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Chemical and Sensory Assessment for some Complementary Food for Older Infants

Shalaby, M. T.; M. A. Abou-Raya; F. Y. Ibrahim and S. I. Mohamed
Food Industries Dept., Fac. Of Agric., Mansoura University, Egypt

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ABSTRACT

The present study was carried out to develop cereal and legumes based supplementary food from indigenous raw materials for young children and to estimate the chemical composition, physical properties and sensory assessment of five formulas of complementary infant foods. These formulas were compared with commercial one namely Nestle Cerelac product. The results indicated that the protein contents of all prepared formulas range from (15.00 to 26.13%), the fat contents being (2.95 to 3.31%), the fiber content were (3.57 to 3.85%). Also, the ash content was recorded for (2.53 and 3.50%).The carbohydrates contents ranged between (63.57 to 75.59%),while total number of essential amino acids ranges from (28.14 to 45.36 g/100g) protein .All formulas contained the following elements : Iron (5.53-6.67 mg/100g), Zinc (4.25- 5.58 mg/100g), Calcium (0.135-0.323)g/100g, Potassium (0.524-1.033)g/100g. Sodium (0.199-0.212) g/100g and Phosphorus (0.235-0.348 g/100g), All formulas contained some essential vitamins were (13.04 to 17.02 mg/100g),(0.17 to 0.26 mg/100g),(0.95 to 2.93mg/100g) and (0.395 to 0.83 mg/100g), (0.735 to 1.10 mg/100g) and (0.166 to 0.17 mg/100g) for vitamin C(Ascorbic acid), vitamin A(Retinol), (β-Carotene) , vitamin E(Tocopherols), Vitamin B1(Thiamin) and vitamin B2(Riboflavin) respectively. Anti –nutritional factors was analyzed in all formulas. Phytates were in the range of (0.177 to 0.484% mg/100 g), tannins was in the range of (0.38 to 0.71%) . From the functional properties results it was observed that bulk density values ranged from (1.017 to 1.o6 g/cm^3), while the viscosity between (2740 to 9880 cp).From mentioned results formula F5 could be recommended due to their higher protein and micronutrient contents than other formulas. From this study we concluded that the addition of partially defatted soybeans increases the protein and micronutrient to solve the problem of malnutrition in developing countries.

Keywords: Complementary food, Formulas, Partailly Defatted soybean,Chickpea.

INTRODUCTION

In developing countries, children usually undergo from underfeeding while being weaned, partly due to inadequate or inappropriate intake of safe and nutritious weaning foods (Anamika and Vishakha, 2017). A complementary food is any apposite food given to older infants and young children once breast-milk or infant formula alone can no longer meet a growing child's nutritional requests corresponding to a healthy development. (Adepoju and Etukumoh1 (2014).

Development of weaning foods from cereals and legumes has been suggested by the Integrated Child Development Scheme (ICDS) and FAO (Imtiaz *et al* 2011). Evidences have shown that in many parts of developing countries many families look for alternative source of protein from plant origin like cereal and legumes, because of high cost of animal-based foods, and this constitute large proportions of overall proteins consumed daily (Adegoke *et al*., 2014). The adding of legume to cereal-based products could be a good alternative for increasing the consumption of legumes. In addition, legume proteins are rich in lysine and deficient in sulphur containing amino acids, whereas cereal proteins are lacking in lysine, but have adequate amounts of sulphur amino acids (Minarro *et al*., 2012).

Wheat is the most important staple crop in temperate zones and is in increasing demand in countries undergoing urbanization and industrialization, wheat also provides amounts of a number of components which are essential or beneficial for health, notably protein, vitamins (notably B vitamins), dietary fiber, and phytochemicals (Shewry and Hey,(2015). Rice is a main food crop, with approximately one-third of the world's population relying on rice as a staple food and as the sole source of nutrition (Kusano *et al*., 2015), and using local ingredients with rice to produce micronutrient-rich complementary infant foods in emerging countries. (Pobee *et al*., 2017). Soybean could be an crucial part of functional foods, as well as it could be used for enhancement of product quality (Ahmad *et al*., 2014). Chickpea consumption is gradually increasing in current years. In growing countries, chickpea brings a multiplicity of taste and texture to the cereal-based diet, as well as high-grade protein, fiber, carbohydrates and minerals, thus ensuring a balanced diet and refining the nutritional station of the population (Bar-El Dadona *et al*., 2017). Carrots is one of the most generally used vegetables for human nutrition, due to are a rich in pro-vitamin A β-carotene, minerals and other valued nutrients, diet fortification with carrots is healthful and protective from various cancers (von Lintig, 2012).

