected to sensory evaluation by 10 trained personnel; using the hedonic scale method. The weaning foods were assessed for their colour, flavour (aroma), taste، palatability, mouth feel and overall acceptability. The evaluators were instructed to sip water before and after tasting each product. The of each sample on an 8-point hedonic scale. Each treatment was evaluated three times by each panelist.

***In vitro* indices (Pepsin-Pancreatin Digest)**

This was carried out according to Saunders *et al*. (1973).

RESULTS AND DISCUSSION

Formulation, processing and composition

The composition values of wheat, fenugreek, seasame and skim milk given in Jansen and Harper (1985) reference, in addition to composition of broad beans (Elhardallou, 1990) were used for calculation of weaning food formulae. Out ofa large number of calculated formulae، six were selected for their reasonably high amino acid score (particularly lysine, threonine, tryptophan and sulphur containing amino acids) using variable combinations. Components of selected formulae designated as F_l, F_2, F_3, F_4, F_5 and F_6 are shown in Table l، including added sugar, refined groundnut oil, vitamins and minerals. They were processed, using drum drying technique.

Table 1. Proximate levels of ingredients used in weaning food formulations (F_l-F_6).

SI. No.	Ingredients (%)	Formulations					
		F_1	F_2	F_3	F_4	F_5	F_6
1.	Wheat	50	50	50	55	55	50
2.	Broad beans	25	20	15	20	25	35
3.	Fenugreek	5	10	15	5	-	8
4.	Sesame	5	5	5	5	5	0
5.	Skim milk powder	8	8	8	8	8	4
6.	Sugar	4	4	4	4	4	1.5
7.	Vitamins and minerals*	1.5	1.5	1.5	1.5	1.5	1.5

•Level of addition (per 100g) was as follows:
ca: 8.89 ; P: 0.6B, Fe: 10mg•, Vitamin-A: 150 IU•, Vitamin-D: 300 IU،•
Vitamin-BI: 0.5 mg; Vitamin-B2: 0.6 mg; Niacin: 5 mg; and Vitamin-C: 30 mg.

Data on the chemical composition of F_1 to F_6 and the commercial sample are presented in Table 2. The moisture of F_1 to F_6 ranged from 3.4 to 4.9, higher than that of CS (2.5 0/0). The protein content values were ranging from 17.4 in F_3 to 18.7 % in F_6. These values were Weaning food formulations relatively higher than that of CS (15.5%). The fat content of F_1 to F_6 was rather low (4.4 to 5.6 %) compared to 9% in CS. Dietary fibre (including soluble and insoluble portions) varied significantly, ranging from 5.9 % in F_5 to 12.8% in F_3. For CS, 1.4 % was recorded as crude fibre, this figure is expected to be higher if soluble indigestible sugars are included. The ash content of (F_1 to F_6) and CS were all in the range of 2.3 to 2.7 %.

Table 2. Proximate composition of weaning food formulations F_1 to F_6

Attribute(%)	F_1	F_2	F_3	F_4	F_5	F_6	Commercial sample
Moisture Protein	3.5	3.5	3.9	3.4	4.9	3.5	2.5
(Nx6.25)	17.8	17.9	17.4	18.5	17.8	17.7	15.5
Other extract	4.4	4.6	4.8	4.4	4.2	5.6	9.0
Diectary fibre	6.9	10.9	12.8	7.9	5.9	8.0	*1.4
Total ash	2.7	2.6	2.8	2.6	2.3	2.4	2.7
Carbohydrates (by difference)	64.7	60.5	58.3	63.2	64.9	62.8	68.9
Energy (Kcal)	370	355	346	366	369	372	430

%1.4*was recorded as crude fibre for the commercial sample.

These compositional values are in general conformity with the specifications of weaning foods, except the distinct feature of the low fat content of the formulations. In comparison of the calculated protein values of the six formulations (16.8 in F_4 to 17.6% in F_1) with the experimental values (17.4 in F_3 to 18.7% in F_6) given in Table 2; it can be noted that experimental values are slightly higher (by 0.6- (%1.1) than calculated ones. This indicates the efficiency of the formulation procedure. The minor differences between calculated and experimental protein values, may be due to varietal differences in raw materials or de-husking process.

The caloric content of all the formulations varied between 346 and 372Kcal for every 100 g (Table 2). The lowest value, (360 K cal / 100 g) was recorded for F_3. This can be attributed to the high dietary fibre 12.8%) content and low fat content.

Functional properties

Four important functional properties, namely, water retention capacity (WRC), apparent viscosity and pasting characteristics have been investigated.

a) Bulk density

The bulk density (BD) values (g/ml) of the six formulations and that of the commercial sample were in the same range of 0.46-0.65 (Table3).

b) Water retention capacity

The water retention capacity (WRC) of the weaning foods is an indicator of the volume of water need to be added to form gruel with a suitable thickness for child feeding. The WRC values (ml/g) of the formulated weaning foods were in the range of (4. I-4.8), compared to 3.2 for CS (Table 3).

c) Apparent viscosity

The apparent viscosity (AP), of the six formulations and of the commercial sample at four different gruel concentrations (W/W), 5‘ 7.5, 10 and 12.5 % are given in Tables 3 and 4. Table 4 which shows viscosities at different gruel concentrations, indicate that at the lowest gruel concentration (5%), there was no significant difference between viscosities of the weaning foods, (20—30 CP), while the commercial sample had significantly lower viscosity (4 CP). At 7.5 % level,

Table 3. Functional properties of the weaning food formulations (F_1-F_6)

