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Chemical evaluation of both prepared and commercial weaning-food mixtures

التقييم الكيميائي لكل من خلطات الأطفال المحضرة والتجارية

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Abstract

In developing countries, there is a shortage of either milk or dairy production. Moreover, these products are highly expensive. In addition, breast milk alone was insufficient to support normal growth during the second half of infancy, for this reasons complementary foods are usually given to infants during weaning stage. The aim of this study is an attempts have been made to prepare weaning food mixtures with highly nutritional quality, rich in minerals , antioxidants , essential amino acids and economic price. It could be prepared seven formulae from local foods (Rice, chickpea, potato , skimmed milk powder and fortified with coconut and pine). Also, comparative study between prepared and commercial weaning-mixtures were also studied the obtained results could be summarized as the following: all prepared weaning food mixtures are considered as a good source of carbohydrate (

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70.0 - 76.4 g/100 g on dry weight basis) , protein (6.4 - 14.1 g /100 g on dry weight basis) , crude fibers(2.6-3.4 g) , ash (2.5 -3.4g), total energy(349.3 - 365.1 K. calories /100 g on dry weight basis) and minerals Ca (92.8 - 192.2 mg /100g), P (74.8 to 93.7 mg/100 g), K(494,9 - 650.9 mg/100g) , Fe (2.82 - 6.91 mg/100g) and Zn (5.04 - 5.80 mg/100g) . Moreover, were rich source with essential amino acids (EAA) (50.6-56.8 mg), especially leucine , (5.0 - 11.2 mg) and lysine (1.8 – 8.0 mg) as compared with commercial samples. In addition, consuming 100g of any prepared formula could cover the daily requirements for babies from protein, EAA and more than half of the total energy as recommended . The obtained results indicated that histidine had the highest chemical protein score in prepared weaning-mixtures. It was ranged from 126.1% in formula (5) to 139.5% in formula (4).Meanwhile, chemical score of histidine in commercial weaning-mixtures was 56.5% and 73.9% in formula (8) and (9). On the other hand, commercial weaning-mixtures were recorded the lowest protein score, it was ranged between 47.4% and 57.9% of methionine and cysteine. Also, all prepared formulae is a good source of phenolic compounds, especially chlorogenic and gallic acids as compared with local baby foods. Also, these are eleven phenolic compounds of prepared weaning mixtures, meanwhile commercial baby foods contained eight phenolic compounds.

Keywords: Chickpea , Rice, Potato , Coconut , Pine , Weaning food , Prepared , Commercial , Chemical composition, Amino acids , Minerals , Phenolic compounds.

الملخص العربي :

تم تحضير سبعة خلطات غذائية للأطفال باستخدام الأرز، حمص الشام ، البطاطس، اللبن الجاف المعقم والتدعيم بالمكسرات (الصنوبر وجوز الهند). كما تم عمل مقارنة بينهما و بين عينتين (أ) ، (ب) من السوق المحلي، وتم التقييم الكيميائي كالبروتين ، والدهون ، الكربوهيدرات ، الألياف ، المعادن ، الرطوبة والطاقة الكلية وكذلك تقدير العناصر المعدنية (الكالسيوم ، الفوسفور ، البوتاسيوم ، الحديد، الزنك)، وكذلك تقدير المركبات الفينولية والأحماض الأمينية وكانت أهم النتائج المتحصل عليها ما يلي : تعتبر الخلطات المصنعة مصدر جيد للبروتين (٦,٤ – ١٤,١ جم / ١٠٠ جم كوزن جاف)، الكربوهيدرات (٧٠ - ٧٦,٤ جم/ ١٠٠ جم كوزن جاف)، الدهون (١,٥ – ٣,٢ جم /١٠٠جم كوزن جاف) ، المعادن (٢,٥ – ٣,٤ جم/١٠٠جم كوزن جاف)، الألياف (٢,٦–٣,٤ جم/١٠٠ جم كوزن جاف) والطاقة الكلية (٣٤٩,٣ – ٣٦٥,١ كيلو كالوري لكل ١٠٠جم كوزن جاف) وكذلك العناصر المعدنية الكالسيوم (٩٢,٨ – ١٩٢,٢ ملجم / ١٠٠ جم كوزن جاف)، الفوسفور(٧٤,٨ – ٩٣,٧ مجم / ١٠٠ جم كوزن جاف) ، البوتاسيوم (٤٩٤,٩ – ٦٥٠,٩ مجم / ١٠٠ جم كوزن جاف)، الحديد (٢,٨٢ – ٦,٩١ مجم / ١٠٠ جم كوزن جاف)، الزنك (٥,٠٤– ٥,٨٠ مجم / ١٠٠ جم كوزن جاف). وأن استهلاك ١٠٠ جم من أي خلطة من الخلطات المصنعة يمكنها أن تغطي احتياجات الطفل اليومية من البروتين وبعض العناصر المعدنية ونصف كمية الطاقة تقريباً بعكس خلطات السوق المحلي. تم تقدير الأحماض الأمينية بواسطة جهاز تحليل الأحماض الأمينية وتم التعرف علي سبعة عشر حامض أميني تشمل عشرة أحماض أمينية أساسية ، سبعة أحماض أمينية غير أساسية وكان من الأحماض الأمينية الأساسية السائدة هي الليوسين والذي تراوح قيمته (٥ – ١١,٢ ملجم / جم)، والحامض الأميني اللايسين (١,٨ – ٨ ملجم / جم). وأظهرت النتائج احتواء الخلطات المحضرة علي الأحماض الأمينية الأساسية بنسبة أكبر من خلطات السوق المحلي، وأن استهلاك ١٠٠ جم من أي خلطة يمكنها أن تغطي حاجة الطفل اليومية بعكس خلطات السوق المحلي .دلت نتائج الأحماض الأمينية الأساسية علي أن الحامض الأميني الهستدين أنه أعلي نسبة بروتين كيميائي في جميع الخلطات المصنعة وتراوحت نسبته ١٢٦,١ % في الخلطة رقم (٥)

