Preparation and Evaluation of Some Weaning Foods Made from Rice and Legumes

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ABSTRACT

Weaning is a gradual process of introducing solids foods to an infant's diet, alongside breast milk from the age of six months, since the breast feeding along cannot meet the infant nutritional requirement. in this study three composite foods were prepared from rice and some legumes (roasted soybean, roasted peanut and roasted chickpeas) ratio 70:30. The formulations were made to meet the greatest amino acid scores, the desired amount of energy and protein according to the FAO/WHO recommendation for infants. Concentrations of energy, protein, amino acid, phytates, trypsin inhibitor, tannins and protein digestibility were determined by standard methods. The proximate chemical composition results indicated that the moisture (10.01% to 11.77%), as water was added during cooking, protein (7.90% to 10.70%), ash (0.99% to 4.52%) crude fiber (0.91% to 1.04%), energy (344.3 kcal/100g to 400.3kcal/100g), fats (0.88% to 11.82%) and carbohydrates were (61.99% to 74.0%). the levels of protein in blends of weaning food were higher than the control. the results of anti-nutrition factors ranges phytic acid (3.90 to 4.52mg/100g), trypsin inhibitor (0.39 to 0.47 tiu/mg) and tannins (17.12 to 19.50 mg/100g). heat processing and cooking of the blends resulted in low levels of anti-nutrition and higher in vitro protein digestibility ranged from(83.30 to 87.59 %) of the weaning food blends respectively. the result of the sensory evaluation showd that the best blend was contained rice/peanut and rice/ chickpeas but rice/ soybean was low in the acceptability. this study recommends that mix cereals with legumes to achieve complementation of amino acids and consequent improvement in protein quality.

Keywords: rice, soybean, peanut, chickpeas, chemical composition, protein digestibility, anti-nutrition and sensory evaluation.

INTRODUCTION

Breast milk is the ideal food for infants during the first six months of life, In spite of its superiority. Breast milk cannot provide all of the nutrients and calories that allow infants to thrive after 6 months of life (Gairdner and Pearson, 1998). After six months of breast feeding, supplementary feeding is essential because breast-milk alone cannot provide enough nutrients and energy for growing children. (Ijarotimi and Famurewa, 2006 and Udensi *et al*., 2012).

Weaning is a period of transition for the infant during changes diet in terms of consistency and source (Xia *et al.,* 2018). The child is gradually weaned into a semi solid food which is generally described to be digestible, having high energy density and low bulk (Onweluzo and Nwabugwu, 2009).

A variety of commercially available complementary foods with high nutritional value, which are used directly to prepare gruels. However, in many developing countries, these products are beyond the economic means of most families (Njongmeta *et al*,. 2003). So, mothers use traditional gruels-water suspensions of maize or sorghum, as complementary foods for infants. These gruels usually have low energy density, poor protein, vitamin and mineral contents (Zaker, 2017). Thus, protein-energy malnutrition is a common problem among infant and children in the poor socio-economic groups of developing countries.

Cereals, the main source of calories in the diet, are adequate in methionine and cysteine and are a good source of B-complex vitamins but limiting in lysine (Gulzar, 2011). Cereals are deficient in lysine but have sufficient Sulphur containing amino acids which are limited in legumes whereas legumes are rich in lysine (Iqbal *et al*,. 2006).

Rice is a staple food of the world and being a major source of carbohydrates over half the world's population (Tran *et al*., 2005 and Megat Rusydi *et al*., 2011). Rice is belonging to the grass family of Gramineae and related to other grass plants such as wheat, oats and barley which produce grains for food (Arber, 2010). Rice also provides nutritionally significant amounts of thiamin, riboflavin, niacin and zinc with lesser amounts of other micronutrients (Megat Rusydi *et al*., 2011).

