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# Chemical and Physical Properties of Weaning Food Containing Legumes

**Hanan S. Shalaby[1] and Gehan A. El-Shourbagy[2]**

**[1.] Food Science Department, (Rural Home Economics), Faculty of Agric., Zagazig Univ., Zagazig, Egypt.**

**[2]. Food Science Department, Faculty of Agric., Zagazig Univ., Zagazig, Egypt.**

## ABSTRACT

This study was carried out to evaluate the chemical composition and physical properties of six weaning formulations (M1 to M 6) containing 10 or 20g /100g of some legumes as cowpea, lentil and crushed ground bean when added as powder flour, 2.5% carrot, 2.5% peas, 5% sugar and 8.5% skim milk powder. These formulas were compared with Cerelac product. The results indicated that high protein contents were found in formulas M2 and M6, ( 18.75% , 18.09%), then M1 and M5, (17.21%, 16.99%) then M4 and M3 ( 15.68 % , 15.00%) respectively in compare with Cerelac (10.00% ) with a significant differences. The high energy contents were found for M2 and M6 (376.08, 374.93 Kcal) and the low energy contents was noticed for Cerelac with a significant differences. The high fiber contents were noticed in M 2 (1.59% ), M 1 (1.54%), then M6 (1.42% ) and M5 (1.34% ), then Cerelac (1.33%) with a significant differences. Also ,the high ash content was recorded for Cerelac 1.72% then M 2 (1.71 %) while the lower was M3 ( 0.98%) and M4 ( 1.05 %) . It was also observed that bulk density values ranged from 5.56 g/ml to 6.78 g/ml where the highest was M2 (6,78 g/ml ) while the lowest was Cerelac (5.56g/ml). Water absorption capacity showed a significant differences. The lowest viscosity was for Cerelac (1050 cps) ,then M3 (1600 cps) and M4 (1700cps ) with a significantly differences.. Formulas had chemical composition and physical properties similar to the Cerelac and were a good potential for using of high-protein–energy weaning formulas. The formulas of M2(20% Cowpea) or M6(20% Crushed Ground Bean) could be recommended due to their higher protein , energy and essential amino acids contents than other formulas or Cerelac.

**Keywords :** Weaning food, formulas blend, Physical properties, legumes foods.

## INTRODUCTION

Milk only is no longer sufficient to meet nutritional requirements when a baby reaches four to six months of age, calories and other nutrients are needed to supplement milk until the infant to eating and adult foods. This is the weaning stage. Weaning is the process of expanding the food and water than breast. Sajilata, *et al.* (2002). Infants between 6 and 12 months old, weighing 8.6 kg requires a daily food intake of about 98 Kcal/kg body weight or about 843 Kcal. This would require 1.258 liters of breast milk having 67 Kcal/100 ml, to meet the child's caloric needs making most nursing mothers resort to the use of local weaning foods. (Onuoha, *et al.* 2014).

Weaning food had a important vital in the all-round growth, evolution and mental health of infants (Amankwah *et al.*, 2009). The first supplementary foods introduced that are prepared from cereals or starchy roots, commonly mixed with water. Starch granules proportion gelatinized when they are cooked, making the food mix viscous and difficult to feed to infants. (Sajilata, *et al.*, 2002).

Farag (1999) used available local ingredients for preparing some weaning foods such as cereals (wheat, white maize and rice), legumes ( faba beans ,lentils, chickpeas , cowpeas and white beans) fruits (apples and banana) and vegetables (carrot and potatoes) .

Cereals are deficient in lysine but had sufficient sulphur containing amino acids which are limited in legumes (Tsai *et al.*, 1975 and Iqbal *et al.* 2006). Udensi *et al.*, 2012 noticed that quality of protein was benefiting in cereal- legume mixture because of the essential amino acids methionine and cysteine within the cereal.

The problem malnutrition in protein and energy among weaning infants in tropical Africa, relatively inexpensive sources of protein that investigated in the development of weaning formulations by several studies. The materials for low-cost weaning formulations must be derived from foods in the region of interest that are afford able to the section of the target population and readily available in sufficient quantity (Yvonne *et al.*, 2001).

The implications of these findings are far reaching since all the components used in the formulation are obtained from local market and toasting is a processing method that can easily be practiced at home (Comfort *et al.*, 2016).