١٣٩,٥، % في الخلطة رقم (٤) بينما كانت نسبته في الخلطات التجارية (٨) ، (٩) هي ٥٦,٥% ، ٧٣,٩ % علي التوالي. وعلي العكس سجل كل من الحامض الأميني السيستين والمثيونين أقل نسبة في البروتين الكيميائي والذي تراوح من (٤٧,٧ – ٥٧,٩ %).أظهر التحليل الكيميائي للمركبات الفينولية لجميع الخلطات باستخدام جهاز الفصل الكروماتوجرافى (HPLC)عن وجود أحد عشر مركب فينولي في العينات المحضرة بينما لوحظ وجود ثمانية مركبات فينولية في عينات السوق المحلي . وكان من أهم المركبات الفينولية كل من حمض الكلوروجينيك والجاليك بعكس خلطات السوق المحلي.

INTRODUCTION

Breast-milk is universally accepted as the best food for infants and hence, its desirable properties had been described extensively. However, breast-milk alone was insufficient to support normal growth during the second half of infancy, for this reason, supplementary feeding was required for a successful transition to solid food during this period (**Dualeh and Henery, 1989**). Complementary foods are usually given to infants. In developing countries, complementary foods are based on local staple foods, usually cereals that are processed into porridges, cereal based gruels are of poor nutritional value. Thus, incorporation with vegetables, fruits, dairy products and other nutrients (**Mehder,2014**).

In developing countries, researchers have focused their attention on the possibility of formulation of infant weaning food from locally available foods, vegetable proteins, cereal to reduce frequent maternal morbidity and mortality (**Ibrionke,2014**).

Weaning refers to introduction of food other than mother’s milk or complete discontinuation of breast-milk or

introduction of solids to diet. Generally the term weaning is used to denote the process in which infant changes from breast-milk to mixtures diet (**Temesgen, 2013**). It is the process of expanding the diet to include food and drinks other than breast-milk or infant formulae as it is the period of infant vulnerability (**Sajilata, *et al.*, 2002**), represents a period of dietary transition, just when nutritional requirements for growth and brain development are high. Observations of traditional child feeding practices in many developing countries reveal that, weaning period is the whole period, during which breast-milk is being replaced by other foods, usually starts when infant is 4-6 months old and is expected up to the age of two to three years.

Weaning is a period of transition for the infant during changes diet in terms of consistency and source (**Xia, 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**).

In Egypt ,as in many countries of the world, the production of milk is not sufficient to supply the need of population ,thus several efforts has been carried out to produce weaning food-mixtures that suitable for infants age. Also, it is an important to produce weaning-mixtures from the local materials which should be have high nutritional value, acceptable taste and odor, economic price and microbiologicaly safe for infant consumption (**Emam, 2002, Abou-Sebaa, Sherin,2004, Baghdady, Fatma,2015,Alqallaf, Jenan,2017 and Al-Shemary ,Fatma,2019**).

Rice (*Oriza sativà*) is considered as the main source of energy and one of the most important cereals in the world .Rice it is the dominant staple, providing about half of the daily calorie consumption for children, and slightly more for pregnant and lactating women (**Roukaytou and Matin, 2004**).

Chickpea (*Ciceer arietium* L.) is an important food legume and it is a major ingredient in many human diets as reported by (**Xu *et al*., 2014**). They found that carbohydrate and protein were two major components in al seeds. Cooking increased fiber and carbohydrate; but decreased ash content. Protein and oil levels of the cooked samples either decreased or did not change significantly. Seed weight and density decreased with cooking.

Potato (*Solanum tubersoum*, L.) and sweat potato (*Lopoomoea batats*) contained a considerable amounts of phenolics and has antioxidant activity by DPPH radical scavening activity better than butylated hydroxy toluene (**Mateus *et a*l., 2017**) . Several studies showed that potato peels is considered as a good source of antioxidative effects (**Rehman *et al* . , 2004 , Mohdaly *et al*., 2010 ; Sepelev and Galoburda, 2015 and El – Harbi, Entsar, 2019**).