In this research work, efforts were made and develop a weaning foods based on flour of rice with some legume (soybean, peanut and chickpeas) blended together in the ratio 70/30. The purpose of the study aims to producea low-cost weaning foods from easily available Resources that is nutritionally adequate, acceptable and easily available from rice and some legumes Thus, a weaning foods rich enough in energy and proteins for infants was obtained by proximate chemical analysis and anti-nutritional factors.

MATERIALS AND METHODS

1. Materials

The seeds of Egyptian rice, soybean, peanut and chick peas were obtained from the local market, Alexandria, Egypt. The seeds were kept at room temperature in air tight containers.

2. Preparation and conditioning of rice for using in weaning foods

Rice samples were washed with sufficient tap water. Then, samples were soaked in distilled water for 72 hours with the water was changed in every 24 hr (Megat Rusydi *et al*., 2011). The rice was air dried at room temperature for 8 hours, and then dehulled, followed by milling and sieving. The flour was then packaged. The samples were contained in plastic sealed and stored in refrigerator at 4°C.

3. Preparation and conditioning of legume flours

Soya beans were thoroughly sorted to remove all extraneous covers. Then soaked in tap water for 6 hours and washed several times with more water. Peanuts and chickpeas were manually cleaned to remove debris. Split and discoloured seeds were discarded, legumes were roasted in an oven at 70˚C for 30 minutes, (Soaking and roasting were intended to remove the beany flavor). Followed by milling and sieving. The flour was packaged in dry pack. (Isaac and Koleosho, 2012).

4. Weaning foods formulation using rice and some legumes

Weaning foods were formulated using white rice and some legumes including soybean, peanut and chickpeas, respectively with a ratio 70:30 where, 70% rice with 30% one of the tested used legumes.

5. Weaning foods formulation

Cooked blends (gruels) were prepared. An initial flour paste was made mixing 100 g of flour cereal with legumes and 200 mL of deionized water. To the paste, 700 mL of boiling 30 deionized Water was added and mixed well. Flour-water slurries were cooked in a boiling water bath until the temperature reached 100°C. Cooking was continued an additional 15 min. the result obtained to gruels soft and acceptability color (Griffith *et al*, 1998).

6. Sensory evaluation of prepared weaning food

The sensory characteristics were evaluated according to Hooda and Jood (2005) hedonic scale by mothers in health offices and children aged from 6 to 24 months by facial expressions. The Evaluated characteristics including color, odor, texture, flavor and the overall acceptability. The 9- point hedonic scale with a scale ranging from 1 (Extremely dislike) to 9 (Extremely like) was used to evaluate the sensory attributes.

7. Proximate chemical composition

The proximate chemical composition including moisture, crude protein, total fats, crude fibers and carbohydrate of weaning foods were analyzed according to (Anderson, 2007).

Caloric values were calculated from the sum of the percentages of crude protein and total carbohydrates multiplied by a factor of 4 (Kcal/g) plus the crude fat content multiplied by 9 (Kcal/g) according to (Zambrano *et al*., 2004).

8. Minerals

Fe, Ca, Mg, Zn, Were determined using Atomic Absorption Spectrophotometer (Shimadzu model AA- 6650) as described in AOAC Official methods with (Anderson, 2007).