Chemical composition of wheat flour 72% was 11.37% moisture, 9.19% protein, 0.91% fat, 0.90% fiber, 0.34% ash, 76.19% carbohydrates according to Shalaby and ElShourbagy, (2014). Also chemical composition of cowpea was 38.6%protein,9.94%fat, 3.41%ash, and 0.98% starch according to Ahmed, (2012). lentil was 12.52%moisture 29.37%protein, 2.19%fat, 2.66%ash and 65.77% carbohydrates according to Khatun *et. al.*,(2013). Peas was 21.53%protein, 1.40%fat, 4.31%ash and 7.62% fiber, in dry matter according to Ranjani, (2009) and crushed ground bean was 29.62%protein,1.26%fat, 3.49%ash and 6.94% fiber, in dry matter according to Ranjani (2009).

The objective of this work was producing a rich protein and energy weaning formulas based on markets present protein high food materials and low cost to produce nutritionally adequate and acceptable weaning foods.

## MATERIALS AND METHODS

### Materials

**Formulation and evaluation of some infant food mixture:**

The raw ingredients used in the current work for the preparation of the different infant food mixture were as follows :

Wheat flour was 72% (*Triticum aeritinum L*). Cowpea (*Vigna sinesis*). lentil (*Lens culinaris*). Peas

( *Pisum sativun pea*). Crushed ground bean (*Vicia faba L.*). Carrot (*Daucus carota*), sugar and skim milk powder.

All previous ingredients were obtained from local market at Zagazig city, Sharkia Governorate, Egypt. Skim milk powder wads prepared from Misr Dairy food company, Cairo, Egypt.

**Methods**

**Preparations of raw ingredients**

Formulas were prepared as described by Egounlety and Kakai, (1999). Legumes (cowpea , lentil, peas, and crushed ground bean) were purifies from impurities, washed , soaked, in distilled water (1:3 w/v) at room temperature for 4 h. to remove antinutritional factors (trypsin inhibitors, phytic acid and tannins ). These treated legumes were cooked in a pressure cooker for 10, 2, 5and 7 minutes respectively , cooled , mixed and were dried in steamed hot air drier at 40 °C for 48 hours, milling and sieved and mixing as shown in Figure 1 and Table 1. Carrots was washed in distilled water, dipped into Sodium Metabisulphite (1.5 g/L) for 3 minutes, carrots sliced, dried at 40 °C for 48 hours were collected and ground into fine powder. بخار

**Formulas of food mixtures**

Different weaning formulas were chosen according to the methods described by Jansen and Harper (1985) with some modification as shown in Table 1. Composition of the six weaning formulas based on cowpea , lentil, crushed ground bean and peas to ably high amino acid and increased protein contents for weaning foods also energy addition to carrot ,sugar, and skim milk powder. Blending weaning formulas are given in Table 2. Cerelac was used as control for comparison.

**Table 1. Formulation of the processed weaning food mixtures**

| Mixtures | Wheat Flour | Cowpea powder | Lentil powder | Crushed Ground Bean powder | Peas powder | Carrot powder | Skim Milk powder | Sugar | *Vitamins and Minerals Mixture |
|---|---|---|---|---|---|---|---|---|---|
| M1 | 70 | 10 | ------- | -------- | 2.5 | 2.5 | 8.5 | 5 | 1.5 |
| M2 | 60 | 20 | ------ | -------- | 2.5 | 2.5 | 8.5 | 5 | 1.5 |
| M3 | 70 | ------- | 10 | -------- | 2.5 | 2.5 | 8.5 | 5 | 1.5 |
| M4 | 60 | ------- | 20 | -------- | 2.5 | 2.5 | 8.5 | 5 | 1.5 |
| M5 | 70 | ------ | ------ | 10 | 2.5 | 2.5 | 8.5 | 5 | 1.5 |
| M6 | 60 | -------- | ------- | 20 | 2.5 | 2.5 | 8.5 | 5 | 1.5 |

**M1 : Containing Cowpea 10% M2: Containing Cowpea 20% M3 : Containing Lentil 10% M4 : Lentil 20%**
**M5 : Containing Crushed ground bean 10% M6 : Containing Crushed ground bean20%**
*** Vitamins and minerals /100 g of mixture: Ca: 0.89 g; P: 0.6 g; Fe: 10 mg; Vitamin A: 1500 IU; Vitamin D: 300 IU; Vitamin B1: 0.5 mg; Vitamin B2: 0.6 mg; Niacin 5 mg; Vitamin C: 30 mg B6 (0.4 g); B12 (2 mg); Folic Acid (0.2 g) according to AOAC(2000).**

**Chemical analysis**

Moisture, crude protein, dietary fibers and ash contents were determined according to AOAC (2001). The energy densities of different infant formula samples were calculated according to Insel *et al.* (2002).