Property	Formulations						
	F_1	F_2	F_3	F_4	F_5	F_6	Commercial sample
Bulk density (g/ml)	0.65^a	0.46^e	0.57^b	0.56^c	0.55^c	0.53^d	0.55^c
Water retention capcity (g/g)	4.1	4.3	4.3	4.1	4.8	4.6	3.2
Apparent viscosity (CP) (at 12.5% w/w) gruel concentration	4650^c	5800^b	8350^a	3500^d	2600^f	3250^e	400^g
Colour:							
Whiteness(%)	35.1e	39.0^d	28.4^f	45.9^c	50.7^a	48.0^b	45.4^c
δE,Colour difference	32.1^b	29.8^c	36.4^a	25.8^d	25.8^f	24.6^e	26.1^d

Means followed by different letter(s) in each row were significantly different at the probability of 5% according to Multiple Range Test (DMRT)

Table 4. Apparent viscosity of the weaning food formulations (F_1-F_6) at various gruel concentrations.

SI no.	Formulation	Viscosity (centipoise) at specified gruel Concentration (w/w)			
		5%	7.5%	10%	12.5%
1.	F_1	20[c]	135[c]	800[c]	4650[c]
2.	F_2	30[b]	170[b]	1300[b]	5800[b]
3.	F_3	36[a]	200[a]	2200a	8350[a]
4.	F_4	20[c]	123[d]	450[d]	3500[d]
5.	F_5	15[d]	80[f]	400[d]	2600[f]
6.	F_6	22[C]	105[e]	440[d]	3250[e]
7.	Commercial sample	04[e]	20[g]	200[e]	400[g]
	SEM	1.1	1.9	23.4	52.7

however, F_5 had lowest viscosity (80 CP) among the formulations and F_3 had the highest (200 CP), while at this concentration the commercial sample had a viscosity of only 20 CP. At 10 % level, the viscosity of the formulations ranged from 400 to 2200 CP, commercial sample being 200 CP. At the highest gruel concentration of 12.5, % there seems to be significant differences in viscosities of the six formulations ranging from 2600 to 8350 CP. At the same concentration, commercial sample showed a comparatively low value of 400 CP.

An advantage of weaning food is to have a high bulk density, a low water retention capacity and a low apparent viscosity. The three formulations (F_4, F_5 and F_6) seem to have values of the three parameters, which are of the same order. These values may need to be improved to obtain a more functional weaning food. This will also make it in line with the current concept that weaning foods and foods for pre-school children should be of high calorific value (Jansen et al،. (1981). This can be achieved by reducing the viscosity of starchy food components by pre-processing (Deskachr, 1980; Malleshi and Desikachar, 1981). A lower viscosity or less bulky food contains a higher nutrient content since the volume of the food is low. However، the reduction of cereal-legume based weaning food viscosity can be done by the addition of amylase containing malt (e.g. sorghum malt) which can considerably reduce high viscosity of the native starch.

Kikafunda *et al*. (1997) studying the viscosity and energy density of maize porridges for infants in developing countries, found that viscosity can be reduced and energy density increased by addition of groundnut or milk through their fat content. In this study, fat content of processed weaning food ranges from 4.2 to 5.6 %. Addition of oil up to 9% level can achieve a notable decrease in viscosity and increase in energy value.

d) Pasting characteristics

The pasting characteristics, in Rapid Viscoanalyser Units (RVU) of F_1 to F_6 and CS are shown in Table 5. Peak viscosity, hot paste viscosity (HPV) and cold paste viscosity (CPV) are not detectable in the commercial sample. F3 showed the highest HPV (63 RVU), CPV (102 RVU), area (1467 RVU) and total set back (CPV - HPV, 39 RVU). This, however, can be attributed to the high fenugreek content of the sample (15 %). Fenugreek is known to have the mucilage characteristics due to the high galactose-mannose content. The other five food formulations were similar in pasting characteristics, with F_6 having least values, possibly because of its high de-hulled faba bean content (35%).

Table 5. Pasting characteristics of processed weaning foods (Fl-F6) and commercial sample in Rapid Viscoanalyser Units (RVU).

Sample	Peak viscosity	Hot paste viscosity	Cold paste viscosity	Area	Total setback	Break down
F_1	86	33	59	895.7	26	53
F_2	130	33	57	1236.0	25	97
F_3	105	63	102	1467.2	39	42
F_4	101	30	53	940.4	23	71
F_5	129	27	51	1149.5	24	102
F_6	115	24	46	1045.1	22	91
Commercial sample	ND	ND	ND	132.0	ND	ND

ND: Not detected

Organoleptic evaluation

The results of organoleptic evaluation given by 10 trained personnel، for colour, flavor (aroma), taste, palatability and mouth feel showed that for colour, F_5 scored the highest marks and F_3 the lowest، reflecting that white colour is more desirable. In the overall acceptability, samples F_4, F_5 and F_6 were more acceptable than F_1 and F_2. However, F_3 was unacceptable by the panelists and this can be attributed mainly to the bitter taste of the sample, caused by high fenugreek content (15 %). The yellowish colour of F_3 can be also due to the fenugreek content.

***In vitro* digestibility**

The pepsin-pancreatin *in vitro* digestibility of the proteins of F_1 to F_6, CS and the control (casein) were 81, 80, 76, 82, 84, 81, 87 and 92 % respectively. The highest digestibility among the six weaning foods was for F_5 (84 %), F_4 (82 %), followed by F_6 and F_1 (81 %), F_2 80%) and F_3 (76 0/0).

ACKNOWLEDGEMENT

The author is thankfull to the Technical Staff at Central Food Technology Research Institute, Mysore India; and greateful to United Nations University for their fellowship.

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