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PRODUCTION AND EVALUATION OF SOME HEALTHY CHEAP PRE-SCHOOL CHILDREN FOOD MIXTURES

BY

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ABSTRACT

The aim of this work to formulate and prepare ten different children food mixtures. The materials used are cereals (wheat and rice), legumes (hulled broad beans, dried pea, hulled chickpea and lentil), oil seed (peanut), vegetable (carrot), fruit (dried date) and full dried milk from Dano company (Germany). The raw materials and prepared mixtures were chemically analyzed. The energy values for mixtures were calculated. Minerals and amino acids were determined for all prepared mixtures. Sensory evaluation for the mixtures was done compared to commercial products. The formulated children foods were examined for total bacterial count. Moreover, the cost for formulated children foods were estimated. The moisture content of the formulated children mixtures ranged from 4.17 to 5.61%. The protein content for all mixtures ranged from 21.90 to 22.70 %, while the total lipids content ranged from 6.9 to 10.13%. Ash content ranged from 2.21 to 3.02%. The energy values of the formulated mixtures ranged from 404.97 to 419.66 Kcal. /100g. One hundred grams of any mixture would provide the baby with about 100% for calcium and magnesium, 62-100% for iron, 21-58 % for zinc and 20-30% for copper from the recommended daily requirements. The mixtures No. 5, 10 and 7 had the highest amount of EAA, ratios of E: N, E: T, E: P and EAAI (%), which contained 52.525, 51.319 and 50.857 g/16g N for EAA, 1.148, 1.109 and 1.079 for E: N ratio, 0.534, 0.526 and 0.519 for E: T ratio, 0.525, 0.513 and 0.509 for E: P and 97.80, 95.55 and 94.69% for EAAI. The mixtures No. 5 and 7 had higher score for overall acceptability. The microbiological quality of mixtures was within the advisable standard limits. The costs of producing formulated mixtures are less than commercial products.

Key words: Children food mixtures, minerals daily requirements, amino acids, microbiological quality, Sensory evaluation.

INTRODUCTION

Malnutrition in developing countries is very serious for the small child, particularly after weanling, because the child enters the family eating pattern and acts not only small amounts of foods, but foods unsuitable for weanling purposes (Bressani, 1981). Blended foods, corn soy, wheat soy and rice soy blends have been specially developed as nutritional supplements for the diets of weanling infants, preschool children, pregnant and lactating mothers in many countries of the world (Aguilera and Lusas, 1981).

Childhood malnutrition, in the form of protein energy malnutrition, is the most common deficiency disease in the world, especially in developing countries (WHO, 1998). This is related to poor food quality, insufficient food intake and infections (Onis and Blossner, 1997).

In the case of baby food products, mothers often try the product first and decide whether to give it to their children or not (Gambaro *et al.*, 2005).

Several approaches have been suggested to improve the nutritional quality of the weanling foods, including fortifying the locally produced cereal-based foods with specific nutrients and/or blending them with other nutrient-rich foods to form nutritious composite mixtures (Ngoddy *et al.*, 1994).

Different baby food formulas consisting from dehydrated rice, soybean flour and different fruit purees were prepared by Segura *et al.* (1988) and acceptable to be given to children. Soliman *et al.* (2003) studied the characteristics of baby food formulas based on Anna apple pulp in addition to other ingredients such as some fruits, dry milk and sugar. Some of those formulas had high scores when evaluated by children as panelists. The quality of fruit-based infant foods is of considerable important, since babies may be obtaining all their nutrients from a small number of foods, so over-processed infant foods may affect the nutritional status of consumer (Maite *et al.*, 2002).

Wadud *et al.*, (2004) prepared different formulated baby foods based on soymilk and cereals, such as rice, wheat and corn. Baby foods prepared from soymilk with corn, soymilk with rice and soymilk with wheat, contain protein 28.5, 25.0, and 26.0%, fat 9.50, 9.00 and 10.0% and carbohydrates 54.9, 58.5 and 56.0%, respectively. Protein efficiency ratios of the three formulations were comparable with casein. The prepared products were of cream-white color, possessed good taste and fluffy texture and contained all nutrients known to be essential for babies and preschool children.

In most developing countries comercial weanling foods of excellent quality either imported or locally produced are presently available, but due to sophisticate processing, expensive packing, extensive promotion and solid profit margins, the price of these comercial products are generally in the order of 10-15 times the cost of the common staple foods. While these products are generally highly appreciated and their use and value are well understood, they are priced beyond the purchasing power of the majority of population in the lower income groups, Who spent already about 50-75% of their income in common foods (Wurdemann and Van de Meerendok, 1994).