Coconut (*Cocos nucifera*, L.) is the fruit of the palm tree cocas that grows in the tropical and subtropical region .it is known that coconut as a source of oil , with various industrial and culinary applications (**Bawalan and Chapman , 2006**) . Coconut is many uses , it is called the tree of life **(Chan and Elevitch , 2006) .**Coconut is widely available , inexpensive , non-toxic and highly palatable and consuming a regular intake

of good quality coconut oil (**Fernando *et al* . , 2015**) . Coconut fruit products have been used in popular medicine for the treatment of various diseases (**Esquenazi *et al.* , 2002**) . The kernel of coconut is composed of oil, proteins, carbohydrates, vitamins and minerals. **(Marikkar and Madurapperuma, 2012**) .

Pine (*P .eldarica*) nuts are eaten raw or roasted: they are included as ingredients in a variety of traditional dishes. such as breads, cakes, sauces, candies , as well as vegetable and meat dishes, pine nuts are a good source of nutrients (**Savage , 2001**) . In particular, nuts include plant protein, unsaturated fatty acids, dietary fiber, plant strolls, phytochemicals and micronutrients like tocopherols (**Kris-Etherton *et al* ., 2001**). The pine nut (*Pinus Koraiensis Sieb . et Zuce*) as an abundant plant resource has the capacity of anti-fatigue, anti-aging anti-radiation etc. (**Xie *et al* ., 2016**) . It contains essential and relatively complete amino acids, and fatty acids **(Noa *et al.*, 2015)**.

Weaning food plays a vital role in children's overall growth, development and mental health **(Sheriff, 2015)**. Babies need complementary food-balanced foods, as well as breast-milk, due to increased dietary needs of the growing body **(Sajilata *et al.*, 2002 and Umeta *et al.*, 2003).**

MATERIALS AND METHODE

Materials

The raw materials used throw out the present study for preparation of weaning–food mixture formulae were rice, chickpea, potato, skimmed milk powder, coconut and pine as follows: both **rice** (*Oriza sativà*), variety and **chickpea** (*Cicer artictinum* L.) variety were Giza 3 was obtained from Ministry of Agricultural , Giza City, Egypt. **Potato** (*Solanum tuberosum*, L.) was obtained from Ministry of Agricultural Research Center, Giza City, Egypt. **Skimmed milk powder** was obtained from local market of Zagazig City, Sharkeia governorate, Egypt. Both **coconut** (*Cocos nucifera*, L.) and **pine** (*P .eldarica*) were obtained from Ministry of Agricultural, Dokki, Giza City, Egypt. Two local weaning-food mixtures were obtained from local market of Benha City, Qalubia, Governorate , Egypt.

Methods

Preparation of food ingredients

Rice grains were cleaned from the impurities, washed with clean tap water for several times, cooked in water for 30 min. until swelling. The grains dried in an electric oven at 60 °C , ground into fine flour by using an electric grinder ,rice flour was packed in polyethylene bags .

Grains of chickpea were cleaned from impurities, washed several times with clean tap water, soaked in clean tap water for three days till the grains swelling and change the water to remove the alkaloids .The swelling grains of chickpea were blanched in the amount of suitable clean tap water for about 15min, then dried in an electric oven at 60° C, crushing

by an electrical grinder to obtain suitable granules or blended to the flour. The flour of chickpea was packed in polyethylene bags .

Potato were washed with clean tab water for several times, and blanching for about 20 min , then peeling, dried in an electric oven at 55 °C and blended by an electrical grinder to fine powder. The potato flour were packaged in polyethylene bags.

Pine and coconut were dried by solar energy in the National Research, Dokki, Egypt Center Laboratory. The dried pine and coconut were ground into fine power in an electrical grinder very well and packed in polyethylene bags.

Preparation of weaning food mixtures.

In this study, seven formulae of weaning food mixtures were prepared by using the previously prepared ingredients (Rice flour, chickpea flour, potato flour, skimmed milk powder, dried coconut and pine). The percentages of different prepared weaning mixtures are shown in the table (1). The ingredients of each formulae were blended together in an electrical mixture for full homogenization. Prepared formulae were packed in Pyrex glass jars which were closed tightly and sterilized in the autoclave at 121°C for 15 min.

Table (1) : The percentages of food ingredients used in prepared baby food mixtures.

Ingredients / Formulae	Rice flour	Dried chickpea	Potato flour	Skimmed milk powder	Dried coconut	Dried pine	Mix. of coconut and pine
1	35.0	30.0	25.0	10.0	-	-	-
2	35.0	30.0	20.0	10.0	5.0	-	-
3	30.0	30.0	20.0	10.0	10.0	-	-
4	35.0	30.0	20.0	10.0	-	5.0	-
5	30.0	30.0	20.0	10.0	-	10.0	-
6	35.0	30.0	20.0	10.0	-	-	5.0
7	30.0	30.0	20.0	10.0	-	-	10.0

Chemical analysis

Moisture, crude protein, ash content, total protein and crude fibers were determined according to the method described by **AOAC, (2000).** Results expressed as g/100g on dry weight samples. Carbohydrates were calculated by the difference. Total energy calculated according to **FAO/WHO/UNA, (1985)** and results as expressed as Kcal/100g on dry weight.