This study purposed at using locally and cheaply available food ingredients rich in micronutrients, in formulating complementary food for infants. This would give to solving both of protein energy malnutrition and micronutrient deficiencies and disease protection among infants in developing countries. In this study wheat flour (72% extraction), rice flour, partially defatted soybean flour, chickpea flour, carrot powder and skim milk powder were used to formulate complementary infant foods.

MATERIALS AND METHODS

Raw Materials:

Partially defatted soybean flour was obtained from Agricultural Research Center, Ministry of Agriculture, and Giza, Egypt. wheat flour (72% extraction), chickpeas brand (Effendeena), rice brand (Egyptian Camoline Rice), fresh carrot and skim milk powder, were purchased from local market, Mansoura, Egypt.

Methods:

Preparation of chickpea flour:

Chickpeas were cleaned, washed, soaked in (tap water) for 12 hours, drained dehulled,(the dehulled in order to minimize associated anti-nutrition factors ,and dried in GARBUIO (essiccatoi, TRVISO, made in Italy) dryer, at 50° C for 12 hours, finally grinding using an electric grinder (Moulinex the genuine blender, LM24025) in order to pass through a 60 mesh sieve as mentioned by Malunga *et al* ., (2014).

Preparation of carrot powder:

Carrot Powder was prepared according to Akinola *et al* .,(2014) method which describe as follows: fresh

Carrots were washed , scraped ,grated, dried in GARBUIO (essiccatoi, TRVISO) dryer, made in Italy , At 50 ° C for 8 hours, finally grinding using an electric grinder (Moulinex the genuine blender, LM24025) in order to pass through a 60 mesh sieve.

Preparation of rice flour:

The rice was washed, dried in GARBUIO (essiccatoi, TRVISO) dryer, made in Italy, At 50°C for 4 hours and grinded with an electric mill (Moulinex the genuine blender, LM24025) in order to pass through a 60 mesh sieve as describe by Pobee et al.,(2017).

Formulation of the complementary infant foods:

The complementary infant foods were prepared from different materials were wheat flour (72% extraction), rice flour, defatted soybean flour, chickpeas flour, carrot powder and skim milk powder in compare with Nestle Cerelac as control sample. The formulas were formulated as follow: Five formulas of raw materials were weighed according to the percentages shown in Table (1), Each formula were mixed , packaged in Polyethylene bags and placed in the refrigerator until tests were done on them.

Table 1. Different formulas of complementary infant foods by gram (g):

Ingredients / Formulas	Wheat flour (Ext.72%)	Rice powder	Defatted soybean flour	Chickpea flour	Carrot powder	Skim milk powder
F1	20	20	0	40	10	10
F2	20	20	10	30	10	10
F3	20	20	20	20	10	10
F4	20	20	30	10	10	10
F5	20	20	40	0	10	10

Proximate Composition of raw materials and prepared formulas:

The chemical composition (moisture, ash, crude fat, crude protein and crude fiber contents) of raw materials and their formulas were determined according to the method described by AOAC, (2016). At Micro Analytical Unit, fac.of Agric, Mansoura university.

Determination of carbohydrate: carbohydrate content was calculated by the difference: [100- (protein + fat + ash + fiber)].

Determination of Amino acids Content:

Amino acids were estimated using ezchrom (software used for data collection and processing). the system used for the analysis was high performance amino acid analyzer (Biochrom 30) that for determining all amino acids other than tryptophan which was estimated as method is depend on hydrolysis with barium hydroxide, precipitation of barium sulphate from an acid solution and colorimetric analysis using p-dimethylaminobenzaldehyde. (AOAC,2012) at Regional Center for Food and Feed (RCFF), Agricultural Research center, Giza, Egypt. Determination of The total energy:

The total energy value of the complementary infant foods were calculated according to sharoba *et al*., (2013). equation : Total energy (kcal/100 g) = [(% Carbohydrates × 4) + (% Protein × 4)+ (% Fat × 9)].

Determination of elements content:

Calcium, zinc, and iron were determined using atomic absorption (Perin-Elmer 2380) according to Cottenie *et al*.,(1982).Phosphorous was determined colorimetrically as described by Page (1982). Sodium and potassium were determined using flame photometer according to Hesse (1971).Previous determination were achieved at Agricultural Research center, El,mansoura, Egypt.

Determination of vitamin content: Vitamin (C) were determined using (HPLC) according to (Danish official,1999).Vitamin A (Retinol) and Vitamin A (B Carotene) were determined using (HPLC) (Danish official ,1996)a. Vitamin E (Tocopherols) were determined using method as characterized by (Leth and sondergaro ,1981) . Vitamin B1(Thiamin) and B2 (Riboflavin) were determined using (HPLC) as mentioned by (Danish official ,1996)b. At Regional Center for Food and Feed (RCFF), Agricultural Research center,Giza,Egypt.

