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FORTIFYING KIDS' FOOD WITH LABORATORY GROWN-LEGUMES AND STUDYING OF MICROBIAL AND NUTRITIONAL PROPERTIES

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Abstract

This study was conducted on the possibility of manufacturing kids' foods fortified by legumes. Three raw materials of boiled vegetables (carrots, potatoes and zucchini) were used, one of the pre-boiled legumes was added to the mixture, which included chickpeas, lentils, mung, soybean, fenugreek, by the percentage of 5% and 10%. The results of the chemical analysis showed no statistically significant differences ($P < 0.05$) between the coefficients of moisture, ash and fiber. However, the ash ratio increased from 0.76 to 0.88% and fiber from 0.43 to 0.87%. As for protein and fat, A8 coefficient (add 10% soybean bean) recorded highest ratio of 2.54 and 0.71% respectively, the results of the analysis of mineral elements showed that the A8 coefficient were significantly higher in calcium, phosphorus and potassium content, which reached (10.64, 18.26, 145.53) Mg/100G, respectively, while (A10) coefficient significantly exceeded in iron content which was 0.89 mg per 100 gram. The sensory evaluation results referred that the mixtures having 5% of the laboratory-grown legumes got the highest sensory valuation scores. The results of the microbial analysis referred to possibility of, well-protected kids' food mixtures for 24 hour in a refrigerator after preparation, where the microbial numbers are within the allowed limits for human consumption.

Key words : Kids' food, laboratory-grown legumes, nutritional, microbial characteristics.

Introduction

Children's food has a special place among food products because of nutritional characteristics. The goal of feeding children is to stimulate the appropriate growth of the child. Children in general need to be gradual in the variety of different foods that have an important role in the development of children, where mothers have recently increased the adoption of ready-made and canned kids' foods for infants. These foods may be useful and may be harmful depending on how they are used, their nutritional content and how they are prepared (Themar Al-Sehah, 2011). The prepared food is safe, as long as the raw materials are carefully selected; the area is kept clean and takes care during all stages of preparation. The home-made foods are balanced and contain all nutritional requirements. The home-made foods should be steamed before being mashed to prevent any pollution, as adding water to children's food makes food suitable and homogeneous when taken.

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The children's food is prepared either from one substance such as vegetables, fruits, meat or poultry, or mixed with each other, and filtered to small granules that do not need to be chewed (SASO, 1994). Vegetable foods containing vegetables, fruits, meat and grains are a good source of vitamin E (Majchrzak and Elmad, 2010), and vegetables are a good source of carotene and fiber and have a high proportion of iron and calcium (Maysaqer, 1999) and to improve the nutritional value of children's food, attention has been drawn to cheap protein alternatives, to meet the nutritional deficiency, these plant proteins must be of high nutritional value (Sulaimi *et al.*, 1999). The leguminous family (leguminosae) is one of the most important plant families for its large economic crops such as lentils, chickpeas, mung, soybeans, beans, field pistachios, etc. The importance of these crops comes directly from grain crops because of the high protein content of 20-40. As well as the content of starch, oil, vitamins and minerals essential for the body (Salunkhe, 1982). As well as the possession of protein legumes many functions working to show some qualities such as solubility and association with water and gluten, which

have a role in the forming of the composition according to their source, either chickpeas or green beans (Paraskevopoulou *et al*., 2012) and legume crops contain fatech acid by 1-5% and its nutritional importance in the ability of linking with some minerals like (calcium, magnesium, iron, copper and zinc), which reduces its readiness and bioavailability in the intestines (Sebastia *et al*., 2007). Because of the nutritional and health benefits of legumes. The need arises to be added to products in markets (Anton *et al*., 2008) legumes were used to boost lysine in food (Akubor, 2004) and containing anti-nutrient factors, including Trypsin Inhibitors, which reduces digestibility and manufacturing processes helped to get rid of a lot of nutritional antibiotics such as thermal coefficients of all kinds (EI-Adawy, 2001), which has negatively affected the nutritional value of legumes such as the loss of certain vitamins and minerals (Naji, 1983). Therefore, the use of germination as a means of elimination of nutritional determinants because of their positive effects on nutritional value, such as improving the digestibility of protein and increasing the content of vitamins in legumes (FAO, 1989). The researcher (Abdul Kadir *et al*., 2014; Abdul Kadir *et al*., 2016). Pointed out that germination has an effect on the increase of the ratio of crude and isolated protein and reached the maximum in the second day of germination, while the process of germination resulted in a slight decrease in the amount of fat and minor changes in the fixed amount of fiber and the rest of carbohydrates.