Determination of phenolic compounds

Extraction of phenolic compounds

The phenolic compounds of both prepared and commercial weaning - mixtures were extracted the method described by **Ibrahim,(1996)**, in which methanol 80% at zero

time for 72 hours used .The methanol being changed every 24 hours as illustrated by **Daniel and George, (1972).** The combined methanolic extraction was transferred into aqueous phase and evaporated the methanol to a known volume.

Separation conditions of phenolics

HPLC analysis was carried out in the laboratory of National Research Center, Dokki Giza, Egypt using an Agilent 1260 series. The separation condition was carried out using Kromasil C18 column (4.6 mm x 250 mm i.d., 5 μm).The mobile phase consisted of water (A) and 0.05% trifluoroacetic acid in acetonitrile (B) at a flow rate 1 ml/min. The mobile phase was programmed consecutively in a linear gradient as follows: 0 min (82% A); 0–5 min (80% A); 5-8 min (60% A); 8-12 min (60% A); 12-15 min (85% A) and 15-16 min (82% A). The multi-wave length detector was monitored at 280 nm **(Donner *et al.*, 1997)**. The injection volume was 10 μl for each of the sample solutions **(Escarpa *et al.*, 2000)**. The column temperature was maintained at 35 °C.

Determination of amino acids

Dried and defatted samples were weighted in the screw-capped tubes (50-100 mg) and 5 ml of 6.0 N HCL were added. The hydrolysis tubes were attached to a system, which allows the connection of nitrogen and vacuum lines without disturbing the sample. The tubes were placed in an oven at 110 °C for 24 hr**. (Suzanna, Nielson, 1998).** The tubes were then opened and the contents of each tube were filtered and evaporated until dryness in a rotary evaporator. A suitable volume of sodium citrate buffer pH 2.2 was added to dissolve the contents of each

dried film of the hydrolyzed sample, followed by ultrafiltration using a 0.2 um membrane filter **(Baxter, 1996).**

Elution buffers and detection reagent:

Amino acids were achieved by using buffers with different pH and molarity. In general, the higher pH and molarity, the faster elute amino acids. Three citrate buffers were used to elute 17 amino acids, buffer 1(0.2 M, pH 3.2) and buffer 2 (0.2 M, pH 4.25) elute the acidic and neutral amino acids, while buffer 3 (0.2 M, pH 6.45) elute basic amino acids. In addition, a loading dilution citrate buffer (0.2 M, pH 2.2) and a column regeneration solution (0.4 M NaOH) were used. All citrate buffers and NaOH solution were Pharmacia Biotech Chemical. Ninhydrin detection reagent was used which consisted of ultrasolve 1.75L, Ultra Ninhydrin Solution 250 ml. All these items were Phamacia Biotech Chemicals.

Apparatus and analytical conditions:

All analysis were performed on a High Performance Amino Acid Analyzer Biochrom 20 (Auto sample version) Pharmacia Biotch constructed at NCRRT. Amino Acid Analyzer Equipped with stainless steel column (200 x 4.6 mm) packed with altropac 8 (8 um + 0.5 um) cation exchange resin. Stepwise elution with the aforementioned 3 buffers resolved 17 amino acids. The following programme was used for the separation and detection of the amino acids.

Buffer 1 was pumped for 9 min , followed by buffer 2 for 12 min and buffer 3 for 17 min, the column was regenerated (0.4 M NaOH) for 4 min , followed by equilibration in buffer, for 16 min. The column was initially

heated at 53 °C for 9 min. The temperature was changed to 58 °C for 13 min then changed to 95 °C for 24 min, finally cooled down to 53°C for the reminder of the cycle 12 min. The cycle time from injection to injection was 58.4 min. The flow rate was 25 ml/hr for ninhydrin reagent and 35 ml/hr for the buffer. The reaction between the amino acids and ninhydrin occurred at 135 °C in a 10m PTEE reaction coil (0.3 mm L.D) immersed in a silicon oil. Detection was performed at two wave lengths (570 and 440 nm). The data of each chromatogram was analyzed by EZ Chrom^{TM} chromatography data system tutorial and user's Guide- Version 6.7.

Chemical protein score

Chemical protein score of both prepared and local weaning-food mixtures were estimated by the essential amino acids in samples to those provisional reference protein of **(FAO/WHO , 1989).**

RESULTS AND DISCUSSION

Chemical composition

Chemical composition of both prepared and commercial weaning-food mixtures are tabulated in table (2) .Total protein of prepared formulae was ranged from 12.2 to 14.1 g /100 g on dry weight basis , the highest value was found in formula (5) and the lowest value was in formula (1) .Meanwhile , commercial samples(8 and 9) were 6.4 and 7.4 g protein /100g on dry weight basis. It is obvious from the result that, the protein content of any prepared formulae not less than 12.2 g/100g dry weight .This may be due to the addition of skimmed

milk powder which is the main source of animal protein as found by **Gomaa, (2000) and Allam, (2007).** Also, all prepared formulae contained chickpea which considered as a rich source of plant protein by **Abou-Sebaa, Sherin, (2004), Ouazib *et al.*, (2015) and Xu *et al* ., (2016) .**Such results are in agreement with those recommended by **FAO/WHO, (1989).**It is worthy to mention that all prepared formulae contained the higher percentages of protein than commercial samples. These results are in agreement with those obtained **Abou-Sebaa, Sherin (2004) and Al-Shemery, Fatma (2019).**

