Omdurman Islamic University Journal(OIUJ)
مجلة جامعة أم درمان الاسلامية
https://journal.oiu.edu.sd/index.php/oiuj
https://doi.org/10.52981/oiuj.v18i2.2280
2022; 18(2):16-39
ISSN: 5361-1858

Proximate analysis of Weaning Food formula based on Sorghum bicolor and legumes

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To cite this article:

Ibrahim, M., M. Hamad, R., & H. AL kamali, H. (2022). Proximate analysis of Weaning Food formula based on Sorghum bicolor and legumes. Omdurman Islamic University Journal, 18(2), 16-39. https://doi.org/10.52981/oiuj.v18i2.2280

Abstract

Different formulation of sorghum-based weaning foods were suggested by blending sorghum (Sorghum *bicolor* L.) with various combinations and quantities of locally available legumes as sources of protein such as pigeon pea, fenugreek seeds in addition to the date palm and godeim as source of fruits and moringa leaves as a source of vegetables. Twenty four meals of these ingredients divided into three groups, the first group (A_{1-8}) contained 80% Sorghum with 20%uncooked pigeon pea flour(A1) , 70% Sorghum with 30% uncooked pigeon pea flour in meal recipe (A2) , 80% Sorghum with 20% cooked pigeon pea in meal recipe (A3) ,70% Sorghum with 30% cooked pigeon pea in meal recipe (A4) ,80% Sorghum with 20% decorticated pigeon pea in meal recipe (A5) ,70% Sorghum with 30% decorticated pigeon pea in meal recipe (A6) , 95% Sorghum with 5% fenugreek seeds in meal recipe (A7) and 90% Sorghum with 10% fenugreek seeds in meal recipe (A8). Godeim and moringa added to group (A_{1-8}) to form the second group(B_{1-8}) and the last group (C_{1-8}) contained date palm and moringa plus meal recipe of group one (A_{1-8}). These meals (uncooked and coocked porridge flour) were analyzed for proximate composition, the protein content range between (11.76- 21.16%) to (12.25-%14.88%) , moisture from (7.30- 11.49%) to (5.79- 9.11, %), ash from (1.90- 3.38%)to (1.60- 3.13%),fat from(7.30-10.67%)to (3.02- 8.54%), fiber from (1.58 -5.37%) to (0.53- 9.89 %), carbohydrate from(56.09-68.45%) to (61.04- 72.13%), energy from (371.74- 405.61%)to(334.58- 388.42). The result indicated that the protein content of meals (A_{2-8} , $B_{7,8}$ and $C_{7,8}$) decreased significantly ($P \leq 0.05$) by

cooking. The protein content of all meals recipes within the range of recommended dietary allowances (RDA) and higher than the value of commercial products. The crude fiber of the weaning food was below the maximum value (5%) and decreased significantly than the fiber content of commercial products in meals (B_{1-6}, $A_{5,6}$ and $C_{7,8}$). The carbohydrates of all meals was lower than the value of commercial products and higher than the minimum standard level of specified by FAO (58%). The energy value of all meals was in line of the Recommended Dietary Allowances (RDA) and decreased significantly than the energy value of commercial product except in meals ($A_{2,4,5,6}$,B_{1-5} and $C_{5,7}$).

Keywords: Weaning food, Proximate analysis, Infants, Sorghum, Pigeon pea, Fenugreek, Godim, Date Palm.

Introduction

The weaning period is a crucial period in an infant's life .At the age of 5-6 months, most infants being to eat supplementary some solid foods. At this stage homogenized infant food play a major role in their nutrition **[1]**. Weaning food for a child in Sudan are relatively expensive in out of reach of a majority of the people and may result in malnutrition and pose a risk to the life of child , particularly if the parents are low – income earners.

The formulation and development of nutrition weaning foods from local and readily available raw materials has received a lot of attention in many developing countries **[2, 3]**. Legumes are largely replacing milk and other sources of animal protein, which are expensive and not readily available, as suitable substitutes for high quality protein. Study has shown that over 70% of dietary protein of developing countries is supplied by cereals that are relatively poor sources of protein.

Protein-energy Malnutrition (PEM) is a serious problem in most developing countries, the prevalence of under nutrition and micronutrient deficiencies is high among infants and young children aged 6 to 23 months, which increased the risk of underweight, stunt growth, and death at these ages. In Sudan the number of children treated for severe acute malnutrition (SAM) increased to 140,000, compared to 120,000 cases in 2013, although this only represents 27 percent of cases requiring treatment **[4, 5]**.

Ideally, all children in this age range are breastfed, however, when they get older, the energy and nutrient contribution of complementary food become increasingly necessary for meeting daily requirements. The small quantities of cereal-based porridges commonly fed to the infant and young

children were not contain enough energy and micronutrients to meet daily requirements **[6]**.The generally accepted recommendations for improving the nutritional status of children in this age group are to feed children with locally available micronutrient rich foods and encourage local production of low cost processed, fortified cereal-based complementary foods **[6, 7]**.

Accordingly, formulation and development of nutritious weaning foods from local and readily available raw materials has received considerable attention in many developing countries. However, the development of low-cost, high-protein food supplements for weaning infants is a constant challenge for developing countries **[7]**.The high cost of weaning foods, vegetables, and animal protein, together with the unavailability of nutritious foods, adds more to the difficulty of providing good nutrition to children.

A very good first food to give a baby, along with breast milk, is a soft, thick, creamy Porridge, made from the staple food of the community. Every community has a main staple food. It is often the first food that people think of when asked about their diet. The staple food contains starch, and it is eaten by most of the people in the community at most meal. It is usually less expensive than other types of food. The staple varies from country to country. It may be rice, wheat maize, cassava yam, potato etc. The staple is an excellent base for preparing babies' first weaning foods because it is usually cheaper than other types of food, is easily available, and provides most of the carbohydrates (starch) and often other nutrients needed for growth. A soft, thick, creamy porridge can be made from any staple food, and can be given to the baby along with breast milk **[8]**.

Protein requirement for infants 9.1g/day for infant from 0 – 6 month age and 11.00 g/day for infant from 7 -12 month age, the protein requirement of infants can be defined as the minimum intake that will allow nitrogen equilibrium at an appropriate body composition during energy balance at moderate physical activity, plus the needs associated with the deposition of tissues consistent with good health.

Infants require high quality protein from breast milk, infant formula, and/or complementary foods to build, maintain, and repair new tissues, including tissues of the skin, eyes, muscles, heart, lungs, brain, and other organs, Manufacture important enzymes, hormones, antibodies, and other components; and perform very specialized functions in regulating body processes.