Wheat, lentils, chickpeas, sugar and vanilla with the addition of laxative emulsifier (Amiri *et al*., 1991) for the production of mixtures for children's food and also used (Sahi *et al*., 1998; Sulaimi *et al*., 1999) concentrated soybean protein and wheat and full fat milk powder for the production of baby's foods.

He also mentioned (Kostic *et al*., 1997) the possibility of using the types of pumpkins in the production of children's food, where it was studied to strengthen and mix with dry milk, sugar and rice flour to increase the nutritional value by comparing the biological value of the bioretic product of this mixture with the product of the purée of the carrots for the same mixture, soy protein was used in baby foods (Hunt, 1999).

Theuer *et al*. (1998), orange carrots were used in the study of preposterous foods. Carotene content was 75-150 ppm and the largest content being B-carotene. As a result, the source of vitamin A raised, the product colored with orange color. As in white and yellow carrots, the content of the B-carotene was greater than 10 parts per million. Apples, guava, bananas, powdered milk, yellow carrots, sugar (Abdel Salam *et al*., 2016) were used to produce mixtures for children's food and study their sensory and chemical properties.

The researcher (Mulkey *et al*., 1991) found the possibility of the use of winter pumpkin in the manufacture of baby's food produced by Gerber in Arkansas State (about 2000 tons) annually. While he (Badi *et al*., 1990) mentioned the new nutritional value of the children's food in Sudan, which contains sorghum and millet in different types of basic food in Sudan and some kinds supported with chickpeas and peanuts. It was found that adding chickpeas and peanuts improves the quality of basic food. The results of the study showed (Seaman *et al*., 1996) that most of the used children's food in Britain was ready-prepared, working mothers, using commercial baby's food more than women who do not work.

Therefore, the current study aimed the possibility of manufacturing of supplementary foods for infants, rich in protein, mainly consisting of vegetables with the addition of legumes in certain percentages, that comes because of the positive effects of the germination legumes on the nutritional value and it could be given to infants from the fifth month of age supplementing breast milk or powdered milk, as it's rich in protein on the one hand and cheap and available on the other.

Materials and Methods

Germination of legumes

Five different types of legumes were used: lentils, mung, chickpeas, soybeans and the available fenugreek in local markets in Baghdad, washed with distilled water and left to germinate in stainless steel containers at 20°C for three days. The different legumes were placed between two layers of cloth moistened with distilled water and sprayed with water sporadically to maintain proper moisture for the germination process and then washed after germination and was individually boiled and mixed with electric mixer to be used later, in prepared mixtures (vegetable soup).

Mixtures making (vegetable soap)

In this research, three raw materials were used and they were potato, carrot and zucchini. They were peeled, washed and boiled individually and equal weights from potato, carrots and zucchini were taken and mixed by an electrical mixer with adding some of the boiled water, then 100 gram of the mixture (vegetable soap) was taken and the available germinated legumes were added individually at 5% and 10% ratios and then they were mixed well. Table 1 shows ratios of germinated legumes addition to the prepared mixtures (vegetable soap).

Table 1 : Ratios of the germinated legumes addition to the mixtures (vegetable soap).

Replacing ratios	Transaction symbol
A	-
A1	Lentil 5%
A2	Lentil 10%
A3	Mung bean 5%
A4	Mung bean 10%
A5	Chick peas 5%
A6	Chick peas 10%
A7	Soy bean 5%
A8	Soy bean 10%
A9	Fenugreek 5%
A10	Fenugreek 10%

Sensory evaluation

The sensory evaluation was conducted at the University of Baghdad, College of Education for Girls, Department of Home Economics, where the prepared mixtures, evaluated by ten evaluators. The sensory evaluation scores were given according to the followed method (Romerand Renner, 1976) with some changes and the addition of general acceptance property by Arbo (1988). Distribution of grades as follows:

