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Production, Storage and Evaluation of Homemade and Processed Diet, Based on Wheat, Legumes, Sesame and Dates; for Under-Five Children

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Abstract

This study aimed to formulate a nutritive diet enriched with protein, iron and energy for under-five children. It was conducted in Elhosh rural area, Gezira State, Sudan, 2010. The diet was formulated and blended using locally available foods, produced at home level, by a twin-roller drum dryer and in biscuit form. The raw materials included pigeon pea (*Cajanus cajan*) sesame (*Sesamum indicum*) and dates (*Phoenix dactylifera*). The three products were evaluated for their proximate composition, energy value, iron content and acceptability after storage at (4˚C - 6˚C) and at room temperature for 5 months. The protein content of the products was (14.0 - 14.1 g/100g); the energy value ranged from 382 to 390 Kcal/100g, both in-line with many recommendations for children aged under five. The iron content was found in the range of 14.6 - 14.8 mg/100g, in agreement with the codex recommendation. Yeast, mold and salmonella were not detected while other microbes were found within acceptable values. Studied products were found nutritious and remained acceptable after storage for five months. Legumes, sesame seeds and dates can be effectively used in wheat-based baby foods as a source of protein and mineral supplement.

Keywords

Under 5 Children, Pigeon Pea, Sesame Seeds, Dates, Wheat Flour, Energy, Iron

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1. Introduction

Protein energy malnutrition is an important nutritional deficiency condition that often occurs during the critical transitional phase of weaning infants, crippling their physical and mental growth. This condition can be prevented to a large extent by introducing weaning foods of quality and quantity at the right time and in the right proportions [1].

Nutritional anemia remains a major public health problem throughout the world [2] [3]. The vast majority of nutritional anemias are due to iron deficiency [3]. Several facts were recognized about the concept of "anemia". Nutritional anemias are caused when there is an inadequate body store of a specific nutrient needed for hemoglobin synthesis [4]. Iron deficiency anemia is a common problem worldwide, 50% of individuals in high-risk groups such as preschool children and women of childbearing age.

Sudan household health survey (SHHS) in 2006 conducted a survey among children under-five years at Gezira State, Sudan. Results indicated that approximately 31%, 32.5% and 14.8% of children were found to be moderately under nutrition, stunting and wasting, respectively. The intractable nature of this problem underscores the need to understand the epidemiology of childhood anemia and plan appropriate interventions. Hence the present study was undertaken to study the nutritional anemia and its effect of supplementary feeding program in children aged between 6 months and 59 months in Elhosh Unit, Gezira State, where recent estimates situated prevalence of anemia among children in this age group at 40% level [5].

In Sudan, all commercial weaning foods are imported because there is no domestic infant food industry. These imported foods are too expensive for low-income families. In addition, because of poverty and illiteracy, infant foods, when prepared at home, do not fulfill the nutritional requirement for children under 5 years of age because knowledge about food processing is limited and the processes applied may destroy nutrients [6]. To address this public health problem, effective strategies for improving the nutritional status of young children should be considered by promoting the use of high-quality home-prepared supplementary foods or by increasing the availability of low-cost processed foods through commercial channels. Therefore, there is a real need to study the development of an inexpensive, but nutritious and safe, complementary mixes from available food materials using simple technology to produce foods accessible to all sectors of the population. Crude fiber of starchy legumes was reported, *in vitro* studies simulating human digestion, to bind with iron, reducing its availability for absorption [7].

The major criteria for a good-quality supplementary food are high iron content, high balanced-protein content, high caloric value per unit of food volume, soft texture with low fiber content, adequate vitamin and other mineral contents, in addition to absence of anti-nutritional factors. With these requirements kept in mind, staple food materials such as wheat supplemented with pigeon pea, sesame, and date flour may be considered for the development of supplementary foods. Malting, soaking, and cooking techniques could be adopted. The present research work, using locally available foods and traditional processing techniques, aims to formulate, develop and assess the nutritive value, and quality of instant supplementary foods to alleviate anemia. For quality evaluation, a multi-parameter approach was followed [8] and the effect of processing on finished products [9] was recorded.

2. Materials and Methods

2.1. Materials

The raw materials included wheat, pigeon pea (*Cajanus cajan*) sesame (*Sesamum indicum*) and dates (*Phoynix dactilifera*) (Barakawi). In addition to wheat and legumes as protein sources, sesame, provides sulfur containing amino acids and dates, a readily available plant energy and minerals source.

2.2. Mixes and Products

The recipe of selected formula, based on FAO/WHO/UNU [10] recommendation for children, was wheat (40%), pigeon pea (30%), sesame (10%), dates (10%) and sugar (10%) for homemade, drum drier and biscuit form mixes. Additives, as vanillin and salt then oil were added to each mix.

Mixes were prepared (homogenously) by manual or electrical blending, weighed in poly ethylene cup, sealed and labeled. Products were developed either at home or in a community facility level as drum drier or biscuit form. The raw materials were prepared as shown in **Figure 1**.