Determination of tannins content: tannin contents were determined using Folin Denis Reagent as described by Makkar *et al*. (1993). At Regional Center for Food and Feed (RCFF), Agricultural Research center, Giza, Egypt.

Determination of phytic acid content: An indirect colorimetric method described by Wheeler and Ferrel, (1971) was used for phytate determination. at Regional Center for Food and Feed (RCFF), Agricultural Research center, Giza, Egypt.

Functional properties of different complementary infant foods:

Bulk density (B.D):

The method described by Wang and Kinsella (1976) was used to determine the B.D of the formulas was expressed as gram material occupied by one ml volu.T." (g/ml) . At agricultural Research center, Giza, Egypt.

Apparent viscosity: This was estimated by the modified method of Quinn and Beuchat (1975) . At agricultural Research center, Giza, Egypt.

Sensory Evaluation:

The five different samples of complimentary diet were evaluated using hedonic method for sensory characteristics and the overall acceptability by panelists of 15 judges from mothers as described by (Ihekoronye and Ngoddy, 1985) was used. The hedonic was used to compare (Nestle Cerelac) and formulated food to know which formula was preferable in colour, texture, aroma, taste and overall acceptability. At food industries dept, fac.of Agric, Mansoura university.

Statistical Analysis: The statistical analyses were made according to the statistical analysis system (SAS, 2010) software program .

RESULTS AND DISCUSSION

Chemical composition of used raw materials:

The proximate chemical composition of raw materials is shown in Table (2).The data indicated that the moisture content of different materials was in the range of (3%) of skim milk powder and defatted soybeans flour to (10.7%) of wheat flour (72% extraction) respectively. Partially defatted soybeans flour contains the highest content of protein (47.9%) followed by skim milk powder (34.8%). Partially defatted soybean flour and chickpea flour had higher fat content (5%) than other used materials. The highest ash content was recorded in skim milk powder being (7.5%) compare with other used materials. While partially

defatted soybeans flour and carrot powder have highly crud fiber content (7.4 % and 7 %) respectively. Those results disagree with Gazalli *et al* .,(2013) who reported that the chemical composition of carrot powder was moisture 8.78% ,Protein % 6.16 , fat 2.43%, Ash 5.05%, except crude fiber 24.66%.

Table 2. Chemical composition of raw materials used in complementary infant foods (g/100g) (on dry weight basis).

Contents Raw materials	Moisture %	Crude Protein %	Crude Fat %	Crude Fiber %	Ash %	Total carbohydrates %
Wheat flour (72% extraction)	10.7	10.75	1.92	0.63	0.53	86.17
Defatted soybean flour	3.0	47.9	5.0	7.4	4.9	34.8
Chickpea flour	9.5	19.30	5.8	6.8	2.52	65.58
Rice flour	7.7	6.5	2.02	0.51	0.50	90.47
Carrot powder	8.5	6.0	1.0	7.0	6.0	80
Skim milk powder	3.0	34.8	0.91	0	7.5	56.79

Amino acids content of raw materials used in complementary infant ood:

The essential and non-essential amino acids content of raw materials used in different formula preparation were shown in Table (3). The total number of essential amino acids for skim milk powder being (42.74g/100 protein) it was the highest one compare in others, that agreement with Ibrahim *et al*.,(2014). The data also in the same Table indicate that Glutamic (GLU) amio acid content had highest level in all raw materials that used in this study compare with other determined amino acids, while Tryptophan (TRY) had lowest level. Also it could be observed that partially defatted soybeans flour and chickpeas flour contain (36 and 36.63g/100 protein) respectively of essential amino acids, which higher than other used materials, also there were similarity in non-essential amino acids content (55.39 and 55.96 g/100 protein) respectively, which lower than prepared materials. The total sum of all amino acids of was highest in skim milk powder (98.67 g/100 protein) and carrot powder (98.13 g/100 protein) compare with other used materials. As a result of this difference in levels of amino acids between used raw materials can be argued that when mixing these used materials together and introduced them in a formula will provide an appropriate amount of amino acids that meet the needs of the infants.

Table 3. Amino acids (g/100 protein) of raw materials used in different prepared formulas of complementary infant food.