**E = 4 (Protein% + Carbohydrate % ) + 9 × Fat%.**

**Where** E= Energy density per 100g of sample.

**Physical properties**

**1. Bulk density of weaning formulas:**

Bulk density of weaning formulas were determined by using Onwuka (2005) method . A 10 ml capacity graduated measuring cylinder was pre-weighed. The cylinder was then filled gently with the sample (10g) . Bulk density was then calculated as:

$$\text{Bulk density (g/ml)} = \frac{\text{weight of sample (g)}}{\text{volume of sample (ml)}}$$

**2. Water absorption capacity of weaning formulas:**

Water absorption capacity was calculation by using the method described by Onwuka (2005). 1 g of the sample was weighed in a conical graduated centrifuge tube. Mixed was thoroughly with 10 ml distilled water using a Warring whirl mixer for 30 seconds. The sample was allowed to stop for 30 minutes at room temperature and then centrifuge at 5000 × g for 30 min. The volume of free water (supernatant) was then read directly from the graduated centrifuge tube.

**3. Viscosity of weaning formulas:**

Viscosity was determined according to Quinn and Beuchat (1975). Cold water slurries containing 20% sample solids were fired in a boiling water bath with changeless stirring until boiling for three minutes. They were cooled to room temperature and their viscosity was measured. Viscometer using RVT Spindle No. 4 at a constant speed of 100 rpm. Conversion into cps units was done using by Spindle 4.

**Amino acids determination**

Amino acids were determined using automatic amino acid analyzer (AAA 400 INGOS Ltd). as described by Csomos and Simon-Sarkadi (2005).

**Statistical analysis:**

The obtained results were analyzed using SD--Duncan's new multiple range test. The difference of means, and P≤0.05 was considered to be statistically significant (Steel and Torrie, 1980).

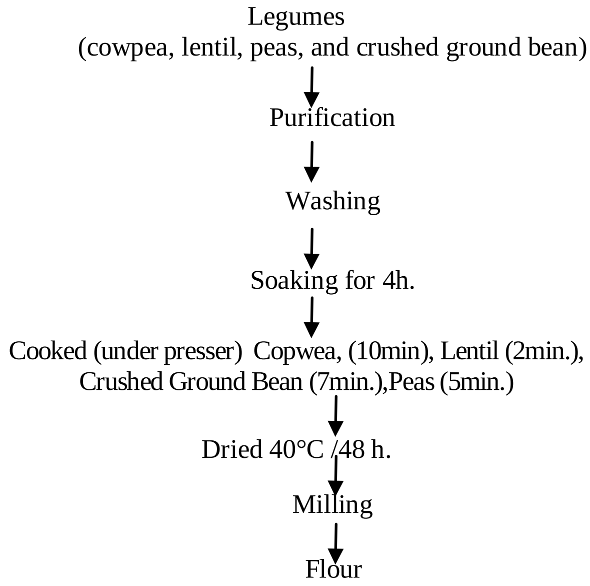


**Fig.1. Flaw chart of blends preparation.**

## RESULTS AND DISCUSSION

**Chemical composition of different weaning food formulas:**

Weaning food formulas were analyzed for moisture , protein, fat , fiber , ash , total carbohydrate and energy contents .The obtained results are shown in Table 2 .These results showed that blends of weaning formulas (M1 to M6) had significant higher protein and energy compared with Cerelac. However, there were no significant differences in carbohydrate content. The increase of protein values of M2 and M6 may be due to the high protein contents of cowpea (18.75%) and crushed ground bean (18.09%). These results are in agreement with those observed by Imtiaz *et al.*,( 2011), who found that cereals and legumes are a good source of protein, carbohydrates and dietary fiber and important source of vitamins and minerals.

Also, the high energy contents was M2 and M6 (376.08 % and 374.93%) and the low energy contents of (348.10 Kcal) Cerelac with a significantly differences. The high fiber contents of M2 (1. 596%), M1 (1.54%), then M4, (1.27%), M6 (1.42%) ,then Cerelac (1.33%) with a significant differences. Also, the high ash content was recorded for (C) Cerealac 1.72% then (M2), cowpea 20% (1.71%) while the lower was(M3) (0.98%) and M4 ( 1.05%). These results agree with those reported by Mahgoub (1999) who indicated that formula containing (60% sorghum, 20% chickpeas, 5% sesame 8.5% skim milk powder, 5% sugar, and 1.5% vitamins and minerals and formula containing (55% sorghum 15% chickpeas 5% groundnuts 10% sesame 8.5% skim milk powder 5% sugar and 1.5% vitamins and minerals) formulations were have compositions and properties comparable to those of Cerelac and had a good potential for using by weaning formulas.