9. Phytochemical characterization (anti-nutritional factors)

Trypsin inhibitor (TrI) was extracted and determined according to (Hamerstrand *et al*., 1981). A sample (1.00 g) was extracted with 50 ml of (0.01N) NaOH (the pH adjusted, when required, to 8.4-10.0) for 3 hr. Stirring sufficient to keep the sample in suspension was maintained. This suspension was then diluted so that 2 mL of the sample extract inhibited 40-60% of the trypsin used as a standard in the analysis. The appropriate dilutions were determined from either a pre-knowledge of the heat treatment of the sample or from a urease analysis, which reflects the heat treatment of the sample. If the value obtained did not fall within the specified range of inhibition, the analysis was repeated with the correct dilution. To each of four test tubes, 2-mL aliquots of the diluted sample extract were added with a wide-tip pipette. A fifth tube was prepared for the trypsin standard by adding 2 mL of distilled water. To three of the four tubes containing the sample extract and the tube containing distilled water, 2 mL of the trypsin solution was added, and the tubes were placed in a constant temperature bath (37°C) for 10 min. Five milliliters of BAPA solution (pre-warmed to 37°C) was rapidly blown into each tube. The contents were stirred immediately on a vortex mixer, and the tubes were replaced in the constant temperature bath. The reaction was terminated exactly 10 min later by blowing in 1mL of 30% acetic acid with immediate mixing with a vortex mixer. A sample blank (the fourth tube containing sample extract) was prepared by the same procedure except that the trypsin solution was added after the reaction was terminated by the addition of acetic acid. The absorbance of each solution was determined at 410 nm against the sample blank. Values obtained from each of the three sample extracts were subtracted from the trypsin standard. These values were averaged, and the trypsin inhibitor content was determined from the following equation (1):

$$TrI\ (mg/g\ sample) = \frac{\Delta OD}{0.019 \times 1000} \times dilution\ factor \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Tannin was determined according to (Ahmed *et al*., 2006). While phytate was determined According to (Davies and Reid, 1979**)**.

10. Determination of Protein digestibility

Protein digestibility was determined using enzymatic hydrolysis (pepsin and pancreatin), then the nitrogen contents were analyzed by the micro-Kiel-dahl method. The protein digestibility of samples was calculated by subtracting undigested protein from crude protein of the blends (Prakash and Prakash, 1999).

11. Amino acid composition

Determination of amino acid contents of the prepared weaning meals was done at Regional Center for Food and Feed, Cairo, Egypt by using amino acid analyzer (biochrom30) according to (Otter, 2012).

12. Statistical analysis

The statistical analysis was performed using the SPSS 25.0 software (Statistical Package for Social Sciences, USA). Analysis of variance (ANOVA) of the data was conducted and means property values were separated ($p \leq 0.05$) with LSD test for the property values. Differences were considered significant at $p \leq 0.05$.

RESULTS AND DISCUSSION

1. Sensory properties

The results of sensory analysis of the formulated weaning food samples are shown in Table (1). Sensory evaluation was studied by children aged from 6 to 24 months, as well as mothers (n=50) in nurseries and health offices. The data showed that there were significant differences ($P \leq 0.05$) among the prepared weaning food in color, texture, taste, and acceptances. Color is less important for babies, mothers would play a vital role for any complementary food to be successfully utilized and accepted. However, the control and rice/soybean blend was the least scored in color, texture, taste, and acceptances assessment and there are significant differences between it and other blends. Followed in the ascending order by the rice/peanuts in color and odor with score 4.06, and 3.72, respectively then rice/chickpea with score 4.28 and 4.08. Moreover, there is no significant difference between the rice/chickpea and rice/peanut weaning in other parameters including texture, and taste and over acceptance.

2. Proximate chemical composition of prepared weaning food

Table (2) shows the proximate composition analysis of blends with ratio of 70:30 and compared with control rice. The results showed that the moisture content decreased when the rice mixing with peanuts compared with rice /soybeans, while there is no significant difference between control rice and rice/peanuts with 10.24 and 10.01, respectively. However, the rice/soybeans have a highest moisture content with (11.77%). Followed in the descending order by rice/chickpea with (10.97%). The protein contents were increased with blend the rice with legumes than control rice only. The rice/soybean with (10.70%), was the highest protein contents among all prepared blends. Then the rice/chickpeas have a moderately protein content of 10.21%. In addition, the mixture of rice / peanuts was the least percent of protein (7.90%). The ash contents were increases when the rice blend with legumes. There are significant differences ($P \leq 0.05$) among all prepared weaning food. The ash contents were ranged from 0.40 to 2.23%. The fiber content in the wide range in all blends and control. However, there are significant differences ($P \leq 0.05$) between control rice and its blends with legumes. In addition, there is no significant differences among all blends with 1.14, 0.91 and 1.04% for rice/soybean, rice/chickpea, and rice/peanut, respectively. The proportion of fat in blends was balanced with the needs of the child in weaning phase where the proportion of fat ranged from 0.88% to 11.82%. At all events, the fat contents of all blends were decreased compared to control rice except the rice/peanuts blend the fat was increased about control rice that is due to the high fat content of peanuts. The highest percentage of carbohydrate was in the Control 83.93% while the lowest carbohydrate ratio was in the rice mixture with chickpea 64.71%. Followed in the descending order by rice/soybeans 74.0%.