Amino acids	Raw materials					
A- Essential amino acids	**Wheat flour (72%ext)**	**Rice flour**	**Defatted soybeans flour**	**Chickpea flour**	**Carrot powder**	**Skim milk powder**
1-Leucine (LEU)	6.70	8.33	8.17	7.85	5.90	9.58
2-Isoleucine (ILE)	3.46	4.07	4.25	4.40	3.93	4.95
3-Methionine (MET)	1.67	2.78	1.67	1.75	0.98	2.89
4-Tryptophan (TRY)	1.08	1.60	1.65	1.58	1.45	2.30
5-Threonine (THR)	2.90	3.33	3.63	3.66	3.60	4.18
6-Phenylealanine (PHE)	5.02	5.37	4.93	5.94	3.93	4.82
7-Lysine (LYS)	2.46	3.70	7.03	7.00	5.57	7.85
8-Valine (VAL)	4.47	5.74	4.67	4.45	5.25	6.17
Total of essential	27.76	34.92	36	36.63	30.61	42.74
B-Non-essential amino acid						
1-Aspartic (ASP)	4.25	9.63	10.84	11.41	19.67	7.72
2-Serine (SER)	4.80	4.26	4.21	4.99	3.93	4.82
3-Glutamic (GLU)	31.84	19.26	18.02	17.45	25.57	21.41
4-Proline (PRO)	11.96	4.07	4.71	3.55	4.59	9.06
5-Glycine (GLY)	3.80	4.63	3.83	3.71	4.26	1.74
6-Tyrosine (TYR)	3.58	3.52	3.85	3.50	3.27	5.01
7-Histidine (HIS)	2.35	2.59	2.78	2.65	1.97	2.89
8-Arginine (ARG)	4.13	9.40	7.15	8.70	4.26	3.28
Total of non-essential	66.71	57.35	55.39	55.96	67.52	55.93
Total	94.47	92.27	91.39	92.59	98.13	98.67

Minerals content of raw materials used in complementary infant food :

The elements contents of the raw materials included in this study were analyzed as shown in Table (4). Wheat flour (72% extraction) contained some essential minerals namely iron (Fe) with the amount of (3.0 mg/100g) and Zinc (Zn) with the amount of (2.11 mg/100g), while Macroelements were also, detected with different amounts. Results also in the same table showed that partially defatted soybeans flour exhibited the highest amount of iron was (11.49 mg/100g) and Zinc (Zn) with (10.35 mg/100g).. Calcium content in skim milk powder (0.936 g/100g) was the highest compare with other used materials. Partially defatted soybeans flour had highest contain in k (1.878 g/100g) and P(0.639g/100g) while carrot powder had highest in Na (1.317 g/100g). those outcomes agree with that recorded by El-Beltagi *et al*., (2017) who refer to that wheat flour (72% extraction) flour contain about 3.00mg/100g and 1.7mg/100g of Iron and Zinc respectively ,but different with Turab, (2017) who stated that mineral composition of partially defatted soybean flour comprise around (25.62 mg/100g), (4.56 mg/100 g), (274.07 mg/100 g) and (743.58 mg/100 g) of Iron, Zinc, Calcium and Phosphorus respectively.

Table 4. Minerals contents of raw materials used in complementary infant food.

Minerals	Microelements (mg/100g)		Macroelements (g/100g)			
Raw materials	**Fe**	**Zn**	**Ca**	**Na**	**K**	**P**
Wheat flour (72% extraction)	3.0	2.11	0.022	0.048	0.169	0.114
Rice flour(RF)	2.21	2.18	0.012	0.041	0.051	0.070
Defatted soybean flour (DSF)	11.49	10.35	0.204	0.084	1.878	0.639
Chickpea flour (CF)	8.69	6.42	0.153	0.068	0.618	0.325
Carrot powder	9.91	4.36	0.086	1.317	1.734	0.197
Skim milk powder	0.7	4.5	0.936	0.0231	0.623	0.931

Vitamins contents of raw materials used in complementary infant food:

Results in Table (5) shown vitamin content in all used raw materials. The highest content of vitamins could be summarized as follows: Vit C(Ascorbic acid) being (41.5±0.017 mg/100g) of skim milk powder, Vit A(Retinol) being (3.5±11.12 mg/ 100g) of Carrot powder , Vit (E)(Tocopherols) being (5.55 mg/100) of Partially defatted soybean flour , Vit B_1(Thiamin) being (1.7± 0.0001 mg/100g) of Chickpea flour and Vit B_2(Riboflavin) being (1.0± 0.00006mg/100g) of carrot powder. Our obtained results of rice flour were higher than that recorded by USDA, (2018) who cited that the white rice flour contained Vit B_1 (Thiamin) with the amount of (0.138 mg/100g), Vit B_2 (Riboflavin) 0.021 (mg/100g) and (Vit E) 0.11(mg/100g).

Table 5. Vitamins contents of used raw materials in complementary infant food.