**Physical properties of weaning food formulas:**

Results in Table (3) illustrate physical properties of weaning food formulas (M1 to M6 and Cerelac).The bulk density of all formulas did not show significant differences of all formulas. The data was observed that bulk density values ranged from 5.56 to 6.78 where the highest was recorded for M2 while the lowest was Cerelac. These results agree with Onuoha, *et. al.* (2014) determined bulk density values ranged from 5.889 ± 0.98 to 7.953 ± 0.103. Akpapunam *et al.* (1996) showed that malting significant impacted the water absorption capacities as well as the viscosities of flours. The important of the low bulk density of these complementary foods is that the gruel or porridge made from this food had a lower dietary bulk. This is important in complementary foods because high bulk limits the caloric and nutrient intake per feed per infants and child are sometimes unable to found enough to satisfy their energy and nutrient requirements. The important of bulk density is also in the packing requirement and intaking of the complementary food (Karuna *et al.* 1996 and Onuoha, *et al.* 2014).

Water absorption capacity was significant differences in the mixtures. The highest water absorption capacity was noticed in M4 (5.5% ) and M3 (5.1%) then M5, (4.5% ) and M6 (4.2%) compare with the low water absorption capacity of Cerelac (3.3% ).

El khalifa *et al.* (2005) and Oluwalana and Ijarotimi (2013) indicated that a lower water absorption capacity, of formulae were lower water absorption and binding capacity which is desirable for making thinner gruels with high caloric and nutrient density per unit volume.

Results agree with Mahgoup (1999) who showed that the volume water of absorption needed to form a gruel with due to thickness for infants feeding of the five formulations compared to that Cerelac.

Results in Table (3) showed that viscosity of M3 (1600 cps) and M4 (1700 cps) which were lower than the other six formulations ,but were higher than of Cerelac (1050cps). Also Cerelac was less viscosity than the other treatments and was significantly differences. These results agree with Mahgoup, (1999) who determined viscosity values (measured at 20% w/w gruel consistency) of the formulation were also high (4150–5400 cps) in comparison to Cerelac (2250 cps).

**Amino acids contents of the prepared mixtures:**

The essential amino acids are necessary for tissue maintenance and are also required for the growth of infants (Wilson *et al.* 1974). Table (4) shows that the prepared baby food mixture contained higher amount of the essential amino acids individually and totally than those of the FAO pattern .This means that the mixtures contained the essential amino acids in which would meet the recommends requirements for infants. (FAO/ WHO 2002).

The highest value of essential amino acids contents of weaning food formulas (M2,M4 and M6,) were Lysine (6.82, 6.51 and 5.94 g/100g) respectively then Valine (6.68, 6.84, 6.37, g/100g for M2,M6, M4 respectively). Tsai *et al.*, 1975 and Iqbal *et al.*, 2006 reported that legumes are rich in lysine.

**Table 2. Chemical composition of different weaning formulas**

| Component (%) Treatments | Moisture % | Protein % | Fat % | Fiber % | Ash % | Carbohydrates % | Energy (Kcal/100g) |
|---|---|---|---|---|---|---|---|
| M1 | 5.97c | 17.21b | 1.18bc | 1.54b | 1.50bc | 69.96a | 359.30bc |
| M2 | 6.30bc | 18.75a | 1.13bc | 1.596a | 1.71a | 74.14a | 376.08b c |
| M3 | 7.46a | 15.00c | 1.14bc | 1.17c | 0.98d | 73.57a | 364.54c |
| M4 | 7.13ab | 15.68c | 1.34ab | 1.27c | 1.05d | 74.01a | 370.82bc |
| M5 | 7.02ab | 16.99b | 1.21abc | 1.34b | 1.34c | 71.32a | 364.13a |
| M6 | 7.46a | 18.09ab | 1.61a | 1.42b | 1.52b | 72.02a | 374.93a |
| C (Cerelac) | 6.00c | 10.00e | 0.9c | 1.33b | 1.72ab | 75,00a | 348.10d |
| LSD | 0.9630 | 10262 | 0.4307 | 0.1464 | 0.162 | 10.542 | 247.27 |