In developing countries, infants who are deprived of adequate types and amounts of food for long periods of time may develop kwashiorkor, resulting principally from a protein deficiency;

marasmus, resulting from a deficiency of kilocalories; or marasmus-kwashiorkor, resulting from a deficiency of kilocalories and protein.

Carbohydrates are necessary in the infant's diet because they are supply food energy for growth, body functions, and activity, allow protein in the diet to be used efficiently for building new tissue, allow for the normal use of fats in the body; and Provide the building blocks for some essential body compounds. Carbohydrates serve as primary sources of energy to fuel bodily activities while protein and fat are needed for other essential functions in the body, such as building and repairing tissues.

Dietary fiber is found in legumes, whole grain foods, fruits, and vegetables. Breast milk contains no dietary fiber, and infants generally consume no fiber in the first 6 months of life. As complementary foods are introduced to the diet, fiber intake increases; however, no all for fiber has been established. It has been recommended that from 6 to12 months whole-grain cereals, green vegetables, and legumes be gradually introduced to provide 5 grams of fiber per day by 1 year of age **[9]**.

Infants require lipids in their diets because they are supply a major source of energy – fat supplies approximately 50 percent of the energy consumed in breast milk and infant formula, Promote the accumulation of stored fat in the body which serves as insulation to reduce body heat loss, and as padding to protect body organs, Allow for the absorption of the fat-soluble vitamins A, D, E, and K; and Provide essential fatty acids that are required for normal brain development, healthy skin and hair, normal eye development, and resistance to infection and disease.

weaning food represented major nutritional problems of infants in poor rural areas **[10]**. Inadequate feeding practices during the weaning period caused high mortality among infants and young children in the Sudan. Clinical survey carried out in Khartoum Teaching Hospital showed that all children suffering from malnutrition were mainly depending on kisra or aceda as source of energy **[11]**.

Sorghum has been successfully used in weaning programs after fortification with legumes. Various types of sorghum supplemented with chickpea used for the development of weaning foods, had shown good improvement of protein efficiency ratio **[12]**. described various weaning foods made from fortified sorghum that were promoted in a number of African countries.

Pigeon pea flour has been tested and found to be suitable as a protein source for supplementing cereal food products due to its high level of protein, iron and phosphorus **[13]**. Therefore It has

been recommended for school feeding programs and vulnerable sections of the populations in developing nations.

Wheat, rice sorghum and legumes grains were recommended as good ingredients for production of cereal-based baby foods. Feeding the weaned child in Sudan depends equally on the availability of milk and sorghum and millet **[14]**.

Fenugreek is a good source of protein, fiber, ash and carbohydrate; it is rich in minerals such as Ca, Na and Cu **[15]**. Like other legumes fenugreek can be considered as a highly nutritive seed since it contains both essential and non-essential amino acids.

Moringa seems to have the potential for solving, at least partially, many of the needs of the members of such communities and could play an important role in sustainable communities due to its high nutritious quality and adaptability to diverse and challenging environments in various reports **[16]**.

In Sudan, a drink is prepared by soaking the fruits of Godeim over-night, and then they are hand pressed, sieved and sweetened. A light porridge is prepared by the addition of flour or custard to Godeim drink and served during the fasting month of Ramadan and is also fed to lactating mother to improve their health and lactating abilities. Moreover, the fruits are made into a fermented drink in Sudan and Southern Africa **[17]**.

The date palm (*Phoenix dactylifera L*.) fruit is an important component of the diet in most of the hot arid and semi arid regions of the world. It is found to contain carbohydrates (total sugars 44% - 88%), fats (0.2% - 0.4%), proteins (2.3% - 5.6 %), fibers (6.4% - 11.5%), minerals and vitamins **[18]**.

The formulation and development of nutritious weaning foods from local and readily available raw materials has received a lot of attention in many developing countries, therefor this study aimed to evaluate the nutritional quality of sorghum, pigeon pea and fenugreek seeds with moringa leaves and godeim or dates palm based weaning food. Also represented specially cooking recipes for weaning food from available local materials to cover daily requirements for infants in rural area.

Materials And Methods

Materials

The raw materials which used to prepare the weaning food were fitereita (*Sorghum bicolor*) ,pigeon pea (*Cajunus cajan*) , Fenugreek seed (*Trigonella foenum- graecum*), fruits such as godeim (*Grewia tenax*) , date palm fruit(*Phoenix dactylifera*), sun flower oil ,sugar and commercial

products (Nestle cerelac). These materials were purchased from Khartaum local market, but the green leaves of moringa (*Moringa olifera*) were collected from the plant growing in Khartoum area . The green leaves were dried for (2-3 days) and then pounded to pass through 0.4 mm screen.

Godeim fruit were sorted manually and clean .The pulp separated from the seed and mill using electric blender, the pulp was packed in polyethylene bags and was stored in refrigerator until used for chemical analysis .For prepared baby food, godeim was soaked in water over night and blended with electric blender and sieved .Godeim sullury was made from 50%water and 50% godeim (w/v) .The whole grain of sorghum "fitereita " ,pigeon pea, fenugreek seed and date palm fruit were clean and sorted manually from the foreign material and mill to pass through 0.4mm screen.

The pigeon pea prepared by different treatments to make flour used for preparation baby food .One of the treatment the whole grain of pigeon pea cooked in boiling water (for 2 hour) until soft by hand feel in Sudan called "Baleila adasia" .The cooked grain of pigeon pea was dried and mill to pass through 0.4 mm screen ,another treatment, decorticated of pigeon pea by soaked whole seed of pigeon pea in water water for10 hours ,the seed bounding by using mortar and pestle. Seed were drained and dried and mill to pass through 0.4mm screen .These ingredient of (sorghum ,legumes, godeim, dates palm, moringa ,oil and sugar) were mixed in different ratios, table (1) and (2) to make flour which used to prepare porridge meal recipes of weaning food.

Weaning food formulation

Twenty four diet formulations were prepared by mixing varying proportion of sorghum flours and legumes with godeim and moringa or dates palm and moringa as shown in tables (1), (2) and (3).

Table (1) Mixed flour ratio of the different ingredients used in the preparation of the meals.