Raw materials Vitamins (mg/100g)	Wheat flour (72% extraction)	Partially Defatted soybean flour	Chickpea flour	Rice flour	Carrot powder	Skim milk powder
Vit(C)	17.5±0.007	18.5±0.007	7.85±0.003	4.2±0.0017	5.65±0.002	41.5±0.017
Vit(A) Retinol	0.42±13.32	0.21±6.80	0.04±1.16	0.08±2.48	3.5±11.12	0.21±0.67
Vit(E)	0.66±0.03	5.55±0.04	1.02±0.06	0.32±0.03	1.99±0.08	0.11±0.6
Vit(B1)	1.6± 0.0001	0.84± 0.00006	1.7± 0.0001	0.15± 0.00003	0.23± 0.0001	0.44± 0.0003
Vit (B2)	0.09± 0.00004	0.60± 0.00003	0.61± 0.00003	0.19±0.00005	1.0± 0.00006	0.75±0.0004

Chemical composition of complementary infant food:

There were (5) formulas prepared for complementary infant foods . Results of chemical composition of prepared complementary infant foods and control (Nestle Cerelac) (on dry weight basis) is shown in Table (6). The moisture content of formulas were in the range of (10.0 to 7.3%) of F1 and F5 respectively. The moisture content decreased gradually with the increment addition of partially defatted soybeans flour from (10.0 to 7.3%) that results were in agreement with that mentioned by Naik and Sekhon, (2014) . Moisture contents were within the recommended value (5-10%) as mentioned by Achidi *et al*., (2016). Crude protein contentS in complementary infant foods were in the range of 15 to 26.13%. Results also, showed that it was higher than those of control with (13%) as shown in Table (6). The protein content increased with the increase in the proportion of partially defatted soybean flour as mentioned by Naik and Sekhon, (2014).

Table 6. Chemical composition of formulated baby food (on dry weight basis).

Chemical contents Formulas	Moisture %	Protein %	Fat %	Crude fiber%	Ash %	Total carbohydrates	Energy (kcal/100g)
Control	3.36	13	9	1.3	3.04	73.66	426
F1	10.0	15.00	3.31	3.57	2.53	75.59	400
F2	9.5	17.76	3.27	3.63	2.77	72.57	398
F3	8.4	21.18	3.18	3.70	3.03	68.91	395.8
F4	8.0	23.83	3.03	3.78	3.26	66.10	393.6
F5	7.3	26.13	2.95	3.85	3.50	63.57	391.7
Codex standard[a]	< 5	15	10-25	< 5	< 3	60-75	400-425

A= (Nestle Cerelac)b= Codex standard

F1=20g wheat flour(72%extracion),20g rice flour, 40g chickpea flour ,10g carrot powder and 10g skim milk powder.

F2==20g wheat flour(72% extraction),20g rice flour, 10g partially defatted soybeans flour , 30g chickpea flour, 10g carrot powder and 10g skim milk powder.

F3=20g wheat flour(72% extraction),20g rice flour, 20g partially defatted soybeans flour , 20g chickpea ,10g carrot powder and 10g skim milk powder.

F4=20g wheat flour(72 extraction %),20g rice, flour,30g 20g partially defatted soybeans flour ,, 10g chickpeas flour ,10g carrot powder and 10g skim milk powder.

F5=20g wheat flour(72% extraction),20g rice flour, 40g 20g partially defatted soybeans flour ,10g carrot powder and 10g skim milk powder.

Fat content in all formulas were ranged between (2.95 to 3.31%) of F5 and F1. All prepared formulas contained lower amount of fats than those of control (Nestle Cerelac). Due to low fat content in all prepared formulas it might be can store those formulas for long time. Whereas, products with high fat content is more liable to spoilage than one with a lower fat content (Parvin *et al* .,2014). Decreasing amount of chickpeas flour caused a decreased in the fat content in formulas that agreement with that mentioned by Bashir *et al*.,(2012). The formula (F5) had the highest fiber content (3.85%) in compare with control (1.3%) and other formulas. It is noticeable that there was slight increase in fiber content and this caused by the amount of partially defatted soybeans flour, that approve with that noted by (Turab, 2017). The ash content in formulas indicated the level of minerals present (Kavitha and Parimalavalli, 2014). Results in same table also, showed that ash content in all formulas ranged from (2,53 to 3.50 %) for F1 and F5 respectively, which close to control and those found by Sodipo and Fashakin,

(2011). This increasing in ash might be due to the addition of partially defatted soybeans flour as cited by Naik and Sekhon, (2014). Data in the same table illustrated that the total carbohydrates content in all prepared formulas decreased from (73.66 to 63.57%) with the increasing levels of partially defatted soybean flour in all formulas ,a lowered of carbohydrate content in formulas due to add more of partially defatted soybean flour which approved that stated by Naik and Sekhon, (2014). Also results indicated that energy content of the all prepared formulas ranged from 391.7 to 400 kcal/100 g this result was agreement with those of (Tenagashaw *et al* .,2017) who found that energy content of the complementary foods ranged from 391.63 to 400.60 kcal/100 g.