In Egypt most of baby foods are mainly prepared from cereals, which are inadequate to supply the needed requirements of some essential nutrients recommended for children in this stage of growth (Soliman *et al.*, 1996). With increasing the numbers of working mothers in the developing countries, the market of baby foods has been increased tremendously (Ahmed and Ramaswamy, 2004).

The Arabic countries included Libya produced a lot of raw materials such as peanut, rice, dried date, dried carrot, broad bean, chickpea, lentil and dried pea

Therefore, owing to all these advantages, the present work aims to formulate different children food formulas consisting mainly from dried whole milk, peanut, rice, dried date, dried carrot, broad bean, chickpea, lentil, dried pea and wheat. To evaluate the formulas from standpoint of organolyptically by some children with helping by their mothers. The main chemical components of different formula with estimating the energy values. The amino acids and minerals contents were also determined. Finally, the production cost of formulas was estimated.

MATERIALS AND METHODS

Materials:

The raw materials used in this study for children food formulas namely:

Wheat (*Triticum species*), rice (*Oryza sativa*), lentil (*Lens culinaris*), chickpea (*Cicer arietinum*), peas (*Pisum sativum*), broad beans (*Vicia faba*), peanut (*Arachis hypogaea*), carrot (*Daucus carota*) and date (*Phoenix dectylifera* L.) were purchased from local market in Brack Governorate, Libya.

Whole milk powder imported from Germany, Commercials products children food (Rii imported from Egypt and Nutriben imported from Spain).

Methods:

Preparation of raw materials:

- Carrot was thoroughly washed with tap water then handily peeled. After that it was sliced approximately for 0.5 cm and blanched by vapor. The blanched carrot was dried in solar dryer at 45-60°C.
- Dry cereals and dry legumes were cleaned from impurities and then washed thoroughly with tap water, the washed cereals and legumes were separately soaked in tap water overnight, except rice was soaked for 30 minutes, according to Soliman, *et al.* (1996).
- The peeled broad bean, chickpea, lentil, dry pea, rice and wheat were cooked separately in a pressure cooker for 15, 5, 7, 5, 5, and 10 minutes, respectively. After cooking, the remaining water was eliminated. After that the cooked materials were dried in solar dryer at 45-60°C. Dried cereals and legumes were milled in an electrical mill, then sieved through a silk sieve (60 mesh) according to Soliman, *et al.* (1996).
- Peanut was roasted for 5 min. at 200-250°C and ground in an electrical grinder.
- Date was thoroughly washed with tap water and dried in air after removing the kernel.

All prepared materials were bottled in glass jars and stored at room temperature until using.

Preparation of formulated baby food formulas:

Formulas of baby food have been chosen according to previous trials. Many samples of baby food formulas in preliminary experiment were prepared containing different ratios of raw materials. After screening of many baby food formulas for sensory evaluation the best formulates of raw materials were selected and shown in Table (1).

Components of the formulated mixtures were blended together in an electrical mixer till homogenization. Then each formula was dried in an air drying oven at 65-70°C. The dried formulas were milled in a powder form and then sieved through a silk sieve (60 meshes).

Table (1): Formulated baby food formulas.

Formulas	Ingredients parts									
	Dry milk	Peanut	Rice	Dry Dates	Dry Carrots	Broad beans	Chickpea	Lentil	Peas	Wheat
1	15%	5%	20%	-	10%	50%	-	-	-	-
2	15%	5%	20%	10%	-	50%	-	-	-	-
3	15%	5%	20%	10%	-	-	-	-	50%	-
4	15%	5%	20%	-	10%	-	-	-	50%	-
5	15%	5%	20%	10%	-	-	-	50%	-	-
6	15%	5%	20%	-	10%	-	-	50%	-	-
7	15%	5%	-	10%	10%	-	20%	20%	-	20%
8	15%	5%	10%	-	10%	-	40%	-	-	20%
9	15%	5%	20%	10%	-	20%	30%	-	-	-
10	15%	5%	-	5%	5%	20%	20%	10%	20%	-

Chemical analysis:

Moisture, ash, total lipids, and protein contents were determined according to AOAC (2000). Titratable acidity was determined by titration with NaOH 0.1 N solution using phenolphthalein as indicator according to AOAC (2000). Total and reducing sugars were determined by Lane and Eynon method as described in the AOAC (2000). Total carbohydrates of raw materials and formulated children food mixtures were calculated by difference. Three replications of all these determinations were carried out.

Determination of amino acids:

Amino acids composition was determined by HPLC-Pico-Tay according to the method described by Cohen *et al.* (1989). Tryptophan was colorimetrically determined

in the alkaline hydrolysate of samples according to the method of Blouth *et al.* (1962).

Energy value (EV):

Total caloric estimates (kcal) for formulas were calculated on the basis of a 100 g sample using Atwater values for fat (9.0 $kcal.g^{-1}$), protein (4.0 $kcal.g^{-1}$) and carbohydrate (4.0 $kcal.g^{-1}$) according to Soliman, *et al.* (1996).