Walker (1990) suggested an energy density of 370 kcal/100 g as the minimum desirable level for infant weaning foods. The calculated energy densities obtained for the experimental blends ranged from 344 to 400.3 kcal/100 g and were comparable to those reported by other researchers (Pedersen et al. 1989).

Table 1: Sensory properties of weaning foods rice – legumes blends (by mothers)

Blends	Color	Odor	Textures	Taste	Acceptance
Control rice	$2.65^{c} \pm 1.49$	$2.76^{bc} \pm 1.50$	$3.50^{bc} \pm 2.13$	$1.99^{b} \pm 0.76$	$1.60^{b} \pm 0.70$
Rice /soybeans	$2.60^{c} \pm 1.48$	$2.26^{c} \pm 1.16$	$3.52^{bc} \pm 2.14$	$1.68^{b} \pm 0.74$	$1.66^{b} \pm 0.77$
Rice /Peanuts	$4.06^{b} \pm 2.32$	$3.72^{b} \pm 1.99$	$5.20^{ab} \pm 2.72$	$6.28^{a} \pm 3.32$	$6.44^{a} \pm 3.36$
Rice / Chickpeas	$4.28^{a} \pm 2.02$	$4.08^{a} \pm 1.54$	$5.34^{a} \pm 2.49$	$6.22^{a} \pm 2.61$	$6.46^{b} \pm 2.86$

Values are mean of three replicates and are given as mean ± standard error. Different letters in the same row indicate significant differences according to LSD test ($P \leq 0.05$).

Table 2. Chemical composition of weaning foods rice – legumes blends

Components	Control Rice	Rice/soybean	Rice/peanut	Rice/ chickpea
Moisture	10.24^{c} ±0.09	11.77^{a} ± 0.31	10.01^{c} ± 0.26	10.97^{b} ± 0.16
Protein	1.22^{d} ± 0.15	10.70^{a} ± 0.09	7.90^{c} ± 0.01	10.21^{b} ± 0.09
Ash	0.40^{d} ± 0.01	2.23^{b} ± 0.08	4.52^{a} ± 0.05	0.99^{c} ± 0.09
Fibers	1.30^{b} ± 0.02	1.14^{a} ± 0.21	1.04^{a} ± 0.18	0.91^{a} ± 0.11
Fats	3.16^{b} ± 0.01	0.88^{d} ± 0.13	11.82^{a} ± 0.24	1.22^{c} ± 0.15
Carbohydrates	83.93^{a} ± 0.08	74.0^{ab} ± 0.01	61.99^{bc}±0.50	66.43^{bc}±0.09
Calories	368.0^{f} ± 0.01	344.3^{h}±0.01	400.3^{d}±0.01	354.0^{g}±0.01

Values are mean of three replicates and are given as mean ± standard error. Different letters in the same row indicate significant differences according to LSD test (P≤0.05).

3. Minerals content

Mineral contents were analyzed for studied of weaning food presented in Table (3) compared with the control rice. The results found that the mineral concentration was decreased after treatment with boil, roasting and grinding. The calcium (Ca) was increased in all blends compared with the control. The highest percentage of Ca was rice/soybeans 1.66%/. The iron (Fe) is the most essential mineral to child for hemoglobin construction, the Fe was increased with mixing with legumes. The highest percentage of Fe were rice/soybean 2.17%. The Magnesium (Mg) was increased in all blends compared with the control. The zinc was increased in rice/soybean and rice/ peanut blends 0.62 %, 0.49% and decreases in rice/ chickpeas blends 0.21 compared with the control.