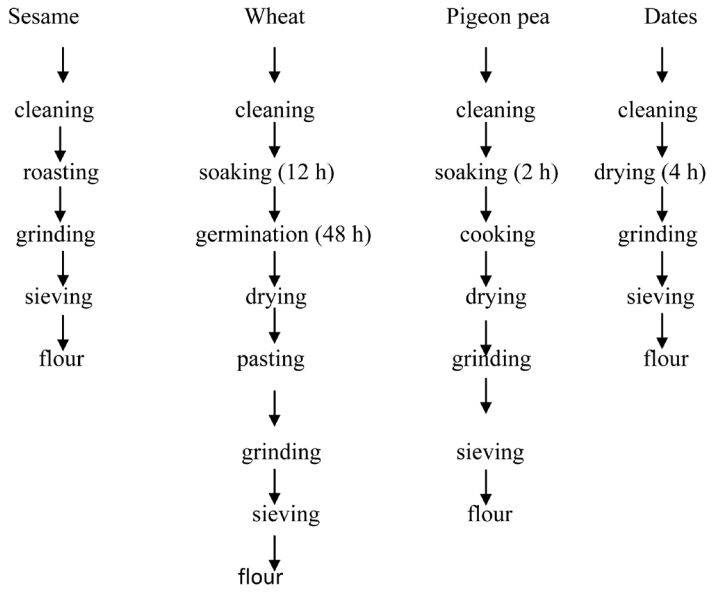

Figure 1. Raw materials preparation for homemade and processed diet, based on wheat, legumes, sesame and dates; for under-five children.

For the drum drier flakes and biscuit form, 4 kg of ingredients at same proportion was used. Slurry was prepared in a stainless steel kettle (50 kg capacity); water added in the ratio of 3:1 to make 25% slurry; continuously stirred with an electric mixer (Lightnin, Rochester, New York, USA), for 5 minutes. Vanillin, salt and oil were added and the mixture was well homogenized.

The slurry was baked using double drum drier (Blaw-Knox, Bufalo, New York, USA) with surface temperature (130˚C - 140˚C) and a speed of 2.5 rpm. Flakes were dried at room temperature and crushed to pass a 24 mesh, mill ground (1.0 mm) to resemble the particle size of the homemade products.

Finally the product was tightly packed in polyethylene sacks and labelled as therapeutic diet of anemic children.

Similar slurry was baked in biscuit form, using stainless steel pans at (130˚C - 140˚C).

2.3. Evaluation of Products

The three products were evaluated for moisture, protein, fat, ash, crude fiber, and carbohydrates [11] [12], iron, calcium and phosphorus [13] and total energy was calculated according to Awater factors [14].

2.4. Products Storage and Microbiological Analysis

The keeping quality of the mixes products were ascertained by storing products at room temperature and at 4˚C - 6˚C followed by microbiological analysis for total aerobic flora, total coliforms, *Staphylococcus aureus*, *Bacillus cerus*, molds, yeast and Salmonella [15].

2.5. Nutritive Value

Nutritive value was assessed by determining the protein and iron content by the standard methods [16] and by calculating the energy value using approximate analysis data.

3. Results and Discussion

3.1. Chemical Composition of Products (g/100g)

As shown in **Table 1** protein content of the products was 14.0% - 14.1%, the iron content (14.6 - 14.8 mg/100g, in line with the codex recommendation. Crude fiber was below the maximum value (5%) specified by codex recommendation. Results also showed that energy value of the products ranged from 382 to 390 Kcal/100g, which

was in line with recommendation for under-five aged children. Products are adequate in protein content and in energy density to meet the guidelines set for weaning food [17].

3.2. Storage and Microbial Analysis

Shelf life and quality of the products was ascertained by storing, a set of freshly prepared samples at refrigerator and another set at room temperature in air-tight containers; testing their quality during 5 months. Microbiological analysis revealed no detection of yeast, mold and salmonella for all stored samples (0, 1, 2, 3, 4 and 5 months), in refrigerator or at room temperature.

Results for detection of bacterial count; *Staphylococcus aurous*; sporeformers and coliforms are presented in **Table 2** and **Table 3** for homemade product; **Table 4** and **Table 5** for drum drier processed product and **Table 6** and **Table 7** for biscuit form product.

In all samples no yeast, mold or salmonella were detected. Recommended values for yeast and molds, $<10^3$; total *Salmonella* sp.; total bacterial count, $<10^5$; *Staphylococcus aurous*, $<10^5$; spore formers, $<10^5$; coliform, $<10^3$; [18]. The effect of storage on homemade mix, showed no constituents of, (*Escherichia coli*) in coliforms;

Table 1. Composition, energy and minerals in homemade and processed diet, based on wheat, legumes, sesame and dates; for under-five children.