Minerals contents:

Minerals contents were determined according to AOAC (2000) using Perkin-Elmer, 2380 Atomic absorption spectroscopy apparatus. Meanwhile phosphorus was determined by the official spectrophotometric method of the AOAC (2000) using UV/visible spectrophotometer.

Sensory evaluation:

Sensory evaluation of the different formulas was carried out by a trained ten panelists. The ten panelists were asked to evaluate color, taste and odor according to Pastor *et al.* (1996). Overall acceptability was calculated from the obtained scores of the evaluated attributes.

Microbiological examination:

The following examinations were done for all formulas: Total viable bacterial count, yeasts and moulds were enumerated according to the methods established by (APHA, 1992).

Estimation of cost:

The cost of formulas was roughly calculated according to the price of the materials used in preparing the formulas, gas, electricity, jars, water and 25% gain. The costs of the prepared formulas were compared with the marketing commercial baby foods at the same time.

Statistical analysis:

Chemical composition data of ingredients and formulas were expressed as mean of three replicates. Data of sensory evaluation for all baby food formulas were subjected to the analysis of variance followed by multiple comparisons using LSD at 0.05 level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Chemical composition of raw materials:

The proximate chemical analysis were carried out on the original raw materials used in this research i.e. cereals (wheat and rice), legumes (hulled broad beans, dried pea, hulled chickpea and lentil), oil seed (peanut), vegetable (carrot), fruit (dried date) and dried full milk. The results are illustrated in Table (2).

It could be noticed that lentil and dried carrot had the higher moisture content being 10.36 and 10.60%, respectively. Meanwhile, dried milk had the lower moisture content. From the results in the same table, it could be noticed that hulled broad bean had higher protein content (31.87%), these results are in agreement with those of Atwa (2003). The protein content of peanut, lentil and dried full milk was 28.76, 22.25 and 21.05%, respectively,

In contrast, dried date and dried carrot had lower protein content which contained 2.92 and 5.66%, respectively. But, rice, wheat chickpea and dried peas had almost the protein content ranged from 8.03 to 18.25%. Higher total lipids content was observed in peanut (45.29%) and dried full milk (28.36%), while lower total lipids content in rice (0.75%), dried date (1.18%) and dried carrot (1.78%). While dried pea, hulled broad beans, wheat, lentil and chick pea had total lipids ranged from 2.14 to 7.33%. Dried carrot and dried full milk had higher total ash content being 5.63and 5.95%, respectively as compared with lower total ash content in rice (0.59%) and wheat (1.75%). Dried date, lentil, peanut, dried pea, chickpea and hulled broad beans contained 2.34, 2.39, 2.56, 2.62, 2.84 and 3.70% total ash, respectively. Dried date had higher total carbohydrate content (86.78%), followed by rice (80.87), while the peanut had lower total carbohydrate content (18.86%). In the other raw materials, total carbohydrate content ranged from 41.85% in dried milk to 76.33 in dried carrot. This data are in according to Soliman *et al.* (1996) and Abd El-Salam (1999 and 2005)

Chemical composition of formulated children food mixtures:

The ten mixtures were chemically analyzed to determine the main chemical composition. The obtained data are shown in Table (3). It could be noticed that the moisture content ranged from 4.17 to 5.61% which was significantly higher in mixtures No. 7 and 9, while it was lower in mixture No. 1. These results are below those obtained by El-Anany (2006). However, this low moisture content is of great important for good keeping quality of reasonable shelf life period for the final product. The protein content ranged from 21.90 to 22.70%, which was significantly higher in mixture No.2. The protein content of all mixture nearly similar to those reported by the Protein Advisory Group (PAG, 1970), who pointed out that the protein content of Supramine produced in Algeria and Tunisia was 20.20%, while the baby food NSP produced in Chili contained 22% protein. On the other hand, the product TRL of Turkey and Chili contained 25.30%. The same trademark produced in Iran and Ethiopia contained 20.70% protein. These data are in according to the results of Soliman, *et al.* (1996). Also the results within the limiting of Egyptian Standards (1972 and 1992).

Table (2): Chemical composition of raw materials (g/100g on wet weight basis).