4. Anti-nutritional factor

Anti-nutrition factors contents including phytic acid, tannins and trypsin inhibitor was presented in Table (4) for the ratio of 70:30, respectively. The phytic acid in the studied weaning foods were ranged from 3.90 to 4.52 mg/100g the lowest percentage of phytic acid were rice/chickpeas. However, there is no clear significant difference between blends. Roasting of legumes also reduced the phytic acid. The inherent phytase activity on cereals is believed to be activated during treatment (Sharma *et al*., 2018).

On the other hand, some authors reported that phytic acid contents were unaffected or increased after heat treatments (Embaby, 2010).

Trypsin inhibitor are heat labile and can be partially and completely denatured when exposed to elevated temperature. The values of trypsin inhibitor in weaning food (low activity of trypsin inhibitor enzyme) ranged from 0.39 to 0.47 that is due to the cooking, roasting and grinding for used cereal and legumes. Wang *et al*., (1997) reported that steam blanching of legume resulted in higher reduction in trypsin inhibitor activity than using water blanching. However, Hamerstrand *et al*., (1981) reported that microwave cooking destroyed trypsin inhibitors to a degree similar to that observed in six legumes cooked using the conventional method.

The total tannins were determined in weaning food as anti-nutritional factor. The most tannins are located in seed coats (skin) and hulls are practically tannin free (Naczk and Shahidi, 2004). The control have the lowest value of tannins (16.25 mg/100g). Followed in the ascending order by rice/soybeans with 17.12 mg/100g and then rice/chickpeas with 19.50 mg/100g. The reduction in tannins contents during roasting treatments might be due to the loss of compounds while treating at a high temperature (Nithya *et al*., 2007).

Table 3. Minerals composition of weaning food cereal – legumes blends

Components(mg/l)	Control Rice	Rice/ soybean	Rice/ peanut	Rice /chickpeas
Mg	4.01^{e} ± 0.06	11.98^{a} ± 0.11	9.66^{b} ± 0.11	5.04^{c} ± 0.07
Ca	0.52^{c} ± 0. 05	1.66^{a} ± 0.11	0.59^{b} ± 0.10	0.60^{b} ± 0.10
Zn	0.36^{bc} ± 0.01	0.62^{a} ± 0.20	0.49^{ab} ± 0.15	0.21^{c} ± 0.10
Fe	2.01^{b} ± 0.14	2.17^{a} ± 0.07	2.04^{b} ± 0.14	0.69^{c} ± 0.28

Values are mean of three replicates and are given as mean ± standard error. Different letters in the same row indicate significant differences according to LSD test (P≤0.05).

Table 4. Anti-nutritional factor and Protein digestibility of weaning foods cereal – legumes blends

Anti-nutritional factor Protein digestibility	Control/rice	Rice/soybean	Rice/peanut	Rice/chickpeas
Phytic acid (mg/100g)	4.40^{b}± 0.10	4.43^{b}± 0.10	4.52^{a} ± 0.21	3.90^{c} ± 0.19
Tannins (mg/100g)	16.25^{d}± 0.09	17.12^{c}± 0.03	19.26^{b} ± 0.03	19.50^{a} ± 0.05
Trypsin inhibitor(TIU/mg)	0.40^{b}± 0.04	0.47^{a}± 0.03	0.41^{b} ± 0.02	0.39^{bc}± 0.02
Protein digestibility (%)	85.55^{d}± 0. 02	83.30^{c}± 0.02	87.32^{b}± 0.02	87.59^{a}± 0.02

Also, the loss of tannins may be due to the degradation or interaction with other components of seeds, such as proteins, to form insoluble complexes (Embaby, 2010). Osman (2007) reported a significant increase in tannins contents in cooked, autoclaved and roasted Dolichols lablab bean. Additionally, Embaby(2010) found that the autoclaving, ordinary cooking and microwave cooking didn't affect tannins contents in bitter lupine seeds.