It is evident from the results that total carbohydrate was ranged between 70.0 and 76.4 g/100 g on dry weight basis, the highest value was found in formulae (8). In addition, all formulae are a good source of carbohydrate and total energy, this may be due to the addition of rice. Such results are in agreement with those found by **Emam, (2002)** and **Alqallaf, Jenan, (2017)** . Whereas, total caloric values of all formulae was ranged from 349.3 to 365.1 Kcal /100 g on dry weight basis. The highest value of total calories was found in prepared formula (3) and the lowest one was in formula (9) or commercial samples. On the other hand , fats of all formulae was ranged between 1.5 and 3.2 g/ 100g on dry weight basis, the highest value was found in formula (7).This may be due to the addition of dried coconut and pine. The obtained results revealed that either prepared or commercial samples are a good sours of ash (2.5 -3.4g) and crude fibers (2.6-3.4 g).Formula (7) recorded the highest value of ash and fat content. Meanwhile, formula (6) was the highest value of crude fibers.

It is worthy to mentioned that, most prepared formulae had recorded the higher percentage of protein and total energy than those commercial samples. Formula (7) recorded the highest value of ash and fats .Meanwhile, formula (5) showed the highest value of protein. Moreover, consuming 100g from any prepared formulae could cover the daily requirement for babies aged from 6 to 12 months from protein and about half the amount of total energy as recommended by **FAO/WHO, (1989)** who reported that the daily requirements of babies from 13 to 14 gram protein and total calories from 650 to 850 K. calories during the first year. Finally, it could be concluded that, all prepared weaning mixtures are considered as a good source of protein, carbohydrates, ash, fibers and total energy.

Table (2) : Chemical composition of both prepared and commercial weaning mixtures.

Constituents / Formulae	*Moisture	*Protein	*Ash content	*Crude fiber	*Fats	*Carbohydrate	Total calories 100 g dry weight /(Kcal)

1	**7.2**	**12.2**	**2.5**	**2.6**	**1.5**	**74.0**	**358.3**
2	**6.6**	**12.3**	**2.6**	**3.0**	**1.9**	**73.6**	**360.7**
3	**6.4**	**12.3**	**2.9**	**2.8**	**2.7**	**72.9**	**365.1**
4	**8.0**	**12.4**	**3.1**	**3.0**	**2.9**	**70.6**	**358.1**
5	**6.5**	**14.1**	**3.3**	**3.1**	**3.0**	**70.0**	**363.4**
6	**6.2**	**13.2**	**3.2**	**3.4**	**3.1**	**70.9**	**364.3**
7	**6.4**	**13.7**	**3.4**	**3.0**	**3.2**	**70.3**	**364.8**
****8**	**8.5**	**6.4**	**3.1**	**3.2**	**2.4**	**76.4**	**352.8**
****9**	**8.9**	**7.4**	**3.3**	**3.1**	**2.1**	**75.2**	**349.3**

Each value represents the mean of three replicates .

*Results as expressed g/ 100g on dry weight basis.
**Commercial baby foods.

Minerals

Minerals of Ca, P, k, Fe and Zn in either prepared or commercial weaning-food mixtures (mg/100g on dry weight basis) were illustrated in table (3). The obtained results indicated that calcium of all prepared formulae was ranged between 92.8 and 192.2 mg /100g on dry weight basis and the highest value was found in formula , (5) followed by (3)and (6) , respectively. On the other hand, phosphorus of all prepared formulae was ranged from (74.8 to 93.7) mg/100 g on dry weight basis, the highest value was found in formula (7) and the lowest value was noticed in formula (3).It is evident from the results that potassium of all prepared formulae was ranged between 494,9 and 650.9 mg/100g on dry weight basis, the highest value was found in formula (7) and the lowest value

was noticed in formula (3) .On the other hand, Fe of all prepared blends was ranged between 2.82 and 6.91 mg/100 g on dry weight basis. The obtained results showed that prepared formula (7) had recorded the highest value of phosphorus, potassium and Zn as compared with the other prepared formulae. However, commercial baby foods' had recorded the highest value of both Ca and P than those prepared blends.

It is obvious from the results that Zn of prepared formulae was ranged between 2.0 and 5.80 mg/100g on dry weight basis, the highest value was found in formula (7) and the lowest was in formula (8). Moreover, consuming of 100 gram of any formula could cover the daily requirements of potassium, while calcium - cover about from 24 to 53.3% , P (14.9 - 33%) , Fe (28 - 69.1%) and Zn (40 – 116%) of recommended daily allowances (RDA) as reported by **FAO/WHO, (1989).** It could be concluded that all prepared formulae are considered as a good source of K, Ca, P, Fe and Zn for the vital stage of childhood age as supplementary foods.

Table (3) : Minerals of both prepared and commercial weaning -food mixtures (mg/100 g on dry weight basis).