Raw materials	Chemical Components					
	Moisture	Protein	Fat	Ash	Total Carbohydrates	Total acidity
Broad beans	9.41	31.87	2.69	3.70	52.33	0.74
Peas	8.81	18.25	2.14	2.62	68.18	0.46
Chickpea	8.65	17.3	7.33	2.84	63.98	0.44
Lentil	10.36	22.25	3.55	2.39	61.44	0.72
Peanut	4.53	28.76	45.29	2.56	18.86	0.63
Wheat	8.82	12.50	3.05	1.75	73.88	0.74
Rice	9.76	8.03	0.75	0.59	80.87	0.05
Full milk	2.79	21.05	28.36	5.95	41.85	1.20
Carrots	10.60	5.66	1.78	5.63	76.33	1.15
Dates	6.78	2.92	1.18	2.34	86.78	0.46

Table (3): Chemical properties and energy values of children food formulas (on wet weight basis)

For-mulas	Chemical Components							
	Moisture %	Protein %	Total Lipids %	Ash %	Total sugars %	Total Carbohy-drates %	Total acidity %	Energy values Kcal /100g
1	4.17 ^{e}	22.57 ^{a}	8.21 ^{e}	2.70 ^{c}	8.52 ^{g}	62.35 ^{b}	0.20 ^{ab}	413.60 ^{bc}
2	4.64 ^{cde}	22.70 ^{a}	8.86 ^{d}	3.02 ^{a}	6.64 ^{h}	61.78 ^{bc}	0.22 ^{a}	408.63 ^{de}
3	5.11 ^{bc}	22.63 ^{a}	9.19 ^{cd}	2.51 ^{d}	13.35 ^{b}	60.44 ^{d}	0.15 ^{cde}	414.84 ^{b}
4	5.13 ^{b}	22.27 ^{b}	7.82 ^{e}	2.74 ^{bc}	11.26 ^{de}	62.16 ^{bc}	0.13 ^{de}	407.32 ^{ef}
5	5.15 ^{ab}	22.27 ^{b}	6.90 ^{f}	2.21 ^{e}	13.10 ^{b}	64.49 ^{a}	0.12 ^{de}	404.97 ^{f}
6	4.62 ^{de}	21.90 ^{de}	8.91 ^{d}	2.30 ^{e}	9.77 ^{f}	62.27 ^{b}	0.14 ^{cde}	416.78 ^{ab}
7	5.61 ^{a}	22.05 ^{c}	9.46 ^{bc}	2.72 ^{c}	16.60 ^{a}	60.15 ^{d}	0.17 ^{bc}	413.93 ^{bc}
8	5.58 ^{ab}	22.26 ^{b}	9.69 ^{ab}	2.51 ^{d}	12.40 ^{c}	59.96 ^{d}	0.11 ^{e}	416.03 ^{b}
9	5.61 ^{a}	22.15 ^{bc}	8.94 ^{d}	2.87 ^{b}	11.42 ^{d}	62.43 ^{c}	0.17 ^{bc}	411.74 ^{cd}
10	5.07 ^{bcd}	22.03 ^{cd}	10.13 ^{a}	2.74 ^{bc}	10.90 ^{e}	60.03 ^{d}	0.13 ^{de}	٤١٩,٦٦ ^{a}
LSD	**0.48**	**0.15**	**0.49**	**0.14**	**0.46**	**0.74**	**0.04**	**3.38**

*Values represent of 3 replicates (Mean)

* $^{a, b, \ldots}$: There is no significant difference ($p \geq 0.05$) between any two means have the same superscripts.

With regard to total lipids content of the formulated mixture, it could be observed that the total lipids ranged from 6.90 to 10.13%, which was significantly higher in mixture No 10, while it was significantly lower in mixture No. 5. Total lipids content was nearly the same for mixtures No. 8 and 10 (9.69 and 10.13%, respectively), No. 7 and 8 (9.46 and 9.69%, respectively), No. 3 and 7 (9.19 and 9.46%, respectively), No. 2, 6, 9 and 3 (8.86, 8.91, 8.94 and 9.18%, respectively) and also for mixtures No. 4 and 1 (7.82 and 8.21%, respectively).

The total ash content ranged from 2.21 to 3.02%, which was significantly higher in mixture No. 2, while it was significantly lower in mixture No. 5. In the other mixtures, total ash content ranged from 2.30 to 2.87%. These results are in agreement with those reported by El-Nahal and Mohamed (2006) and El-Anany (2006). With regard to total sugar of the formulated mixtures it could be noticed that the mixture No. 7, 3 and 5 contained significantly higher content from total sugars (16.60, 13.35 and 13.10%, respectively), while the significantly lower total sugars content was found in mixtures No. 2, 1 and 6 (6.64, 8.52 and 9.77%, respectively).

It could be also seen from Table (3) that highest values of total carbohydrates were in mixture No 5 (64.49%), while the lowest value was in mixture No. 8 (59.96%). These results are lower than those reported by Soliman *et al.*, (1996), El-Anany (2006) and El-Nahal and Mohamed (2006).