Protein is a inextricable component to the human diet. Without proteins, cells would be unable to function properly, our organs and tissues would not be able to perform their duties and our bodies would wither away.

There are many sources of protein available to children. FAO/WHO has adopted a protein-corrected amino acid, as the preferred method of measuring the value of protein in human nutrition (Hulse 1989; Wondimu and Malleshi 1996).

The results of protein digestibility were ranged from 83.30 % to 87.59%, the highest percentage of protein digestibility was rice/chickpeas. The studied formulated weaning blends had good digestibility because their values were high than 75%. The rice/chickpeas have the maximum digestibility with 87.59% and there is no significant difference with rice/peanut with 87.32%. Followed in the descending order by the control rice 85.55% then rice/soybean with 83.30%.

5. Amino acid content

Amino acids analysis showed that the protein from plant sources contained nutritionally available quantities of most of the essential amino acids but was low in sulphur containing amino acids. The essential amino acids including threonine, lysine, valine, methionine, isoleucine, leucine, phenylalanine and Histidine was showed in Table (5). While the non-essential amino acid including Aspartic, arginine, serine, proline, glutamic, cystine, glycine, alanine and tyrosine were also presented in Table (5) as a concentration percentage. The result in the rice blends indicated that the essential amino acids were found in all weaning food blends. The Threonine was found in range 0.34 to 1.56%. The leucin is the most amino acid found in the prepared weaning food ranged from 0.74 to 1.11%. While the methionine was the lowest found with range of 0.23 to 0.45%. The essential amino acids were higher than the control expect lysine because cereals are adequate in methionine but limiting in lysine. The non-essentials amino acids were found in wide range. The glutamic acid was the most found with range of 1.64 to 2.40%. Followed in the descending order by aspartic acid was the most found with range of 1.07 to 1.56%. However, the serine was the lowest of range 0.41 to 0.62%.

The effective use of readily available and inexpensive sources of protein and micronutrients has become a major focus of research in recent years. Development of weaning foods from locally available and low cost raw materials is a constant challenge for developing countries. Weaning foods are generally produced by traditional techniques like milling, roasting, drying, and germination.

Table 5. Amino acid of weaning food cereal-legume

Essential amino acids	Control /rice	Rice/soybean		Rice/chickpeas		Rice/peanut	
	%	%	Rank	%	Rank	%	Rank
Threonine	0.02	1.56	2	0.34	14	1.10	3
Lysine	0.03	0.76	7	0.48	7	0.38	13
Valine	0.05	0.70	10	0.49	6	0.53	10
Methionine	0.40	0.45	15	0.24	17	0.23	16
Isoleucine	0.08	0.63	11	0.39	12	0.38	12
Leucine	0.04	1.11	4	0.74	4	0.79	4
Phenylalanine	0.06	0.77	6	0.55	5	0.59	6
Histidine	0.03	0.39	17	0.25	16	0.27	15
Non-essential amino acids							
Aspartic	0.12	1.56	2	1.07	2	1.10	3
Arginine	0.08	1.07	5	0.90	3	1.11	2
Serine	0.05	0.62	12	0.41	10	0.55	8
Proline	0.06	0.71	9	0.44	9	0.49	11
Glutamic	0.19	2.40	1	1.64	1	2.09	1
Cystine	0.48	0.44	16	0.29	15	0.21	17
Glycine	0.05	0.62	12	0.40	11	0.59	6
Alanine	0.06	0.73	8	0.48	7	0.54	9
Tyrosine	0.04	0.58	14	0.39	12	0.49	11

In the present scenario of convenience and newer products, we explored the possibility of using twin – screw extruder for preparation of weaning foods from maize and chickpea. Effects of feed moisture, barrel temperature, and screw speed on the quality parameters of extrudates were studied. Extrudates produced at lower feed moisture, higher screw speed, and higher barrel temperature showed good physicochemical properties and higher protein and starch digestibility (Pedersen *et al*., 1989; Gomez M, Rooney L,1993; Njongmeta *et al*., 2003; Pobee *et al*., 2017 and Xia *et al*. 2018).