Minerals / Formulae	P	Ca	K	Fe	Zn
1	**83.41** **16.7**	**190.3** **31.71**	**541.9** **271.0**	**6.91** **69.1**	**5.20** **104.0**

2	**75.64** **15.13**	**144.3** **24.0**	**513.7** **256.9**	**3.51** **35.1**	**5.31** **106.2**
3	**74.82** **14.96**	**191.6** **31.9**	**494.9** **247.4**	**3.24** **32.4**	**5.74** **114.8**
4	**74.82** **14.96**	**189.1** **31.5**	**540.1** **270.1**	**2.89** **28.9**	**5.04** **100.8**
5	**87.82** **17.56**	**192.2** **32.0**	**615.9** **308.0**	**4.71** **47.1**	**5.61** **112.2**
6	**75.25** **15.05**	**191.3** **31.9**	**578.6** **289.3**	**2.82** **28.2**	**5.22** **104.4**
7	**93.71** **18.74**	**92.8** **15.46**	**650.9** **325.5**	**5.03** **50.3**	**5.80** **116.0**
8	**165** **33.0**	**295** **49.16**	**510** **255.0**	**7.8** **78.0**	**2.0** **40.0**
9	**160** **32.0**	**320** **53.3**	**512** **256.0**	**6.5** **65.0**	**5.0** **100.0**
RDA	**500**	**600**	**200**	**10**	**5**

Phenolic compounds

Phenolic compounds (µ/g dry sample) of both prepared and commercial weaning foods are shown in table (4) .It could be identified of eleven phenolic compounds from prepared weaning –mixtures. These compounds were gallic, chlorogenic, methyl gallate , coffeic acid, syringic acid, pyrocatecol, coumaric acid, vanillin, naringenin , cinnamic acid

and kaempfrol . Chlorogenic and gallic acids are the predominant or major phenolic compounds of all prepared formulae. On the other hand , it could be separated and identified eight phenolic compounds from extracted of commercial weaning foods i.e, there were three phenolic compounds didn't find (gallic, chlorogenic acids and pyrocatechol). It is evident from the results that, chlorogenic acid of all prepared weaning foods was ranged from 68.27 to 160.7 µ/g on dry weight basis. The highest value was found in formula (4) and the lowest was noticed in formula (3). Meanwhile, gallic acid was ranged between 42.98 and 280 µ/g on dry weight basis .The highest value was found in formula (5). However, commercial samples were free from both gallic and chlorogenic acids. Chlorogenic acids is considered as the most important acid of the cinamics group , showed as prominent inhibitory activity against free radical generations **Jung *et al* ., (1989)**. Polyphenols are almost ubiquitous in legumes especially, phenolic acid (derivatives of benzoic and cinnamic acids) as reported by **Stobieki, *et al*., 1993 and El-Nahas, (2002)**.Chickpea contained a high level of chlorogenic acid (90.3 %) as found by **EL-Nahas, (2002**).

The obtained results showed that total phenolic compounds of all samples were ranged from 114.1 to 478.1 µg/ g on dry weight basis. Prepared formulae could be as ranged from it 's high content of total phenolic compounds as the following

desending maner : formula 5 (478.1) ,followed by formula 6 (423.3) ,and formula 7 (422.9) , respectively µg /g on dry weight samples .It is worthy to mentioned that, most prepared formulae contained the higher value of phenolic compounds as compared with commercial samples. Finally, it could be concluded that, all prepared weaning– food mixtures is considered as a good source of phenolic compounds, especially phenolic acids (chlorogenic and gallic acids),the best prepared formula was found in formula(5) .

Table (4) : Phenolic compounds of both prepared and commercial weaning-food mixtures.

Formulae / Phenolics m/g	1	2	3	4	5	6	7	8	9
Gallic acid	58.70	44.37	42.98	72.38	280.0	274.1	279.4	0.0	0.0
Chlorogenic acid	73.89	74.77	68.27	160.7	137.6	122.3	120.79	0.0	0.0
Methyl gallate	0.29	0.29	0.26	0.0	0.30	0.28	0.26	0.26	1.63
Coffeic acid	0.73	0.90	1.18	0.94	0.93	1.56	1.25	0.0	0.83
Syringic acid	0.0	0.0	0.0	0.0	0.0	11.3	13.5	0.94	0.97
Phro-catecol	0.0	20.70	20.69	15.69	42.23	3.05	0.0	0.0	0.0
Coumaric acid	0.0	0.0	0.0	0.0	1.14	0.0	0.0	1.12	0.92
Vanillin	0.99	0.94	1.13	1.0	3.37	1.82	1.73	110.1	264.8
Narigenin	1.91	1.93	2.24	1.96	12.18	5.08	5.78	0.0	0.47
Cinnamic acid	0.28	0.25	0.25	0.0	0.35	1.59	0.19	1.72	0.43
Kaempherol	2.44	2.19	2.02	2.24	0.0	2.21	0.0	0.0	5.75
Total Phenolic Compounds	139.2	146.3	139.0	254.9	478.1	423.3	422.9	114.1	275.8

Amino acids

Table (5) show amino acids (mg/g on dry weight basis) of either prepared and local weaning food mixtures. Essential amino acids (EAA) are important for baby foods.