The energy values ranged from 404.97 to 419.66 Kcal/100g. The highest values of caloric were in mixtures 10, 6, 8, 3, 7 and 1 (419.66, 416.78, 416.03, 414.84, 413,93 and 413.60 Kcal/100g, respectively). Mixtures 2, 4 and 5 had the lowest value (408.63, 407.32 and 404.97 Kcal/100g, respectively). These results are comparable with reported by El-Nahal and Mohamed (2006), while it is lower than those reported by El-Anany (2006) and finally, these results are higher than those reported by Soliman *et al.*, (1996).

Minerals contents of the formulated children food mixture:

Data in Table (4) illustrates eleven minerals contents of formulated children food mixtures. Potassium content ranged from 1239.22 to 1814.79 mg/100g. The calcium content ranged from 433.43 to 649.68 mg/100g. The phosphorus content ranged from 267.63 to 472.34 mg/100g. The sodium content ranged from 139,98 to 229.54 mg/100g. The magnesium content ranged from 39.32 to 61.02 mg/100g. The iron content ranged from 4.48 to 6.97 mg/100g. Zinc content ranged from 1.27 to2.15 mg/100g. The manganese content ranged from 0.83 to 2.15 mg/ 100g. The copper content ranged from 0.20 to 0.55 mg/ 100g. Heavy metal (cadmium and lead) did not appear on the Atomic Absorption Spectroscopy. According to the aforementioned data it could be said that, if an infant or a baby was given 100g of any formulated mixture, would provide the baby with about 100% for calcium and magnesium, 62-100% for iron, 21-58% for zinc and 20-30% for copper of the recommended daily for these minerals, which reported by FAO (1974)and NAS(1974).

Amino acids composition of the formulated children food mixtures:

Data in Table (5) shows the amino acids composition of different mixtures. From the obtained results, it could be observed that the different mixtures contained high proportions of essential amino acids. Comparing the essential amino acids pattern of the formulated mixtures with of hen's egg protein as a standard, it was found that the essential amino acids content of the mixtures exceeded their corresponding quantities in egg's protein except the methionine for all mixtures, tyrosine for mixtures No. 6, 7 and 9 and tryptophane for all mixtures except mixture No.5. It may be noted that the total essential amino acids of the formulated mixtures also surpassed the total indispensable amino acids in egg protein. This could be explained that although egg protein was provide to have better quality, but the percentage of protein content in the formulated mixtures was much higher than its percentage in egg due to the low moisture content resulted by hydration. The protein content of the formulated mixture ranged from 21.90 to 22.70%, while it was in egg 12.78% (FAO, 1970).

Table (4): Minerals contents of children food formulas (mg/100g on wet weight basis).

For-mulas	Minerals								
	K	Ca	P	Na	Mg	Fe	Zn	Mn	Cu
1	1661.41	433.43	394.39	158.36	39.32	5.99	1.55	0.83	0.49
2	1814.79	461.10	445.73	202.55	43.12	5.36	2.03	1.04	0.51
3	1390.68	541.82	305.12	229.54	49.21	5.65	1.97	1.10	0.38
4	1489.59	617.70	384.14	168.34	56.45	4.98	2.72	1.41	0.54
5	1272.71	452.44	278.07	139.98	45.32	6.41	2.84	1.21	0.34
6	1239.22	487.26	309.59	186.01	46.95	6.02	3.45	1.47	0.43
7	1760.56	492.46	267.63	118.84	51.05	5.55	3.35	2.15	0.55
8	1441.62	519.53	298.39	178.25	50.03	4.71	1.27	1.53	0.21
9	1667.32	649.68	401.33	204.51	61.02	4.48	2.07	2. 07	0.25
10	1541.13	485.41	472.34	161.81	46.89	6.97	2.09	1.06	0.20

Table (5): Amino acids content of children food formulas (mg/100g mixture).

Amino acids	Formulas										FAO, 1970 Hens egg
	1	2	3	4	5	6	7	8	9	10	
Essential amino acids:											
Threonine	1013	955	866	864	1191	1085	864	948	987	1009	583
Valine	1274	1204	1112	1107	1363	1324	1089	1125	1095	1427	818
Methionine	489	467	480	458	518	507	576	497	461	598	707
Isoleucine	1301	1180	1050	996	1492	1315	1649	1296	1193	1572	670
Leucine	1529	1404	1580	1571	1868	1702	1838	1513	1436	1804	1066
Tyrosin	782	725	775	752	791	665	700	746	684	791	702
Phenylalanine	1254	1218	1232	1227	1490	1313	1682	1458	1508	1487	966
Lysine	1538	1478	991	1042	1667	1615	1624	1304	1475	1512	868
Histidine	995	966	968	976	1075	1009	985	952	993	1015	273
Tryptophan	194	191	203	202	212	197	207	186	196	206	211
Total	10369	9788	9257	9195	11667	10732	11214	10025	10028	11421	6864
Non-essential amino acids:											
Aspartic	1263	1292	2350	2321	1409	1475	1564	1504	1681	1668	1190
Serine	1028	1065	1022	1027	1050	1119	975	963	987	1105	946
Glutamic	3473	3308	2499	3236	3175	3041	2960	3128	3367	2543	1576
Proline	1389	1336	1493	1585	777	884	832	1307	1438	1308	515
Glycine	984	934	1164	1182	1218	1293	1364	1189	1495	1218	410
Alanine	1495	1483	1097	1129	1357	1216	1281	1400	992	954	733
Arginine	1765	1659	1261	1279	1175	1282	1417	1495	1456	1502	454
Total	11397	11077	11386	11759	10161	10310	10393	10986	11416	10298	5824
Total amino acids	21766	20865	20243	20954	21828	21042	21607	21011	21444	21719	12688
% Protein	22.57	22.70	22.63	22.27	22.27	21.90	22.05	22.26	22.15	22.03	12.78