Formulation name	**% ratio of mixed flour***	**Mixed ratio of one cup in grams**	**Weight of one cup in gram**
1	80% of sorghum bicolor "fitereita" and 20% of whole untreated pigeon pea seed	101: 32	133
2	70% of sorghum bicolor "fitereita" and 30% of whole untreated pigeon pea seed	89: 48	137
3	80% of sorghum bicolor "fitereita"and 20% of cooked whole pigeon pea seed	101: 34	135
4	70% of sorghum bicolor "fitereita" and 30% of cooked whole pigeon pea seed	89: 51	140
5	80% of sorghum bicolor "fitereita"and 20% of presoaking and dehulling pigeon pea seed.	101:37	138

6	70% of sorghum bicolor (fitereita) and 30% of presoaking and dehulling pigeon pea seed.	89:56	145
7	95% of sorghum bicolor "fitereita"and 5% of Fenugreek seed	119: 6	125
8	90% of sorghum bicolor "fitereita"and 10% of Fenugreek seed	113: 12	125

* add aproximatly 4 cup of sorghum flour plus one cup of pigeon pea flour for (80% sorghum and 20% pigeon pea) or add aproximatly 3 cup of sorghum flour plus two cup of pigeon pea flour for (70% sorghum and 30% pigeon pea) and add one cup of sorghum flour plus two tea spoon of fenugreek flour for (95% sorghum and 5% fenugreek) or add one cup of sorghum flour plus 4 tea spoon of fenugreek flour for (90% sorghum and 10% fenugreek seed flour).

Table (2) Porridge meal recipe based on composite mixed flour from Sorghum and legumes.

Meals recipe	Ingredients
A	one cup of ingredients (1 - 8) +3 cup of water + one table spoon of sun flower oil(10 g) +one tea spoon of sugar (5 g)
B	one cup of (1,2,3,4,5,6,7,8) +3 cup of water + one table spoon of sun flower oil(10 g) +one tea spoon of sugar (5 g) + one Cup of gudeim slurry past (125g) + tow tea spoon of Maringa leaves powder (6 gram)
C	one cup of (1,2,3,4,5,6,7,8) +3 cup of water + one table spoon of sun flower oil(10 g) +one tea spoon of sugar (5 g) + 1/2 cup of date fruit (approximately 7 dates 53g)+tow tea spoon of Maringa leaves powder (6 gram)

Table (3) percentage composition for formulation of studied weaning food.

ingredients	**Percent dry weight basis**				
Blend))	**Sorghum**	**Uncooked pigeon pea**	**cooked pigeon pea**	**decorticated pigeon pea**	**Fenugreek seeds**
A/B/C/1	80	20	_	_	_
A/B/C/2	70	30	_	_	_
A/B/C/3	80	_	20	_	_
A/B/C/4	70	_	30	_	_
A/B/C/5	80	_	_	20	_
A/B/C/6	70	_	_	30	_
A/B/C/7	95	_	_	_	5
A/B/C/8	90	_	_	_	10

A = ingredients + oil + sugar.

B = ingredients + oil + sugar + Godeim and moringa.

C = ingredients + oil + sugar + Dates and moringa.

Preparation Method of the meals

The preparation of porridge meals follows the traditional method of cooking. Two cups of water were placed in the pot until boiling. The remaining of water mixed with cup of composite legumes and sorghum flour in different ratios to make smooth slurry. The slurry was added to the boiling water and mixed well until smooth and cooked for 20 25 minutes, the moringa powder leaves was added and cooked for last 3-4 minute, the ingredient of meal include dates fruit was added to the water before boiling.

Godeim slurry added at the last of 3-4 minute of cooking in the gudeim slurry recipe. Vegetable oil (one table spoon 10g) and sugar (one tea spoon 5g) added , after cooking the porridge spread out thinly in dishes and air dried. The dried flakes milled into fine flour, to pass through 0.4 mm screen and was stored at 4oC until uses for analysis.

Proximate analysis

The determination of moisture, crude fiber, crude fat and ash carried out according to AOAC method **[19]**.

Results and Discussion

Proximate composition of weaning food

Protein content

Protein content of different recipe meals (A, B and C) and the proprietary formula (Nestle Cerelac) are presented in Table (4). The results indicated that protein content of weaning food (cooked porridge) range from 13.00 – 14.88% in all ingredients of meals recipe (A,B and C) higher than the protein content of two commercial products (Nestle Cerelac with milk 11.66% and Nestle Cerelac without milk 9.10%) except the protein content of ingredients (1) of meals recipe (C) higher than the second one (Nestle Cerelac without milk).The protein content of uncooked porridge flour was 21.16% , 18.54 and 17.13% for meal recipe (A 8,7,6) respectively.

cooking decreased significantly ($P \leq 0.05$) the protein content of all ingredients of meals recipes (A), ($B_{7,8}$) and ($C_{7,8}$) , a similar findings was confirmed that cooking decreased the protein content of cereals and legumes**[20]**. The decrease in the protein content by cooking was due to heating which

causes the native protein to unfold and exposing an ionic groups to cross link with divalent cations and sulphohydride groups to form disulphide linkages **[21]**. While cooking increased the protein content of ingredients (B_{1-4}) and ingredients (C_{1-6}) significantly ($P \leq 0.05$).

A dry weight of 100 g of the of meals recipe of the blends were calculated and compared to recommended dietary allowances **[22]**. for the same age groups. The amounts of protein provided by100 g of (23) meals (cooked porridge) range from (13 - 14.88 g) exceeded the RDA value (13 - 14 g), for infants up to 1 year of age, except ingredient (7) of meal recipe (C) fell short of the RDA level 12.25%. Also protein content in 7 formulate meals recipe blends (cooked porridge) was in line with the Codex **[23]**. The minimum protein content should be recommended in the order of 15g/100 on dry bases. **[24]**and the,safe level of protein intake of pre- school children (4-6 years) for developing countries, using two proteins (soy bean and milk protein), should be 0.94g protein/kg/day for milk, and 1.01g protein/kg/day for soya bean isolate**[25]**.

In similar weaning products similar range protein were observed, from 9.69- 13.69% ,15.15% **,** 10. 28-13.7 %, and the range of 14.8 – 15 .6% ,**[26, 27, 28, 29]** also the tested meals show high protein content than the range of 8.70-10.50% for similar weaning food**[30]**.
Since most cereals such as Sorghum have a low protein content (e.g., methionine, lysine, and tryptophan), cereal-based complementary foods should be improved to fortifiy from such ingredients by protein-rich legumes foodstuffs to improve their nutritional value **[31]**.