The obtained results illustrated that there were seventeen amino acids could be identified. These are including10 essential and 7 non-essential amino acids (NEAA). Essential amino acids are valine, therionine, tyrosine ,leucin, isoleucine, histidine, phenyl alanine, lysine, cysteine and methionine. The results indicated that non-essential amino acids are aspartic acid, serine, glutamic acid, glycine, arginine, alanine and proline. These results are in agreement with those found by **Emam, (2002), Abou-Sebaa, Sherin, (2004), Baghdady, Fatma, 2015, Alqallaf, Jenan (2017) and Al-Shemary, Fatma (2019) .**

From the abovementioned results, it could be observed that the major essential amino acids were leucine, (5.0 - 11.2 mg) and lysine (1.8 – 8.0 mg). as compared with the other essential amino acids .While, the predominant non-essential amino acids in all samples were glutamic (11.1 – 24.9 mg) and aspartic acids (5.4-13.8 mg). In the contrary, the lowest of percentage of essential amino acids (EAA) were cysteine (1.2-2.4 mg) and methionine (1.5-2.9 mg) of all samples in either prepared or local baby foods. It is worthy to mention that, all prepared formulae had recorded the higher percentage of total EAA (50.6-56.8 mg) , the highest value was found in formula (7) and the lowest one was in formula (3) .

The addition of skimmed milk powder to all prepared blends with the percentage of 10%, showed the higher percentage of

total EAA but, commercial weaning food mixtures had recorded the lowest percentage of total EAA(24.4 and 26.9 mg) .This results are confirmed by **Abou-Sebba, Sherin (2004) Al - Shemery, Fatma, (2019) .**

However, total amino acids of prepared formulae was ranged between 57.1 and 128.4 mg /g on dry weight basis, the highest percentage was found in formula (6) and the lowest one was noticed in local formula (8).Meanwhile, commercial baby foods 8 and 9 contained 57.1 and 63.0 mg/g dry weight basis, respectively .The best formula was found in (6) , followed by (7), (4), (5), (1), (2) and (3), respectively .It could be concluded that, all prepared formulae are considered as a good source of essential amino acids (EAA) than those two local baby food samples.

Moreover, consuming 100 g from any prepared formulae could cover the daily requirement for babies from essential amino acids (EAA) as recommended by **FAO/WHO (1989).** On the other hand, commercial samples (8 and 9) cannot cover the daily needs of babies.

Table(5): Amino acids of prepared and local weaning-food mixtures (mg/g protein on dry weight basis).

Amino Acids	1	2	3	4	5	6	7	8	9
Essential amino acids (EAA)									
Threonine (THR)	4.8	4.4	4.5	5.2	4.9	5.3	5.2	2.1	2.3
Valine (VAL)	6.2	6.1	6.1	6.8	6.2	6.5	6.5	3.3	3.5
Isoleucine	5.4	5.3	5.2	5.8	5.6	5.8	5.9	2.3	2.6

(ILE)									
Leucine (LEU)	9.8	9.5	9.4	10.4	10.2	11.0	11.2	5.0	5.5
Tyrosine (TYR)	4.5	4.5	4.5	5.1	4.9	5.2	4.8	2.8	2.7
Phenylalanine (PHE)	6.4	6.3	6.3	7.1	7.2	7.0	7.1	3.1	3.4
Histidine (HIS)	3.0	3.0	2.9	3.2	2.9	3.2	3.2	1.3	1.7
Lysine (LYS)	7.4	7.1	7.0	8.0	6.7	7.7	7.8	1.8	1.9
Cystine (CYS)	2.1	2.1	2.1	2.2	2.2	2.2	2.4	1.2	1.5
Methionine	2.5	2.5	2.6	2.9	2.4	2.6	2.7	1.5	1.8
Total EAA	52.1	50.8	50.6	56.7	53.2	56.5	56.8	24.4	26.9
Non-Essential amino acids (NEAA)									
Aspartic (ASP)	12.9	12.9	12.3	13.8	12.9	13.7	13.7	5.4	6.0
Serine (SER)	5.7	5.3	5.5	6.4	5.9	6.3	6.1	2.8	3.2
Glutamic (GLU)	23.0	22.1	22.3	24.1	24.8	24.9	24.6	11.1	12.1
Glycine (GLY)	4.7	4.5	4.5	5.0	5.1	5.2	5.2	2.6	2.9
Alanine (ALA)	5.5	5.4	5.3	5.8	6.1	6.5	6.6	3.2	3.6
Argnine (ARG)	8.1	8.2	8.6	8.7	7.9	9.0	8.8	5.0	5.5
Proline	5.7	5.5	5.4	6.1	6.9	6.3	6.5	2.6	2.8
Total NEAA	65.6	63.9	63.9	69.9	69.6	71.9	71.5	32.7	36.1
Total AA	117.7	114.7	114.5	126.6	122.8	128.4	128.3	57.1	63.0

It could be concluded that, all prepared weaning-food mixtures are considered as a good source of essential amino acids and also has high levels of all individual EAA as comparing to those recommended by **FAO/WHO (1989).** Consuming 100 g of any prepared formula can cover the daily requirement from essential amino acid for babies.