**Values with different letters in the same column or row are significantly different (P< 0.05)**

**Table 3. Physical properties of the weaning formulas**

| Samples properties | Bulk Density(g/ml) | Water Absorption Capacity (g/100g) | Viscosity (cps) |
|---|---|---|---|
| M1 | 6.73a | 3.5ef | 3500a |
| M2 | 6.78a | 3.7e | 3550a |
| M3 | 6.26a | 5.1b | 1600a |
| M4 | 6.00a | 5.5a | 1700b |
| M5 | 6.48a | 4.5c | 1950c |
| M6 | 6.57a | 4.2d | 2000c |
| C (Cerelac) | 5.56a | 3.3f | 1050c |
| LSD | 1.476 | 0.241 | 199.40 |

**Values with different letters in the same column or row are significantly different (P< 0.05)**

**Table 4. Essential amino acids contents of weaning formulas as compare to the FAO/ WHO for infant (g/100g)**

| Essential Amino acid | M2 | M4 | M6 | FAO/WHO |
|---|---|---|---|---|
| Isoleucine | 4.42 | 4.01 | 3.30 | 3.2 |
| Leucine | 6.63 | 6.72 | 7.85 | 6.6 |
| Lysine | 6.82 | 6.51 | 5.94 | 5.7 |
| Methionine+Cystine | 3.2 | 2.95 | 3.84 | 2.8 |
| Phenylalanine +Tyrosine | 5.11 | 5.82 | 5.04 | 5.2 |
| Valine | 6.68 | 6.37 | 6.84 | 4.3 |
| Histadine | 3.56 | 2.71 | 3.39 | 2 |
| Threonine | 5.07 | 5.58 | 4 | 3.1 |
| Total | 41.49 | 4o.67 | 40.20 | 29.8 |

## CONCLUSION

On the light of the obtained results it could be recommended that both M2(20% cowpea) or M6(20% Crushed Ground Bean) formulas could be used as the best weaning foods in compare with Cerelac. These formulas contained higher protein ,energy and essential amino acids.

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## الخواص الكيميائية والفيزيائية لأغذية الفطام المحتوية على البقوليات


**حنان سعيد شلبى[1] و جيهان عبداللة الشوربجى[2]**

**[1] قسم علوم الأغذية شعبة الاقتصاد المنزلي الريفي –كلية الزراعة جامعة الزقازيق**

**[2] قسم علوم الأغذية شعبة الصناعات الغذائية –كلية الزراعة جامعة الزقازيق**



في هذه الدراسة تم تقييم التركيب الكيماوي والخواص الفيزيائية ل6خلطات من أغذية الفطام بتدعيم دقيق القمح بكل من دقيق اللوبيا والعدس والفول المجروش بنسب 10% و 20% وإضافتهما إلى 60و70% من دقيق القمح على الترتيب و 2,5% من مسحوق الجزر و2,5% من مسحوق البسلة و5%من السكر و8,5% من اللبن الفرز المجفف . تم مقارنة تلك المخاليط بالسير يلاك . أوضحت النتائج أن أعلى نسب البروتين والطاقة بالعينات التي تحتوى على اللوبيا ( 20%) والفول المجروش( 20%) بنسب( 18,75 % و 18,09% و376,08 كالورى و 374,93 كالورى) على التوالي بينما كانت عينة السير يلاك اقل النسب ( 10,00% و 348,10 كالورى على التوالي ) . أظهرت النتائج أن أعلى نسب الألياف كانت اللوبيا ( 20%) و (10%) والفول المجروش ( 20%) و(10%) (1,59 % و1,54 % 1,42% على التوالي) واقل النسب كانت العدس (10%) و(20%) (1,17%-1,27%) بينما كان السير يلاك 1,33% وأعلى نسب الأملاح المعدنية كانت بالسير يلاك ( 1,72%) ثم اللوبيا 20% (1,71%) . تم تقييم الخواص الفيزيائية حيث لوحظ أن أعلى قيم الكثافة النسبية كانت باللوبيا20% (6,78 جم/مل ) واقلهم بالسير يلاك(5,56 جم/مل ) ووجدت فروق معنوية بالنسبة إلى قياس القدرة على امتصاص الماء وان اقل درجة لزوجة كانت بالسير يلاك ( 1050 سنتي بواز ) ثم العدس 10 و20 % ( 1600و1700 سنتي بواز )، تلك الخلطات ذات تركيب وخواص مقبولة مثل السير يلاك لذلك يمكن استخدامها كأغذية فطام كما أن محتواها عالي في البروتين والطاقة.و خاصة الخلطات المحتوية على اللوبيا والفول المجروش بنسبة 20% .