The protein content of (cooked porridge) of meals recipes (A) decreased significantly ($P \leq 0.05$) for ingredient (1,3 and 5) when date palm and moringa added to meals recipe (C), and godeim and moringa added to meals recipe (B). The protein content of ingredients (7) was found to be increased significantly ($P \leq 0.05$) when godeim and moringa added in meals recipe (B) ,while it decreased significantly when date palm and moringa added to meals recipe (C).

The results of protein content of all ingredients (uncooked porridge flour) of meals recipe (A,B and C) showed that the protein content range from 14.87- 21.16% and decreased significantly ($P \leq 0.05$) to the range of 12.72 -16.91% when godeim and moringa added in meals recipe (B). Also the decreased was continued when date palm and moringa added in meals recipe (C) (11.54 -

12.60%),the decrease of protein content of meal recipe may be refer to low protein content of godeim and date palm.

Oil content

The results of the oil content in (24) meals (cooked porridge) range from 3.02 – 6.93% increased significantly (P≤0.05) than the oil content in the second commercial product (Nestle Cerelac without milk) but decreased significantly (P≤0.05) than the oil content in the first commercial product (Nestle Cerelac with milk) except one ingredient (4) of meal recipe (A) showed the highest value 8.54% than all ingredients of cooked porridge of all meals recipes (Table 4). While the oil values of (uncooked porridge flour) increased significantly (7.30- 10.67%) in all meals, thus cooking decreased significantly oil content in all ingredients of meals recipe (A, B and C) .

The oil content of all ingredients (cooked porridge) of meals recipe (A,B and (C) except ingredients (6 and 7) decreased significantly (P≤0.05) when godeim and moringa or date palm and moringa added to meal recipe (B) and (C).

The decreased of the oil content showed after cooking and highly decrease represented after adding dates palm or godeim, The decrease may be due to the loss of oil during cooking and during preparation and drying and the second reason increase of porridge quantities specially when adding godeim or dates palm.

The oil level of (cooked porridge) ingredients of all meals recipe range from (3.02 – 8.54%) was kept low to control rancidity during storage this oil level provide about 7.50 -21.22% of the total energy of the weaning food which was reasonable. The recommended calorie derived from oil raised from 8% to level of 20% of total energy **[32]**. The codex standard for processed cereal-based foods for infants and young children recommend the oil content of the tested diet category not to exceed a maximum oil content of 3.3g/100kcal **[33]**this value is equivalent 11.00 - 12.8 % in all ingredient of different recipe of weaning food from (cooked porridge), thus, the oil content for the tested formulae were within the range recommended by the Codex **[33]**, and lower than the range (9.67-11.73%) of oil content in similar weaning diet **[30]**.

The importance of the fats in the diets for young children and infants is to providing fatty acids, enhancing the absorption of fat-soluble vitamins, and augmenting the dietary energy density **[34]**.

Carbohydrate content

The results indicated that the carbohydrate values in all meals (uncooked and cooked porridge) range from 61.13 – 72.13% and decreased significantly (P≤0.05 Table 9) than the carbohydrate

content in commercial product (Nestle Cerelac without milk was 77.38%). The highest value of carbohydrate content of weaning food (cooked porridge) was shown in ingredient (6) of meals recipe (A) 72.13% followed by 70.41 and 70.32% in ingredient (5) of meals recipe (B and A) respectively.

Table (4)Proximate composition(gm%) of weaning food formulated from Sorghum bicolor and legumes + godeim or dates palm and moringa (Protein,fat,CHO and energy)

Meal recipe	Ingredient	Treatment	Protein%	Fat%	CHO%	Energy kca/100gm
A	1. S : UP 80: 20	Uncooked	14.87^{f} ±0.39	10.67^{a} ±1.15	61.11^{l} ±0.35	399.95^{ab} ±10.85
		Cooked	14.88^{f} ±0.40	5.86^{f} ±0.21	62.74^{k} ±0.39	363.22^{e} ±0.8.46
	2. S : UP 70: 20	Uncooked	15.13^{e} ±0.44	10.22^{a} ±1.19	59.79^{n}±0.28	374.58^{d} ±11.06
		Cooked	14.88^{f} ±0.40	6.93^{e} ±0.15	61.21^{l} ±0.32	366.73^{e} ±8.47
	3. S : CP 80: 20	Uncooked	15.86^{e}±0.52	10.53^{a}±1.22	62.58^{k}±0.22	405.61^{a} ±12.19
		Cooked	14.00^{f}±0.36	5.08^{f}±0.07	63.54^{j}±0.25	355.88^{f} ±6.51
	4. S : CP 70: 20	Uncooked	16.2^{d} ±0.53	10.04^{a} ±1.57	61.85^{l} ±0.29	402.64±6.41
		Cooked	14.00^{f} ±0.36	8.54^{c} ±0.24	61.31^{l} ±0.20	378.10^{d}±4.81
	5. S : dP 80: 20	Uncooked	15.77^{e} ±0.51	10.32^{a} ±1.29	61.86^{l} ±0.20	403.40^{a}±6.74
		Cooked	14.00^{f} ±0.36	5.68^{f} ±0.18	70.32^{c} ±0.35	388.40^{c}±5.71
	6. S : dP 70: 20	Uncooked	17.13^{c}±0.69	9.72^{b}±1.20	60.89^{m}±0.36	399.56^{ab}±9.41
		Cooked	14.44^{f}±0.37	3.02^{h}±0.25	72.13^{b}±0.30	373.46^{d}±6.79
	7. S : FK 95 : 5	Uncooked	18.54^{b}±0.7	10.45^{a}±1.33	59.13^{n}±0.29	404.73^{a}±12.09
		Cooked	13.13^{g}±0.15	4.22^{g}±0.34	65.48^{h}±0.28	352.42^{f}±7.41
	8. S : FK 90:10	Uncooked	21.16^{a}±0.77	10.60^{a}±1.74	56.09^{o}±0.30	404.40^{a}±12.21
		Cooked	14.00^{f}±0.36	5.70^{f}±0.38	63.51^{j}±0.27	361.34^{e}±7.26
B	1. S : UP 80: 20	Uncooked	12.72^{h}±0.15	7.96^{d}±0.16	63.12^{j}±0.39	375.00^{d}±9.67
		Cooked	14.00^{f}±0.36	4.44^{g}±0.19	69.04^{d}±0.35	372.12^{d}±7.69
	2. S : UP 70: 20	Uncooked	13.75^{g}±0.29	7.70^{d}±0.14	62.19^{k}±0.36	371.94^{d}±9.41
		Cooked	14.05^{f}±0.37	4.03^{g}±0.12	69.19^{d}±0.34	369.23^{e}±7.64
	3. S : CP 80: 20	Uncooked	12.92^{h}±0.18	7.89^{d}±0.18	64.12^{i}±0.27	379.17^{d}6.54
		Cooked	13.57^{g}±0.28	4.04^{g}±0.05	69.88^{d}±0.28	370.16^{d}±5.64
	4. S : CP 70: 20	Uncooked	13.47^{g}±0.25	7.62^{d}±0.19	63.57^{j}±0.27	377.86^{d}±5.96
		Cooked	14.00^{f}±0.36	3.95^{h}±0.13	68.65^{e}±0.27	366.15^{e}±5.44
	5. S : dP 80: 20	Uncooked	13.41^{g}±0.22	7.79^{d}±0.17	63.57^{j}±0.26	378.03^{d}±8.96