Amino acids content of complementary infant food:

The results of the amino acids for different formulas is shown in Table (7) . Total number of essential amino acids ranged from (25.36 to 34.53 g/100g protein) of formula F3 and F5 respectively which contained. The total amino acids content of F5 is higher than other formulas, control and (RDA) as shown in table (7) is likely to be due to the high percentage of partially defatted soybeans flour as mentioned by Ibrahim *et al*., (2014). In addition of that used raw materials have different levels of amino acids as showed in Table (3) which Contributed in an increase and balance of amino acid in formulas as mention as reported by (Udensi *et al*., 2012).

Table 7. Amino acids content of complementary infant foods (g/100g protein) compare with (RDA) accordingto FAO/WHO.(2013).

Amino acids	Control	Formulas					RDA	
		F1	F2	F3	F4	F5	0.5 year	1-2 years
His	2.37	2.22	2.22	2.08	2.13	3.85	2.2	1.5
Ile	3.64	3.48	3.45	3.32	3.46	4.69	3.6	2.7
leu	6.43	5.96	6.33	6.08	6.60	5.07	7.3	5.4
lys	5.05	4.78	5.38	4.67	5.27	10.30	6.3	4.4
Thr	3.37	3.06	3.16	3.04	2.93	3.54	3.5	2.4
Trp	2.64	2.08	2.60	2.12	2.02	2.45	0.95	0.6
Val	3.87	4.24	4.01	4.05	3.87	4.54	4.8	3.6
	27.37	26.15	27.15	25.36	26.28	34.53	28.65	20.6

His histidine,; Ile, isoleucine; Leu, leucine; Thr, threonine, Trp, tryptophan; Val, valine

Minerals content of complementary infant foods:

The data expressed in Table (8) showed the mineral content in all formulas. The formula F5 which contained (20g wheat flour (72% extraction),20g rice flour, 40g 20g partially defatted soybeans flour ,10g carrot powder and 10g skim milk powder) had the higher content of zinc, potassium, sodium and phosphorus all being (5.58 mg/100g, 1.033 g/100g,0. 212 g/100g and 0.348 g/100g) respectively than other formulas and control one . On other hand , iron and calcium content (6.67mg/100g and 0.323 g/100g) respectively were higher also, than other formulas but lower than that detected of control. Whereas iron content was in range of 5.53mg/100g to 6.67mg/100g that results higher than result was found by Ezeokeke and Onuoha, (2016) who revealed that the iron composition varied from 3.34 mg/100 g to 3.92 mg/100g .There was an increase in minerals content (Fe, Ca, Zn, k, Na and P) in all formulas as a result of increasing the amount of partially defatted soybeans flour that replace chickpeas flour and this corresponds to (Ezeokeke and Onuoha, 2016). Naik and Sekhon, (2014) who stated that total minerals increased from 883.83 mg/100g in control formula to 1315.75 mg/100 g at the 30% level of Defatted Soybeans Flour fortification. The recommended daily allowance (RDA) of iron for children aged 1-3years old is 7mg (Faber *et al* ., 2008) ,According to (Codex Alimentarius,1991), Complementary Foods which satisfied two third of minerals and/or vitamins RDA is acceptable. The iron content in this study was in the range of 5.53 to 6.67 mg / 100gm which fulfilled the minimum RDA.

Vitamins contents of complementary infant foods:

The data in Table (9) indicate that the vitamin content in the range of (13.04 to 17.02 mg/100g),(0.17 to 0.26 mg/100g),(0.95 to 2.93mg/100g) , (0.395 to 0.83 mg/100g), (0.735 to 1.10 mg/100g) and (0.166 to 0.17 mg/100g) of vitamin C, vitamin A(Retinol), (β-Carotene) , vitamin E, Vitamin B1 and vitamin B2. These results were nearly to that recorded by Adepoju and Etukumoh, (2014) .It was added of 10% carrot powder to formulas caused an increase of β-Carotene in compare with those of control as cited by Phebean *et al*., (2017).

Table 8. Minerals contents of formulated baby food (on dry weight basis).

Minerals Formulas	Micro elements (mg/100g)		Macro elements (g/100g)			
	Fe	Zn	Ca	K	Na	P
Control[a]	10	3	0.450	0.522	0.140	0.300
F1	5.53	4.25	0.144	0.524	0.199	0.235
F2	5.82	4.56	0.199	0.654	0.203	0.255
F3	6.10	4.87	0.261	0.801	0.204	0.287
F4	6.38	5.18	0.311	0.938	0.208	0.317
F5	6.67	5.58	0.323	1.033	0.212	0.348.

a= Nestle Cerelac,

Table 9. vitamins contents of formulas of complementary infant food (on dry weight basis).