Data in Table (6) indicates the essential amino acids (E), non essential amino acids (N), essential amino acids to non essential amino acids (E: N ratio), essential amino acids to protein (E: P ratio) and essential amino acid index (EAAI). From the results in Table (6) it could be noticed that the mixtures No. 5, 10 and 7 had the highest amount of EAA, ratios of E /N, E /T, E /P and EAAI (%), which contained 52.525, 51.319 and 50.857 g/16g N for EAA, 1.148, 1.109 and 1.079 for E/N ratio, 0.534, 0.526 and 0.519 for E/T ratio, 0.525, 0.513 and 0.509 for E/P and 97.80, 95.55 and 94.69% for EAAI. These results are comparable with those of egg protein, which contained 53.709 g/16g N for EAA, 1.179, 0.541 and 0.537 for E/N, E/T and E/P ratios and 100% for essential amino

acid index (EAAI%), respectively (FAO, 1965). With regard to the limiting amino acids of the formulated mixtures, it could be noticed from Table (7) that the methionine is the most deficient and the first limiting amino acid in all formulated mixtures. On the other hand, the figures of methionine reflected the better quality of egg protein (Table 5). This essential amino acid proved to be the most limiting and deficient in all pulses. The second limiting amino acid was tryptophan in mixtures No. 1, 2, 5, 8 and 10, while it was lysine in mixtures No. 3 and 4 and it was tyrosine in mixture No. 7 and 9. The third limiting amino acid was tryptophan in mixtures No. 3, 4, 6 and 7, while it was leucine in mixtures No. 1, 2 and 9.

Table (6): Evaluation of protein of children food formulas

Formulas	Essential amino acids g/16 g N	Non-essential amino acids g/16 g N	E/N Ratio	E/T Ratio	E/P Ratio	EAAI(%)
1	45.942	50.496	0.910	0.476	0.459	85.54
2	43.119	48.797	0.884	0.469	0.431	80.28
3	40.906	50.314	0.813	0.457	0.409	76.16
4	41.049	52.496	0.782	0.439	0.410	76.43
5	52.526	45.746	1.148	0.534	0.525	97.80
6	49.005	47.078	1.041	0.510	0.490	91.24
7	50.857	47.134	1.079	0.519	0.509	94.69
8	45.036	49.353	0.913	0.477	0.450	83.85
9	44.662	50.844	0.878	0.468	0.447	83.16
10	51.319	46.277	1.109	0.526	0.513	95.55
Egg *	709.53	45.571	1.179	0.541	0.537	100.00

E/N = Ratio of essential amino acids to non essential amino acids.
E/P = Ratio of essential amino acids to protein (100g).
E/T = Ratio of essential amino acids to total amino acids .
EAAI = Essential amino acid index according to Oser. (1959).
*** FAO, 1965.**

Organoleptic evaluation of formulated children food mixtures:

Data presented in Table (8) shows the results for organoleptic evaluation of the studied ten formulated children food mixtures compared with two commercial infant formula (Riri and Nutriben) to evaluate the color, taste, odor and overall acceptability. All samples were offered to panelists after reconstitute as follow: 30 gms of each formula added to 100 ml boiled water (after cooling to room temperature 25°C) then mixed well.

From the obtained results it could be noticed that the mixture No. 5 and 7 had the higher scores for overall acceptability (245 and 243.3, respectively) compared with the commercial products Nutriben (279.5), while all formulated mixtures except No. 1,2 and 4 had the higher score for all acceptability compared with the commercial product Riri (231.5).