		Cooked	13.57^{g}±0.26	3.78^{h}±0.13	70.41^{c}±0.36	369.94^{e}±11.02
	6. S : dP 70: 20	Uncooked	14.47^{f}±0.45	7.45^{d}±0.12	62.83^{k}±0.27	376.25^{d}±8.73
		Cooked	14.00^{f}±0.36	3.28^{h}±0.21	69.77^{d}±0.28	364.60^{e}±6.46
	7. S : FK 95 : 5	Uncooked	15.13^{e}±0.44	7.69^{d}±0.10	61.83^{l}±0.29	377.05^{d}±5.72
		Cooked	14.00^{f}±0.36	5.38^{f}±0.36	62.16^{k}±0.20	353.06^{f}±6.38
	8. S : FK 90 : 10	Uncooked	16.91^{d}±0.58	7.79^{d}±0.11	59.79^{n}±0.29	376.91^{d}±9.85
		Cooked	14.00^{f}±0.36	5.69^{f}±0.41	61.04^{l}±0.26	351.37^{f}±5.74
C	1. S : UP 80: 20	Uncooked	11.76^{i}±0.11	7.79^{d}±0.19	66.29^{g}±0.32	381.43^{c}±10.56
		Cooked	13.00^{g}±0.24	3.74^{h}±0.17	62.23^{k}±0.33	334.58^{h}±6.74
	2. S : UP 70: 20	Uncooked	12.30^{h}±0.15	7.54^{d}±0.15	66.56^{g}±0.31	383.30^{c}±10.33
		Cooked	14.00^{f}±0.36	5.61^{f}±0.09	63.38^{j}±0.30	360.01^{e}±6.57
	3. S : CP 80: 20	Uncooked	11.54^{i}±0.10	7.73^{d}±0.12	68.45^{e}±0.28	390.41^{b}±5.79
		Cooked	14.00^{f}±0.36	4.24^{g}±0.06	63.48^{j}±0.27	348.08^{g}±5.76
	4. S : CP 70: 20	Uncooked	12.60^{h}±0.17	7.46^{d}±0.17	67.99^{f}±0.22	389.50^{c}±0.5.61
		Cooked	14.00^{f}±0.36	3.67^{h}±0.16	62.59^{k}±0.21	339.39^{h}±10.01
	5. S : dP 80: 20	Uncooked	12.25^{h}±0.14	7.62^{d}±0.11	68.06^{e}±0.24	389.82^{c}±10.03
		Cooked	14.88^{f}±0.40	5.26^{f}±0.12	65.04^{h}±0.26	367.02^{e}±14.50
	6. S : dP 70: 20	Uncooked	13.33^{g}±0.21	7.30^{d}±0.15	67.45^{f}±0.21	388.82^{c}±5.71
		Cooked	14.44^{f}±0.37	4.37^{g}±0.33	65.53^{h}±0.21	359.21^{f}±5.88
	7. S : FK 95 : 5	Uncooked	13.25^{g}±0.17	7.51^{d}±0.18	66.07^{g}±0.28	387.27^{c}±6.06
		Cooked	12.25^{h}±0.14	5.48^{f}±0.37	67.04^{f}±0.22	366.48^{e}±5.74
	8. S : FK 90 : 10	Uncooked	15.62^{e}±0.47	7.62^{d}±0.20	60.60^{m}±0.28	373.46^{d}±8.81
		Cooked	14.88^{f}±0.40	4.54^{g}±0.32	65.74^{h}±0.24	363.34^{e}±6.22
Commercial product	Nestle cerelac with milk		11.66^{i}±0.28	7.30^{d}±0.15	70.66^{c}±0.48	394.98^{b}±9.32
	Nestle cerelac without milk		9.10^{j}±0.23	2.30^{i}±0.08	77.38^{a}±0.55	366.62^{e}±5.99
Recommended values/day			13-14gm	10-25gm	58-64gm	200-425kcal

Mean(s) bearing different superscript(s) are significantly different (P≤0.05) according to DMRT. Values are mean ±SD

Key for ingredients: S: Sorghum, UP: Untreated pigeon pea, CP: Cooked pigeon pea, dp: Decorticated pigeon pea, FK: Fenugreek seeds ,

A ≡ Ingredient + oil + sugar

B ≡ Ingredient + oil + sugar + Godaim and Moringa

C ≡ Ingredient + oil + sugar + dates and Moringa *Recommended values for infant complementary foods .

The codex specified that the minimum standard level of carbohydrate is 58% and the role of energy food to spare protein was early emphasized **[35]**. In similar weaning products similar range from 68.7 – 72.7% of carbohydrate were observed, **[36]**.

Although carbohydrate plays very important sources of the energy value in complementary foods and thus its content should be high for infants to obtain the requirement of the energy, they should be as much digestible as possible **[37]**.

The carbohydrate content of raw constituent (un cooked porridge flour) range from 59.13-68.45% and after cooking increased significantly (P≤0.05) in ingredients (7 and 8) of meals recipe (C) and in all ingredients of meals recipe (A and B) except ingredient (4) of meals (A).

The carbohydrate content of weaning food (cooked porridge) in all ingredient of meals recipe (A) compared to those of meals recipes (B) and (C) showed that: the carbohydrate content increased significantly (P≤0.05) in ingredients (1- 4) and (2,4,7 and 8) when godeim and moringa or dates palm and moringa were added to meals recipe (B and C) respectively, but decreased significantly (P≤0.05) in ingredients (6,7 and 8) and ingredients (5 and 6) when godeim and moringa or dates palm and moringa were added to meals recipe (B and C) respectively. The carbohydrate content of all ingredients (uncooked porridge flour) of meals recipe (A) increased significantly(P≤0.05) when godeim and moringa and date palm and moringa added to meals recipe (B and C) respectively.