Pobee et al. (2017) used flour from broken rice fractions in combination with soybeans and dried mangoes to develop four weaning formulations. Rice-Soy Mango (RSM) was prepared with four different ratios including control RSM-0 with 75% rice, 25% soy and 0% mango flour, RSM-5 with 70% rice flour, 25% soybeans flours and 5% mango flour, RSM-10 with 65% rice flour, 25% soybeans flours and 10% mango flour and RSM-15 with 60% rice flour, 25% soybeans flours and 15% mango flour.

All the three newly formulated rice-mango weaning food met the Estimated Average Requirement (EAR) for energy (393.71-403.25 KCal/100 g), protein (10.7-15.24 g/100 g), carbohydrates (68.44-73.87g/100 g), zinc (8.67-10.84 mg/d and vitamin C (13.96-17.79 mg/100 g) levels but not for iron (3.99-7.61 mg/100 g), fat (6.22-7.61 g/100 g) and calcium (87.2-111.7 mg/100 g). The beta-carotene levels ranged from 74.8 to 346.6 µg/100 g and showed significant differences. The past profile for the blends with low amounts of mango (RSM-5 and RSM-10) had a similar profile as the control (RSM-0), while RSM-15 had a lower profile. Among the three newly formulated blends, RSM-10 had the highest peak viscosity (74.0 BU) and highest final viscosity of 107 BU. The RSM-5, RSM-10 and RSM-15 were all lighter than RSM-0, albeit not significant. Increasing the content of mango resulted in the flour blend becoming more yellow. Even though the sensory quality of RSM-5 was the most preferred, there was no significant difference ($p>0.05$) observed between the sensory quality of all the three newly formulated products (RSM-5, RSM-10, RSM-15) (Pobee *et al*., 2017).

Ali *et al*.,(2017) prepared maize-chickpea extrudates and they found that the ratio of ingredients in the optimized weaning mix was 40% maize- chickpea extrudates, 35% skim milk powder, and 25% sugar (w/w). The nutrient content was in agreement with the standards described by prevention of food adulteration (PFA) with high protein and starch digestibility.

Sheriff (2015) prepared a novel formulation of weaning food based on fermented rice (Dikwa), banjara beans and Sesame in a 70:20:10 ratio. The results indicated an increase in the Mg (69.3 ± 0.02) Zn (2.45 ± 0.02) and Fe (6.34 ± 0.01) levels of the weaning food blend. Low level of calcium (76.4 ± 0.02) and sodium was recorded. The Riboflavin (0.3254±0.00001) and thiamine (0.6287 ± 0.00001) level were higher compared to the control. The protein content was (8.31 ± 5.41), the moisture content (2.86 ± 1.91), while the fibre content was (5.6 ± 4.40). Carbohydrate content of the blend was lower than the commercial weaning food cerelac® but was however higher than the Recommended Daily Allowance (RDA) for infants at weaning age. It can be concluded that; protein, moisture, fat and carbohydrate content, as well as mineral and Vitamin of the weaning food blend met the RDA value of infants (6 month to 1 year) and thus it can be used in the management of problems associated with protein - energy - malnutrition.

CONCLUSION

Weaning is a gradual process of introducing solids foods to an infant's diet, alongside breast milk from the age of six months, since the breast feeding along cannot meet the infant nutritional requirement. The aim of this study were to developed a weaning foods based on commonly consumed, low-cost food materials locally-available in market.

There is need to have maximum utilization of commonly available cheap cereals and legumes to formulate weaning foods that would be low in viscosity high in caloric density and adequate in necessary nutrient. The protein content of the weaning food blend from rice ranged from (7.90% to10.70%) and is the best of control. There is an increase in vitro protein digestibility in the weaning food blends from rice, and this is as a result of reduction in the level of anti-nutritional factor during formation. The results of the sensory evaluation shown that the best blends were contained rice/peanut and rice/ chickpeas but rice/ soybean was lower acceptability.