Microbiological quality of the formulated children food mixtures:

The formulated children food mixtures were tested for total bacterial count and yeast and moulds. The obtained results (Table 9) reveal that the total bacterial count ranged from 6.31×10^2 to 6.92×10^3 cfu/g. The low total bacterial counts of the examined formulated mixtures might be due to their low moisture content. The current results were within the advisable standards reported by Skovgaard (1989), who recommended that a total bacterial count up to 10^4 per gram for dried baby foods might be save enough to be used by babies. The current results were less than those allowable in many international standards in other foods. The obtained results are also agree with those obtained by Radi and Arous (2000) and Radi *et al.* (2003) who produced new production from siwi date for young children. These results are in agreement with those reported by Soliman *et al.* (1996). The yeast and molds did not appear in any mixture, this may be related to low moisture content of all mixtures.

Table (7): Scores of essential amino acids to limiting the three essential amino acids responsible for limiting the quality of protein of children food formulas

Amino acids	FAO/ WHO 1973**	Formulas									
		1	2	3	4	5	6	7	8	9	10
Threonine	40	112	105	96	96	134	124	98	106	110	113
Valine	50	113	106	98	99	123	121	99	101	98	128
Methionine	35	62	59	61	58	67	66	75	64	59	77
Isoleucine	40	144	130	116	111	168	150	187	146	133	178
Leucine	70	97	88	100	100	120	111	119	97	91	116
Tyrosin	35	99	91	98	96	102	87	91	96	87	102
Phenylalanine	48	116	112	113	114	140	125	159	187	140	139
Lysine	55	124	118	80	85	136	134	134	107	119	124
Histidine	21	210	203	204	207	230	219	213	204	211	217
Tryptophan	10	86	84	90	90	95	90	94	84	87	93
1st limiting amino acid		Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine	Methio-nine
2ed limiting amino acid		Trypto-phan	Trypto-phan	Lysine	Lysine	Trypto-phan	Tyrosin	Tyrosin	Trypto-phan	Tyrosin	Trypto-phan
3rd limiting amino acid		Leucine	Leucine	Trypto-phan	Trypto-phan	-	Trypto-phan	Trypto-phan	Tyrosin	Leucine	-

$$\text{Amino acid Score} = \frac{\text{mg amino acid in 1 gm protein} \times 100}{\text{mg amino acid suggested by}}$$

** Joint FAO/WHO Committee (FAO, 1973).

Table (8): Sensory evaluation scores of children food formulas.

Formulas	Sensory attributes			
	Color (100)	Taste (100)	Odor (100)	Overall acceptability (300)
1	78.5 ^{b}	69.5 ^{bc}	75.5 ^{bc}	223.5 ^{b}
2	83.5 ^{ab}	63.5 ^{cd}	69.5 ^{c}	216.5 ^{b}
3	79.5 ^{b}	77.7 ^{ab}	79.0 ^{bc}	237.2 ^{b}
4	76.8 ^{b}	70.0 ^{bc}	73.5 ^{bc}	220.3 ^{b}
5	86.0 ^{a}	80.5 ^{ab}	77.5 ^{bc}	245 ^{ab}
6	84.2 ^{ab}	73.1 ^{bc}	74.5 ^{bc}	232.5 ^{b}
7	78.7 ^{b}	80.8 ^{ab}	78.8 ^{bc}	243.3 ^{b}
8	81.7 ^{b}	77.4 ^{ab}	76.3 ^{bc}	232.4 ^{b}
9	81.5 ^{ab}	77.0 ^{ab}	75.6 ^{bc}	234.1 ^{b}
10	80.5 ^{b}	80.0 ^{ab}	76.0 ^{bc}	235.5 ^{b}
Riri	89.5 ^{ab}	54.5 ^{d}	87.5 ^{ab}	231.5 ^{b}
Nutriben	94.5 ^{a}	89.5 ^{a}	94.5 ^{a}	279.5 ^{a}
L.S.D	13.9	13.39	14.33	35.98

*Values represent of 10 panellists (Mean)

* $^{a, b, \ldots}$: There is no significant difference ($p \geq 0.05$) between any two means have the same superscripts, within the same acceptaptability attribute.

Table (9): Microbiological quality of children food formulas (CFU/g).

Formulas	CFU/g	Yeasts and molds
1	10^2 x 1.48	N.D.
2	10^3 x 1.10	N.D.
3	10^3 x 6.31	N.D.
4	10^3 x 6.92	N.D.
5	10^2 x 6.31	N.D.
6	10^3 x 3.98	N.D.
7	10^3 x 5.10	N.D.
8	10^3 x 1.70	N.D.
9	10^3 x 5.10	N.D.
10	10^3 x 3.16	N.D.

Cost of the children food mixtures:

Cost of the formulated children food mixtures as compared with Riri and Nutriben are calculated and the obtained results are shown in Table (10). It is shown from the obtained results the cost of producing the formulated mixtures commercially, are less than those of Riri and Nutriben as the imported baby foods in Libya. In addition the prices of these formulated children for mixtures shall be quite suitable for the low national income in Libya

Table (10): Cost of formulated children food formulas and commercial samples.