Energy (kcal %) content

The energy value of (cooked porridge) in different recipe meals (A,B and C) range from 334.58 – 366.15%,it decreased significantly (P≤0.05) than the energy value in two commercial product (Nestle cerelac) except five ingredient of weaning food (4, 5 and 6) of meals recipe (A),(1 and 3) of meals recipe (B) (370.16 – 388.40%),all these meals were increased significantly (P≤0.05) than the energy value of the second commercial product (Nestle cerelac without milk 366.62%) (Table

4).The highest value of the energy content (cooked porridge) was 388.40 kcal show in ingredient (5) of meals recipe (A) followed by 378.10, kcal% in ingredient (4) of meals recipe (A).

The energy value of weaning food (cooked porridge) range from 334.58- 388.40% which was in line of the Recommended Dietary Allowances (RDA) **[22]**.,the energy requirement for infants from 6 to 12 months of aged is 700kcal of energy per day, and 830kcal of energy per day for infants from 12 to 24 months of age .These requirement were based on energy reference to human milk (70kcal/100ml) **[24, 38]**, amount of complementary food needed is also variable depending on the source. Assuming the requirement of 700kcal of energy per day and knowing that human milk has an energy density of 70kcal/100ml. We can determine that a consumption rate of 600ml of breast milk per day, an infant will acquire 420kcal **[38]**. A calculation can be made to identify the additional calorie intake required from a complementary food. An additional calorific value of 280kcal per day is required to satisfy the energy needed of an infant aged 6 to12 months **[39]**.reported that the requirement of energy from complementary foods can be calculated as the difference between the total recommended intake and the energy consumed from breast milk at different ages.The estimated energy need from complementary foods is approximately 200 kcal/day for infants aged 6-8 months, 300 kcal/da for infants aged 9-11 months and 550 kcal/day for children aged 12-23.

To compared the energy value of meals recipe (cooked porridge) which range from 334.58 – 388.40% to other weaning food was found to be in the range of 306.07 – 380.59% kcal **[40]**., lower than the value of 414.25% kcal reported by Mohammed *et al.*,(2011) **[41]**. and higher than 198.19 - 308.2% kcal reported by Mohammed (2004) **[42]**.

The energy content of raw constituent (un cooked porridge flour) range from 371.94 – 405.61 % after cooking decreased significantly ($P \leq 0.05$) in all ingredient of meals recipe (A, B and C).

Comparison of the energy content of weaning food ingredients (cooked porridge) of meals recipe (A) to those of meals recipes (B) and (C) show that: the energy content increased significantly ($P \leq 0.05$) in ingredients (1,2,3 and 7),but decreased significantly ($P \leq 0.05$) in ingredient (4,5,6 and 8)

when godeim and moringa were added to meals recipe (B) respectively, and was decreased significantly($P \leq 0.05$) in ingredient (1- 6) and continued to increased significantly($P \leq 0.05$) in ingredients (7 and 8) when date palm and moringa were added to meals recipe (C) respectively, In this study decreased energy values after cooking and after adding dates palm or godeim may be due

to the loss of oil during cooking and during preparation of drying and also the increase of porridge quantities specially when adding godeim or dates palm.

The energy content of all ingredients (uncooked porridge flour) of meals recipe (A) decreased significantly when godeim and moringa were added to meals recipe (B) and continued to decrease significantly when date palm and moringa were added to meals recipe (C) .

The higher energy content explained by the high-fat content of the contributing ingredients used for the weaning food formulations **[43]**.

Moisture content

The results indicated that moisture values in all meals (uncooked and cooked porridge) range from 5.79 - 9.11% in different meals recipe (A,B and C) increase significantly ($P \leq 0.05$) than the moisture content in two commercial products Nestle Cerelac with milk(3.03%) and Nestle Cerelac without milk (3.32%) (Table 5). Moisture content of meals recipes was reasonably low to secure safety difference during storage .Codex international standard recommended maximum level of 10% for such mix Codex, (1994), these values of moisture content of meals recipe agree with similar weaning food from sorghum and legumes where the moisture content was 7.20% and 7.5% **[44, 30]**.

The highest value of moisture content of (cooked porridge) was 9.11% shown in ingredient (6) of meal recipe (B), whereas the highest values of moisture content of (uncooked porridge flour) was11.4.9% shown in ingredients (8) of meal recipe(C).

The moisture content of cooked porridge of all ingredients of different recipe meals (A, B and C) were ranged from 5.79 – 9.11% these values within the range of 6.74 – 7.93% **[40]**.

The moisture content of (uncooked porridge flour) after cooking decreased significantly ($P \leq 0.05$) in all ingredients of meals recipe (A) and four ingredients (5,6,7 and 8) of meals recipe (C), but cooking increased significantly ($P \leq 0.05$) the moisture content of ingredients (3,6,7 and 8) and in ingredients (3 and 4) of meals recipe (B and C).

The moisture content of all ingredients (cooked porridge) of meals recipe (A) increased significantly ($P \leq 0.05$) when godeim and moringa was added to meals recipe (B) and was continued to increased significantly when date palm and moringa was added to meals recipe (C) except ingredients (5 and 6) .

The moisture content of (uncooked porridge flour) increased significantly (P≤0.05) in ingredients(1, 7 and 8) but decreased significantly (P≤0.05) in ingredients (5 and 6) when date palm and moringa was added to meals recipe (C).

Ash content

The results indicated that the ash values of (24) ingredient of (cooked porridge) when compared to the ash values of commercial products showed that the ash values range from 2.07 – 2.95% in ingredients (2, 4, 5 and 6) of meals recipe (A), (1, 3, 5, 7 and 8) of meals recipe (B),and all ingredients of meals recipe (C) decreased significantly (P≤0.05) than the ash content in the first commercial product (Nestle Cerelac with milk 3.21%) , (Table 5). While the ash content of ingredient (2, 4 and 6) of meals recipe (B) increased significantly (P≤0.05) than the ash content in the second commercial product (Nestle Cerelac without milk 2.40 %). On the other hand the ash value of ingredient (1, 3,7and 8) of meals recipe (A) range from 1.60 –1.92 and decreased significantly (P≤0.05) than the ash value of the two commercial product (Nestle cerelac).