Table (6) : The percentages of essential amino acids of all blends which cover the daily requirement for babies as recommended by FAO/WHO (1989).

Formulae / Amino acids	1	2	3	4	5	6	7	8	9	* RDA
THR	111.6	102.3	104.7	120.9	114.0	123.3	120.9	48.8	53.49	4.3
VAL	112.7	110.9	110.9	123.6	112.7	118.2	118.2	60.0	63.6	5.5
ILE	117.4	115.2	130	126.1	121.7	126.1	128.3	50.0	56.5	4.6
LEU	105.4	102.2	101.1	111.8	109.7	118.3	120.4	53.8	59.1	9.3
TUR+PHE	151.3	150	150	169.4	168	169.4	165.3	81.9	84.7	7.2
HIS	115.4	115.4	111.5	123.1	111.5	123.1	123.1	50.0	65.4	2.6
LYS	112.1	107.6	106.1	121.2	101.5	166.7	118.2	27.3	28.8	6.6
CYS+MET	109.5	109.5	111.9	121.4	109.5	114.3	121.4	64.3	78.6	4.2

CYS+MET	**109.5**	**109.5**	**111.9**	**121.4**	**109.5**	**114.3**	**121.4**	**64.3**	**78.6**	**4.2**

* Recommended daily allowances as FAO/WHO, (1989).

Chemical protein score of both prepared and commercial weaning-mixtures were shown in table (7) .

The obtained results indicated that histidine had the highest chemical protein score in prepared weaning-mixtures. It was ranged from 126.1 % in formula (5) to 139.5% in formula (4). Meanwhile, chemical score of histidine in commercial weaning-mixtures was 56.5% and 73.9% in formula (8) and (9). In contrast, cysteine and methionine were recorded the lower score in all prepared formulae, it was ranged from 80.1% and to 89.6%, the highest percent was found in formula (7) and the lowest one was found in formula (1) or control sample. On the other hand, commercial weaning-mixtures were recorded the lowest protein score, it was ranged between 47.4% and 57.9% of methionine and cysteine, thus they are considered as the limiting amino acids .Also, lysine recorded the lowest protein score (25.7 and 27.1%). It is worthy to mention that , chemical-protein score of any prepared formula was higher than the commercial baby food. It could be concluded that all prepared weaning-mixtures are considered as a good source of chemical protein score. Formula (7) was the best chemical-protein score of the most essential amino acids in comparison with the other for formulae.

Table (7) : Chemical protein score of both prepared and commercial weaning foods

Formulae / A.A	1	2	3	4	5	6	7	8	9	Whole Egg Protein
THR	102.1	93.6	95.7	110.6	104.3	112.8	110.6	44.7	48.9	4.7
VAL	93.9	92.4	92.4	103.0	93.2	98.5	98.5	50.0	53.0	6.6
ILE	100.0	98.1	96.3	107.4	103.7	107.4	109.3	42.59	48.15	5.4
LEU	114.0	110.5	109.3	120.9	118.6	127.9	130.2	58.1	64.0	8.6
TYR+PHE	117.2	116.1	116.1	131.2	130.1	131.2	128.0	63.4	66.0	9.3
HIS	130.4	130.4	126.1	139.5	126.1	139.1	139.1	56.5	73.9	2.3
LYS	105.7	101.4	100.0	114.3	95.7	110.0	111.4	*25.7	*27.1	7.0
CYS+MET	*80.1	*80.7	*82.5	*89.5	*80.7	*84.28	*89.6	*47.4	*57.9	5.7

*Limiting amino acids.

CONCLUSSION

Finally, it could be concluded that, all prepared weaning food mixtures are considered as a good source of carbohydrate, protein, crude fibers, ash, total energy and minerals (Ca, P, K, Fe and Zn). Moreover, were rich source of essential amino acids (EAA), especially leucine and lysine as compared with commercial samples . In addition, consuming 100g of any prepared formula could cover the daily requirements for babies

from protein, EAA and more than half of the total energy as recommended .Also, all prepared formulae is a good source of phenolic compounds, especially chlorogenic and gallic acids as compared with local baby foods.

RECOMMENDATIONS

1- It could be recommended mother's that prepare weaning-food mixtures at home from local materials in order to obtain high quality product, as well as rich source of antioxidants , essential amino ,minerals, fiber and economic price.
2- It recommended mother's with the importance of breast-feeding for babies which obtain her babies natural immunity and gives them these blends as complementary foods, beside breast-milk.
3- Mother's milk is a functional food (par excellence): it contains Simi-essential nutrients, free amino acids, enzymes, hormones, growth factor, oligosaccharides and immunity bodies.
4- Food processing factories could prepare weaning-food mixtures on a wide range of commercial scale in order to face the shortage of dairy production.
5- Different media could aware the mother's about correct infants nutrition.
6- Encouragement of researchers to carry out more important applied research to avoid malnutrition in the infants.

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