Formulas	Cost of formulated	
	Cost of Kg by Lipyan Denar	Cost of Kg by USA Dollar
1	2.090	1.65
2	2.025	1.59
3	1.965	1.55
4	1.900	1.50
5	2.090	1.65
6	2.025	1.59
7	2.075	1.63
8	2.164	1.70
9	2.075	1.63
10	2.257	1.78
Riri	12.50	9.84
Nutriben	11.60	9.13

The Net weight of children food in Riri and Nutriben jar were 200 and 300g, respectively.

CONCLUSION

The obtained results indicated that all studied mixtures have healthy quality and low production costs. So, it could be recommended of producing these mixtures.

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إنتاج وتقييم بعض خلطات الأغذية الصحية والقليلة التكلفة للأطفال قبل سن المدرسة

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أجري هذا البحث بهدف إنتاج خلطات مختلفة فى صورة جافة كأغذية تكميلية للأطفال وذلك باستخدام مواد خام محلية وقد تم تقدير التركيب الكيميائى لكل من المواد الخام والخلطات التى تم تحضيرها وقد أظهرت النتائج التى تم الحصول عليها ما يلى: بالنسبة للمواد الخام فقد احتوى العدس والجزر على محتوى عالى معنويا من الرطوبة (١٠,٣٦ و١٠,٦٠% فى كل منهما على الترتيب). إحتوى كل من الفول البلدى، الفول السودانى والحليب الكامل المجفف على محتوى عالى معنويا من البروتين الخام (٣١,٨٧، ٢٨,٧٦، ٢٢,٢٥، و٢١,٠٥% فى كل منهم على الترتيب). إحتوى كل من الفول السودانى والحليب الكامل المجفف على محتوى عالى معنويا من الليبيدات الكلية (٤٥,٢٩ و٢٨,٣٦% فى كل منهما على الترتيب). إحتوى الجزر المجفف والحليب الكامل المجفف على محتوى عالى معنويا من الرماد الكلى (٥,٩٥ و٥,٦٣% فى كل منهما على الترتيب).

تراوح المحتوى الرطوبى للخلطات التى تم تحضيرها من ٤,١٧ – ٥,٦١%، البروتين الخام من ٢١,٩٠ – ٢٢,٧٠%، الليبيدات الكلية من ٦,٩٠ – ١٠,١٣%، الرماد الكلى من ٢,٢١ – ٣,٠٢% وتراوحت قيمة الطاقة الحرارية من ٤٠٤,٩٧ – ٤١٩,٦٦ سعر حرارى/١٠٠ جم.

إحتوت الخلطات على تركيزات مختلفة من العناصر المعدنية وقد إتضح أن إعطاء ١٠٠ جم من الخلطة يكفى لتغطية ١٠٠% لكل من عنصرى الكالسيوم والماغنسيوم، ٦٢ – ١٠٠% من عنصر الحديد، ٢١–٥٨% لعنصر الزنك ومن ٢٠ – ٣٠% لعنصر النحاس وذلك من الإحتياجات اليومية للطفل.

إتضح من النتائج أن محتوى الخلطات من الأحماض الأمينية الأساسية كان أعلى من محتوى بيض الدجاج من نفس الأحماض الأمينية باستثناء الحمض الأمينى ميثيونين فى جميع الخلطات. إتضح أن الخلطات ٥، ١٠ و٧ تميزت بمحتوى عالى من الأحماض الأمينية الأساسية وكذلك معدل كل من الأحماض الأمينية الأساسية إلى غير الأساسية، الأحماض الأمينية الأساسية إلى الأحماض الأمينية الكلية، الأحماض الأمينية الأساسية إلى البروتين ومؤشر الأحماض الأمينية الأساسية.

من نتائج التقييم الحسى للخلطات إتضح أن الخلطتين ٥ و٧ قد حصلتا على أعلى الدرجات بالنسبة للقابلية الكلية. من خلال نتائج الفحص الميكروبيولوجى إتضح أن العدد الكلى للبكتيريا فى جميع الخلطات كان فى الحدود المسموح بها بالنسبة لخلطات أغذية الأطفال المصنعة فى صورة جافة. لم تظهر أى نموات للخمائر أو الفطريات فى أى خلطة من الخلطات. كان سعر التكلفة للكيلو جرام من الخلطات التى تم تحضيرها من مواد خام محلية أقل بكثير من سعر الخلطات التجارية مثل خلطة ريرى المنتجة فى مصر ونيوتربين المنتجة فى أسبانيا والتى تستهلك بكثرة فى الأسواق الليبية.