The highest value of ash content of (cooked porridge was 3.13, 3.04 and 3.12% shown in ingredient 2,4 and 6 of meal recipe (B) respectively, where the highest values of the ash content of (uncooked porridge flour) range from 3.00 -3.38% shown in all ingredients of meal recipe(B)except ingredient (7).

The comparison of the ash content of weaning food ingredients (cooked porridge) of meals recipe (A) to those of meals recipes (B) and (C) showed that, the ash content of all ingredient of meals recipe (A) except ingredient (5) increased significantly (P≤0.05) when godeim and moringa added to meals recipe (B) and continued to increased significantly (P≤0.05) in ingredients (1,7 and 8) when date palm and moringa added to meals recipe (C).

The ash content of all ingredients (uncooked porridge flour) of meals recipe (A) increased significantly (P≤0.05) when godeim and moringa was added to meals recipe (B), and continued to increased in ingredients (7 and 8) when date palm and moringa was added to meals recipe (C).

The result indicated that cooking decreased significantly the ash content of ingredients (1 and 3) of meals recipe (A) and (1, 3, 5 and 8) of meals recipe (B) . The ash content of formulated complementary food within the range 1.26- 2.3% **[37]**, also the ash content it indicated the presence of the minerals in food samples **[45]**.

Fiber content

The result indicated that the higher value of the fiber content of (cooked porridge) was 9.89 % followed by 9.03% in ingredient (1 and 4) of meal recipe (C). whereas the lowest value of the fiber

content was 0.53% show in ingredients (5) of meal recipe(A). The fiber content (cooked porridge) in eight ingredients (5 and 6 of meals recipe A, and (1- 6) of meals recipe B) range from 0.53 – 2.42% were decreased significantly (P≤0.05) than the fiber content in the two commercial products (Nestle Cerelac with milk 4.16% and Nestle Cerelac without milk 5.50%). While the fiber content in ingredients (7 and 8) of meals recipe (C) was 5.89 and 5.87% respectively, they were increased significantly (P≤0.05) than the fiber content in the first product (Nestle Cerelac with milk). Also the fiber content in all ingredients except (5 and 6) of meals recipe (A), (7 and 8) of meals recipe (B) and (1- 6) of meals recipe (C) range from 6.15 - 9.89% were increased significantly (P≤0.05) than the fiber content in two commercial products.

Crude fiber content (of cooked porridge) range from (0.53 – 2.42%) in ingredients (1- 6) of meals recipe (A) and in ingredients (5 and 6) of meals recipe (B) was under the maximum limit of crude fiber for infants and pre –school children set by the Codex **[23]**. These values were similar to fiber content in weaning diet (2009) **[30]**.

The digestive system of infants is incompletely developed so the digesting of high fiber foodstuff is very difficult **[45]**. The high fiber content in complementary foodstuffs can result in high-water and nutrients absorption and also displacement of energy and nutrient required for the growth of children less than 12 months **[34]**.

The fiber content of weaning food ingredients (cooked porridge) of meals recipe (A) compared to those of meals recipes (B) and (C) showed that: the fiber content of ingredient (1, 2, 3,4 and 7) decreased significantly (P≤0.05) when godeim and moringa added to meals recipe (B), and was continued to decreased significantly (P≤0.05) in ingredient (2,3,7 and 8) when date palm and moringa added to meals recipe (C).whereas the fiber content of ingredients (5 and 6) increased significantly(P≤0.05) when date palm and moringa added to meals recipe (C).

The fiber content range from (1.58 – 5.06%) in all ingredients of all meals recipes in raw constituent(un cooked porridge) decreased significantly (P≤0.05) than the fiber content in two commercial products(Nestle Cerelac).

The fiber content of (un cooked porridge flour) range from (1.58 – 5.06%) in all ingredients of all meals recipes, while after cooking it decreased significantly (P≤0.05) in all ingredient of meals recipe (B) except ingredient (7 and 8) also it increased significantly (P≤0.05) in all ingredients of meals recipe (A and C) except in ingredients (5 and 6) of meals recipe (A). A similar finding was investigated that cooking increased the fiber content of pearl millet**[44]**.

The comparison the fiber content of all ingredients (uncooked porridge) of meals recipe (A) to those of meals recipes (B) and (C) showed that the fiber content of all ingredients of meals recipe (A) increased significantly when godeim and moringa were added to in meals recipe (B) but the fiber content of ingredient (1) decreased significantly when date palm and moringa were added to meals recipe (C).

Table (5)Proximate composition of weaning food formulated from Sorghum bicolor and legumes + godeim or dates palm and moringa (Moisture, Ash and Fiber)

Meal recipe	Ingredient	Treatment	Moisture%	Ash%	Fiber%
A	1. S : UP 80: 20	Uncooked	$7.88^{d}\pm0.27$	$2.37^{b}\pm0.19$	$3.10^{g}\pm0.29$
		Cooked	$7.00^{d}\pm0.18$	$1.89^{c}\pm0.14$	$7.63^{c}\pm0.36$
	2. S : UP 70: 20	Uncooked	$7.85^{d}\pm0.31$	$2.60^{b}\pm0.15$	$3.68^{g}\pm0.41$
		Cooked	$6.52^{e}\pm0.21$	$2.23^{b}\pm0.20$	$8.23^{b}\pm0.41$
	3. S : CP 80: 20	Uncooked	$7.72^{d}\pm0.25$	$2.33^{b}\pm0.17$	$1.71^{i}\pm0.66$
		Cooked	$6.49^{e}\pm0.44$	$1.92^{c}\pm0.08$	$8.97^{b}\pm0.25$
	4. S : CP 70: 20	Uncooked	$7.67^{d}\pm0.31$	$2.56^{b}\pm0.24$	$1.67^{i}\pm0.28$
		Cooked	$5.79^{f}\pm0.25$	$2.08^{b}\pm0.25$	$8.28^{b}\pm0.59$
	5. S : dP 80: 20	Uncooked	$8.09^{c}\pm0.26$	$2.31^{b}\pm0.16$	$1.66^{i}\pm0.25$
		Cooked	$7.29^{d}\pm0.18$	$2.18^{b}\pm0.15$	$0.53^{j}\pm0.02$
	6. S : dP 70: 20	Uncooked	$8.15^{c}\pm0.25$	$2.53^{b}\pm0.27$	$1.58^{i}\pm0.15$
		Cooked	$7.14^{d}\pm0.11$	$2.44^{b}\pm0.25$	$0.83^{j}\pm0.06$
	7. S : FK 95 : 5	Uncooked	$7.91^{d}\pm0.15$	$2.53^{b}\pm0.27$	$2.07^{h}\pm0.32$
		Cooked	$6.77^{e}\pm0.12$	$2.44^{b}\pm0.25$	$8.80^{b}\pm0.58$
	8. S : FK 90:10	Uncooked	$7.85^{d}\pm0.29$	$1.98^{c}\pm0.10$	$2.32^{h}\pm0.19$
		Cooked	$6.51^{e}\pm0.17$	$1.67^{c}\pm0.15$	$8.61^{b}\pm0.62$
	1S : UP 80: 20	Uncooked	$7.91^{d}\pm0.22$	$3.23^{a}\pm0.22$	$5.06^{e}\pm0.3$
			$7.83^{d}\pm0.19$	$2.95^{b}\pm0.25$	$1.74^{i}\pm0.21$