RECOMMENDATIONS

- It is recommended that infants feed on this formulation be breast feed for at least 2 years, as the formulation is intended to act as supplement to breast milk.
- Mothers can be advised to prepare these kinds of complementary foods hygienically for their weaning babies. This will go a long way in helping them out of the more expensive commercial formulae as well as improving their infants feeding. This could easily be achieved since all the food materials can be obtained locally and cheaply too.
- It is recommended mixing cereals with legumes because cereals such as maize, the main source of calories in the diet, are adequate in methionine and a good source of B-complex vitamins while

legumes such as soy bean, peanut and chick peas are rich in lysine.

- It is recommended to cook, soak and roasting cereals and legumes to reduce the anti-nutritional factor and increase protein digestibility.

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الملخص العربى

اعداد وتقييم بعض اغذية الفطام المحضرة من الارز والبقوليات

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الفطام هو عملية تدريجية لإدخال الأطعمة الصلبة إلى النظام الغذائي للرضيع، جنبا إلى جنب مع حليب الثدي من سن ستة أشهر، لأن الرضاعة الطبيعية لا يمكن أن تلبي الاحتياجات الغذائية للرضع بعد الستة اشهر الاولي. في هذه الدراسة تم تحضير ثلاثة صيغ من أطعمة الفطام تحتوي على الأرز وبعض البقوليات (فول الصويا، الفول السوداني والحمص) نسبة ٣٠:٧٠% وتم طهي اغذية الفطام ثم تجفيفها ومن ثم تم اجراء التحليلات. أجريت صيغ الفطام لتلبي الاحتياجات الضرورية للرضيع من الحمض الأميني وتلبية احتياجاته من الطاقة والبروتين وفقاً لتوصية منظمة الأغذية والزراعة / منظمة الصحة العالمية. تم تقدير البروتين والطاقة والاحماض الامينية والبروتين والمعادن ومضادات التغذية وهضمية البروتين. اوضحت نتائج التحاليل الكيميائية ما ان نسبة الرطوبة تراوحت من (١٠,٠١ إلى ١١,٧٧٪) وذلك بسبب اضافة الماء عند الطهي، والبروتين (٧,٩٠ إلى ١٠,٧٠٪) والرماد (٠,٩٩ إلى ٤,٥٢٪) من الألياف الخام(٠,٩١ إلى ١,٠٤٪) والطاقة (٣٤٤,٣ إلى ٤٠٠,٣ كيلو كالوري) والدهون (٠,٨٨ الى ١١,٨٢٪) والكربوهيدرات تراوحت من(٦١,٩٩ إلى ٧٤,٠٪).وكانت نسبة البروتين في خلطات الفطام أعلى من المجموعة الضابطة والكونترول عبارة عن الارز دون اضافة البقوليات.

ولقد ادت المعالجة الحرارية والطهي الى انخفاض معدل مضادات التغذية وبالتالي ادي الى ارتفاع هضمية البروتين .حيث تراوحت نسبة الفيتات من ٣,٩٠ الى ٤,٥٢ ملجم / ١٠٠جم والتربسين من ٠,٣٩ الى ٠,٤٧ وحدة مثبط التربسين/ ١٠٠جم والتانين من ١٧,١٢ الى ١٩,٥٢ مجم / ١٠٠جم وتراوحت نسبة هضمية البروتين من ٨٣,٣٠ الى ٨٧,٥٩ %. واظهرت نتائج التقييم الحسي ان افضل خليط من حيث الطعم كان الارز مع السوداني ويليه الارز مع الحمص ولكن كان معدل القبول اقل في خليط فول الصويا مع الارز والكنترول. وتوصي هذة الدراسة الى خلط الحبوب مع البقوليات لتحقيق افضل تكامل من حيث الاحماض الامينية وتحسين جودة البروتين.