Vitamins (mg/100g) Formulas	Vit (C)	Vit(A) Retinol	β-Carotene	Vit (E)	Vit (B1)	Vit (B2)
Control	65	0.3	0.64	2.4	0.43	0.30
F1	13.04	0.17	0.95	0.395	1.10	0.17
F2	14.57	0.19	1.403	0.49	1.014	0.169
F3	15.3	0.21	1.86	0.45	0.928	0.168
F4	16.00	0.24	2.31	0.61	0.842	0.167
F5	17.02	0.26	2.93	0.83	0.735	0.166

Results in Table (9) observed that there were a decrease in vitamin B1 and B2 might be a relief for a decrease in chickpeas flour content, which has a slightly higher level of them than those of partially defatted soy beans. While observed an increase in other vitamins as a

result of increasing the amount of partially defatted soybeans flour added.

Anti -nutrients factors in different complementary infant foods:

Results in Table (10) showed the percentage of anti-nutrients factors contents in the complementary infant foods and control (Cerelac). From the data which recorded in Table, it could be observed that tannin content ranged from (0.0177 to 0.484%). Formula (F3) had the highest value (0.484%) which less than that recorded by Ezeokeke and Onuoha, (2016) who mentioned that the tannin content varied from (0.00 to 2.41%).also results indicated The phytates content ranged from (0.38 to 0.705%). It was observed that tannin and phytates were absent in control sample. The level of the tannins and phytates existent in the formulas are within the innocuous limit according to FAO/WH, Codex Alimentarius Commission (2006)

Table 10. Tannins and phytic acid content of complementary infant food .

Anti-nutrients factors / Formulas	Control	F1	F2	F3	F4	F5
Tannins	0	0.179%	0.177%	0.484%	0.235	0.393%
Phytates	0	0.43%	0.38%	0.64%	0.705%	0.69%

Physical properties of complementary infant foods:

Apparent viscosity:

The viscosity of the samples under study and Cerelac are shown in Table (11) .According to (Victor, 2016) viscosity is defined as the tendency of fluid to resist flow. The viscosity of complementary infant foods showed that the highest viscosity was (9880cP) for formula F1 and lowest (2740 CP) for formula F5 this results were higher than control. Results were close to those of found by Victor, (2014) who reported that viscosities of meals of infant in range of (2050 cp to 9800 cp). The addition of soybeans encouraged viscosity reduction, this conclusion is approve with that testified by Usman *et al*., (2014).

The bulk density:

The bulk density is important in weaning foods because high bulk density limits, the caloric and commercial diet intake per feed per child and infants are sometimes unable to consume enough to satisfy their energy and commercial diet requirements (Omueti *et al*., 2009). Result in the same Table showed that bulk density of all prepared formulas and control ranged from 1.021 g/cm^3 to 1.06 g/cm^3. Where the highest one was recorded for formula F1 while the lowest was detected for Formula F5 respectively. These results were less than those of found by Shalaby and El-Shourbagy, (2016) who stated that bulk density values ranged from 5.56 to 6.78(g/ml).

Table 11. Functional properties of complementary infant foods:

Formulas Functional properties	Control	F1	F2	F3	F4	F5
Viscosity at 35C	1560 CP	9880 CP	7800 CP	7400 CP	2920 CP	2740 CP
Bulk density g/cm3	1.017	1.06	1.055	1.046	1.03	1.021

Sensory Evaluation of different complementary infant foods:

Table (12) presented that the results of sensory assessment of gruel prepared from all 5 complementary infant foods and control .Taste, Texture, Colour, Flavor, Appearance and General acceptability of prepared formulas showed that a significant differences between all prepared formulas. Overall acceptability for the five formulas and control ranged between 64.13±17.11^b and 81.88±10.59^a. We could state that the best general acceptance was in the control (Nestle Cerelac) (81.88±10.59^a) followed by formula F2 (70.38±12.59^b).