B		Cooked			
	2. S : UP 70: 20	Uncooked	$7.89^{d}\pm0.33$	$3.33^{a}\pm0.29$	$5.37^{e}\pm0.47$
		Cooked	$7.95^{d}\pm0.23$	$3.13^{a}\pm0.28$	$1.65^{i}\pm0.17$
	3. S : CP 80: 20	Uncooked	$7.80^{d}\pm0.14$	$3.19^{a}\pm0.12$	$4.08^{f}\pm0.21$
		Cooked	$8.28^{c}\pm0.15$	$2.91^{b}\pm0.11$	$1.32^{i}\pm0.11$
	4. S : CP 70: 20	Uncooked	$7.76^{d}\pm0.25$	$3.38^{a}\pm0.23$	$3.97^{g}\pm0.40$
		Cooked	$7.94^{d}\pm0.18$	$3.04^{a}\pm0.28$	$2.42^{h}\pm0.37$
	5. S : dP 80: 20	Uncooked	$8.06^{c}\pm0.41$	$3.17^{a}\pm0.27$	$4.00^{f}\pm0.27$
		Cooked	$8.58^{c}\pm0.27$	$2.87^{b}\pm0.20$	$0.79^{j}\pm0.08$
	6. S : dP 70: 20	Uncooked	$8.10^{c}\pm0.21$	$3.29^{a}\pm0.33$	$3.86^{g}\pm0.44$
		Cooked	$9.11^{b}\pm0.35$	$3.12^{a}\pm0.30$	$0.72^{j}\pm0.05$
	7. S :FK 95 : 5	Uncooked	$7.94^{d}\pm0.16$	$2.95^{b}\pm0.18$	$4.46^{f}\pm0.24$
		Cooked	$8.24^{c}\pm0.18$	$2.39^{b}\pm0.16$	$7.83^{c}\pm0.51$
	8. S : FK 90 : 10	Uncooked	$7.89^{d}\pm0.23$	$3.00^{a}\pm0.16$	$4.68^{f}\pm0.36$
		Cooked	$8.25^{c}\pm0.26$	$2.52^{b}\pm0.12$	$8.50^{b}\pm0.60$
C	1. S : UP 80: 20	Uncooked	$8.86^{c}\pm0.26$	$2.60^{b}\pm0.17$	$2.92^{h}\pm0.58$
		Cooked	$8.62^{c}\pm0.29$	$2.52^{b}\pm0.18$	$9.89^{a}\pm0.45$
	2. S : UP 70: 20	Uncooked	$7.51^{d}\pm0.25$	$2.76^{b}\pm0.21$	$3.33^{g}\pm0.28$
		Cooked	$7.11^{d}\pm0.22$	$2.39^{b}\pm0.18$	$7.51^{c}\pm0.33$
	3. S : CP 80: 20	Uncooked	$7.52^{d}\pm0.21$	$2.59^{b}\pm0.14$	$1.97^{i}\pm0.17$
		Cooked	$8.21^{c}\pm0.36$	$2.37^{b}\pm0.13$	$7.70^{c}\pm0.24$
	4. S : CP 70: 20	Uncooked	$7.30^{d}\pm0.41$	$2.69^{b}\pm0.21$	$1.93^{i}\pm0.16$
			$8.31^{c}\pm0.28$	$2.40^{b}\pm0.21$	$9.03^{a}\pm0.61$

		Cooked			
	5. S : dP 80: 20	Uncooked	7.60^{d}±0.22	2.55^{b}±0.11	1.92^{i}±0.15
		Cooked	6.19^{e}±0.24	2.48^{b}±0.14	6.15^{d}±0.29
	6. S : dP 70: 20	Uncooked	7.36^{d}±0.18	2.72^{b}±0.21	1.87^{i}±0.19
		Cooked	6.14^{e}±0.20	2.57^{b}±0.26	6.95^{d}±0.32
	7. S : FK 95 : 5	Uncooked	8.05^{c}±0.23	2.29^{b}±0.16	2.23^{h}±0.44
		Cooked	7.27^{d}±0.17	2.07^{b}±0.11	5.89^{e}±0.43
	8. S : FK 90 : 10	Uncooked	11.49^{a}±0.34	2.28^{b}±0.14	2.39^{h}±0.21
		Cooked	6.81^{e}±0.19	2.16^{b}±0.11	5.87^{e}±0.43
Commercial product	Nestle cerelac with milk		3.03^{g}±0.14	3.21^{a}±0.15	4.16^{f}±0.28
	Nestle cerelac without milk		3. 32^{g}±0.16	2.40^{b}±0.11	5.50^{e}±0.35
Recommended values/day			<5	<3	<5

Mean(s) bearing different superscript(s) are significantly different (P≤0.05) according to DMRT.

Values are mean ±SD

Key for ingredients: S: Sorghum, UP: Untreated pigeon pea, CP: Cooked pigeon pea, dp: Decorticated pigeon pea, FK: Fenugreek seeds ,

A ≡ Ingredient + oil + sugar

B ≡ Ingredient + oil + sugar + Godaim and Moringa

C ≡ Ingredient + oil + sugar + dates and Moringa *Recommended values for infant complementary foods

Conclusion

Weaning foods developed from local food materials within the line of recommended dietary allowance (RDA) have the potential for combating children malnutrition. Fortification of sorghum with local available legumes like pigeon pea and fenugreek seeds increased significantly the protein**,** In addition godeim and moringa increased significantly the energy value of meals supplemented with whole cooked and decorticated pigeon pea. According to chemical analysis the best meals recipe of cooked porridge show in ingredients ($A_{4,5}$ - $B_{5,6}$ – $C_{5,6}$).

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