Formulas	g/100g					Kcal	mg/100g			
	Moisture	Protein	Fat	Ash	Crude fiber	CHO	Energy	Fe	Ca	P	Ca/P
I*	6.8	14.1	5.0	2.1	1.9	70.1	382.	14.8	200	185	1: 1
I I**	6.3	14.0	5.8	2.0	1.8	70.1	390.0	14.6	196	187	1: 1
I I I***	6.7	14.0	5.3	2.0	1.8	70.2	385	14.6	196	187	1: 1

I* Homemade product, II** Drum dryer product, III*** Biscuit product. wh = wheat flour (40%); pp = pigeon pea (30%); se = sesame (10%); da = date (10%); su = sugar (10%). Energy: I g protein (4 Kcal), 1 g fat (9 Kcal), 1 g carbohydrates (4 Kcal). Composition data are average of three replicates.

Table 2. Microbiological analysis of homemade diet*, based on wheat, legumes, sesame and dates (for under-five children), stored in refrigerator at 4˚C - 6˚C.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	6.9×10^3	ND	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	ND	ND	4.5×10^2	1.2×10^3	5.9×10^3	$<10^5$
Spore formers	2.7×10^3	ND	7.0×10^2	8.5×10^2	5×10	9.5×10^2	$<10^5$
Coli-form	1.1×10^2	1.1×10^3	2.5×10^2	2.5×10^2	1.1×10^3	1.4×10^2	$<10^3$

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

Table 3. Microbiological analysis of homemade diet*, based on wheat, legumes, sesame and dates (for under-five children), stored at room temperature.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	6.9×10^3	$<10^5$	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	$<10^5$	ND	5×10	7.0×10^2	ND	$<10^5$
Spore formers	2.7×10^3	$<10^3$	5.5×10^2	ND	1.3×10^3	2.7×10^3	$<10^5$
Coli-form	1.1×10^2	1.4 E.Co. −ve	2.5×10 E.Co. −ve	0.5 E.Co. −ve	1.1	1.1	1.1×10^2

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

Table 4. Microbiological analysis of Drum drier processed diet*, based on wheat, legumes, sesame and dates (for under-five children), stored in refrigerator at 4˚C - 6˚C.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	7.2×10^3	ND	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	5×10	ND	1.0×10^2	9.5×10^3	7.5×10^3	$<10^5$
Spore formers	2.7×10^3	ND	1.6×10^3	1.3×10^3	2.5×10^2	5.0×10	$<10^5$
Coli-form	1.1×10^2	ND	0.8	0.8	1.4	1.4	1.1×10^2

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

Table 5. Microbiological analysis of drum drier processed diet*, based on wheat, legumes, sesame and dates (for under-five children), stored at room temperature.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	7.2×10^3	ND	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	ND	ND	2.5×10^2	$<10^2$	1.3×10^3	$<10^5$
Spore formers	2.7×10^3	ND	5.5×10^2	ND	4.5×10^2	1.3×10^3	$<10^5$
Coli-form	1.1×10^2	0.8	0.8	ND	2.5×10	0.5	1.1×10^2

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

Table 6. Microbiological analysis of Biscuits processed diet*, based on wheat, legumes, sesame and dates (for under-five children), stored in refrigerator at 4˚C - 6˚C.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	3.0×10^3	ND	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	5×10	ND	5.0×10^2	4.0×10^{23}	1.3×10^3	$<10^5$
Spore formers	1.4×10^3	ND	8.0×10^2	5.0×10	$<10^2$	5×10	$<10^5$
Coli-form	0.5	1.4	ND	0.8	0.5	ND	1.1×10^2

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

Table 7. Microbiological analysis of Biscuits processed diet*, based on wheat, legumes, sesame and dates (for under-five children), stored at room temperature.

Type of microbe	Storage time/months						
	0	1	2	3	4	5	Recommended value***
**TBC (cfu/g)	0.5	ND	ND	ND	ND	ND	$<10^5$
Staphylococcus aurous	ND	ND	ND	2.0×10^2	4.0×10^2	9.5×10^2	$<10^5$
Spore formers	1.4×10^3	ND	5.0×10	ND	5×10	5×10	1.4×10^3
Coli-form	0.5 EC –ve***	ND	ND E.C –ve	ND	ND	0.5	1.1×10^2

*Wheat flour, pigeon pea, sesame and date; **TBC: total bacterial count; ***CODEX CAC/GL, 1991; ND = not detected.

indicating that the blends are stable against microbial attack, after weaning diet in the range of 3.2×10^3 to 4.3×10^4 cfu/g, both acceptable according to WHO standards.

These results agree with those of Osundahunsi and Aworh [19] who found a total plate count of a tempe-based weaning diet in the range of 3.2×10^3 to 4.3×10^4 cfu/g, both acceptable according to WHO standards.

There was no record of (*Escherichia coli*) for drum dryer product (**Table 4**). The storage of biscuit diet (**Table 5**) at room temperature is better than at refrigerator 4˚C - 6˚C. This means there was no contamination during storage period of biscuits diet [20].

4. Conclusion

Legumes, sesame seeds and date can be effectively used in wheat-based weaning foods as an acceptable protein and mineral supplement.

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