Table 12. The sensory assessment of formulas of complementary infant food:

Sensory properties / Treatments	Taste (20)	Texture (20)	Colour (20)	Flavour (20)	Appearance (20)	Overall Acceptability (100)
Control	16.38±3.03^a	15.50±3.61^a	16.00±2.53^a	17.50±2.97^a	16.50±2.48^a	81.88±10.59^a
F1	12.00±2.92^b	12.25±4.25^c	14.25±3.17^b	12.25±4.37^b	13.38±4.05^b	64.13±17.11^b
F2	12.75±2.82^b	14.75±3.08^{ba}	14.38±2.65^{ba}	14.13±3.53^b	14.38±2.94^{ba}	70.38±12.59^b
F3	11.25±2.52^b	14.00±2.63^{bac}	13.75±3.17^b	13.13±3.50^b	14.63±3.98^b	66.75±12.56^b
F4	12.00±2.31^b	12.75±2.62^{bc}	13.38±2.90^b	13.38±4.24^b	13.13±3.79^b	64.63±12.79^b
F5	11.75±3.09^b	13.37±2.60^{bc}	12.88±3.50^b	13.25±3.09^b	13.25±2.62^b	64.50±12.57^b
Sign	**	*	**	**	**	**
LSD	1.65	2.05	1.68	1.99	1.90	7.12

Values are means±SD A,b,c= Values with different letters in the same column are significantly different (P< 0.05) *= significant difference . **=high significant difference.

CONCLUSION

All formulas contained essential nutrients and their energy can meet the daily energy requirement of infants aged 6- 12months. They contain essential minerals needed for growth and development in adequate amounts, and had low levels of anti-nutrients. Complementary infant foods with defatted soybeans a seemed to be more nutritious and nourishing, containing all the required nutrients, very low in anti-nutrients, cost effective and easy to prepare.

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التقييم الكيميائي والحسي لبعض الاغذية التكميلية للرضع

محمد طه شلبي ، مسعد عبدالعزيز أبوريه ، فاتن يوسف ابراهيم و سالمة ابراهيم محمد

قسم الصناعات الغذائية من الزراعة ، جامعة المنصورة ، مصر

أجريت هذه الدراسة لتطوير الأغذية التكميلية القائمة على الحبوب والبقوليات من المواد الخام للأطفال الصغار و لتقدير التركيب الكيميائي والخواص الفيزيائية والتقييم الحسي لخمس تركيبات للفطام و لمقارنة هذه الخلطات بعينة تجارية منتج(نستله سيريلاك). أوضحت النتائج أن محتويات البروتين في الخلطات تراوح من (15.00 إلى 26.13 ٪)، ومحتويات الدهن من (2.95 إلى 3.31 ٪) ، و محتوى الألياف كان من (3.57 إلى 3.85 ٪)، تم قياس محتوى الرماد وكان من (2.53 الى 3.50 ٪) و تراوح محتوى الكربوهيدرات من (63.57 إلى 75.59٪). تراوحت نسبة الأحماض الأمينية الأساسية من(28.14 إلى 45.36 جم / 100 جم بروتين . جميع الخلطات تحتوي على مجموعة العناصر المعدنية التالية: الحديد (5.53 - 6.67 ملج/100جرام) ، الكالسيوم (0.135-0.323 جرام /100جرام) ، الزنك (4.25- 5.58) ملج/100جرام) . والبوتاسيوم (0.524-1.033 ملج/100جرام). الصوديوم (0.199-0.212 جم/100جرام) ، الفوسفور (0.235 -348 .0 ج/100جرام) ، كما تحتوي كل الخلطات على مجموعة من الفيتامينات التالية (13.04 إلى 17.02 ملج / 100 جم) ، (0.17 إلى 0.26 ملج / 100 جرام) ، (0.95 إلى 2.93 ملج/ 100 جرام) و (0.395 إلى 0.83 ملج/ 100 جرام,(0.735 إلى 1.10 ملحم/100ج و (0.166 إلى 0.17 ملج/100ج) من فيتامين ج(حمض الاسكوربيك) ، فيتامين أ(ريتانول) ,بيتاكاروتين ، فيتامين ه (توكوفيرولات) ، فيتامين ب1 (ثيامين)وفيتامين ب2(ريبوفلافين) على التوالي .كما تم تحليل العوامل المضادة للتغذية في جميع الخلطات ،حيث اعطت الفيتات نسبة من0.177 إلى 0.484٪ ، وكانت التانينات من (0.38 إلى 0.71٪). ومن نتائج الاختبارات الوظيفية للخلطات لوحظ أن قيم الكثافة الظاهرية تراوحت من 1.017 الى1.06 جم / سم ^{3} ، في حين كانت اللزوجة تتراوح من 2740 إلى 9880 cp. يمكن التوصية باستخدام الخلطة رقم (5) بسبب محتواها العالي من البروتين والمغذيات الدقيقة مقارنة مع الصيغ الأخرى و نستنتج من هذه الدراسة أن إضافة فول الصويا المجففة جزئياً يزيد من البروتين والمغذيات الدقيقة لحل مشكلة سوء التغذية في البلدان النامية.