Degrees distribution	Degrees	Adjective
16 - 20 Very acceptable	20	Property
12 -16 Acceptable	20	Flavor
8 - 12 Not Acceptable	20	Color
4 - 8 Unacceptable	20	Consistency
0 – 4 Very rejected	20	General acceptance

Chemical analysis

The chemical analysis of the various mixtures (vegetable soup), which included the assessment of moisture, ash, protein; fat and fiber according to the methods mentioned in A.O.A.C. (2005). Total carbohydrates were estimated by the computational difference according to (Dalaliand Hakim, 1987). The mineral elements, which included calcium, iron, potassium and magnesium, were estimated by using, atomic Absorption Spectrophotometer device, made by perkin-Elmer VSA according to the method mentioned (Haswell, 1991), as for phosphorus, the Spectronic 20 T was used in accordance with the method in A.O.A.C. (2005).

Statistical analysis

The Statistical Analysis System (SAS, 2012) was used in data analysis, to study the effect of different coefficients in the studied traits in full randomized design (CRD). The significant differences were compared between the averages by testing, less significant difference (LSD).

Results and Discussion

Table 2 shows the effect of the addition of grown legumes in the chemical composition of children's food mixtures. There were no statistically significant differences ($P < 0.05$) in the content of moisture, ash, fiber and all the coefficients. Although, there were no significant differences in ash and fiber content, however, they recorded a rise in the ratio of ash to 0.76 for coefficient (control). A compared to the coefficient of A8 (addition of 10% grown- soy bean), which recorded the highest percentage of 0.92 as for fibers rose from 0.43 to 0.76 at coefficient A10 (with the addition of 10%

Table 2 : Effect germinated legumes addition on the chemical composition of kids' foods mixtures.

Coefficient	Medium ± Standard error					
	Moisture	Ash	Protein	Fat	Fibres	Carbohydrate
A	a0.62±0.73	a0.02±0.76	b0.07±1.44	b0.02±0.13	a0.06±0.43	a0.02±6.51
A1	a0.54±91.19	a0.07±0.82	ab0.05±1.83	b0.03±0.14	a0.04±0.48	ab0.02±5.54
A2	a0.36±91.66	a0.04±0.85	a0.05±2.22	b0.02±0.14	a0.03±0.54	b0.07±4.59
A3	a0.48±91.53	a0.02±0.81	ab0.01±1.91	b0.02±0.16	a0.03±0.68	b0.02±4.91
A4	a0.37±91.86	a0.02±0.88	a0.03±2.29	b0.02±0.19	a0.02±0.87	b0.04±3.91
A5	a0.41±91.82	a0.03±0.81	ab0.05±1.78	b0.01±0.21	a0.03±0.53	b0.04±4.85
A6	a0.26±92.40	a0.05±0.86	a0.02±2.12	b0.03±0.29	a0.02±0.59	b0.03±3.74
A7	a0.37±91.60	a0.04±0.84	ab0.04±1.99	ab0.02±0.42	a0.04±0.50	b0.07±4.65
A8	a0.52±92.26	a0.07±0.92	a0.04±2.54	a0.04±0.71	a0.06±0.58	b0.03±2.99
A9	a0.41±91.40	a0.05±0.82	ab0.05±1.84	b0.03±0.24	a0.06±0.59	ab0.11±5.11
A10	a0.38±91.65	a0.03±0.87	a0.07±2.24	b0.05±0.34	a0.03±0.76	b0.06±4.14
LSD value	NS 3.933	NS 0.175	*0.873	*0.329	NS 0.288	*1.552

*NS = not significant at (P<0 .05).

Table 3 : Effect of the addition of grown legumes in the mineral elements of baby food mixes.

Coefficient	Medium ± Standard error				
	Ca	Mg	P	Fe	K
A	b8.52±0.17	b7.50±0.11	c12.31±0.15	b0.43±0.02	b127.51±0.42
A1	b8.92±0.07	b7.81±0.09	abc14.81±0.11	b0.53±0.01	b131.65±0.62
A2	b9.34±0.12	ab8.01±0.12	ab16.27±0.15	ab0.64±0.02	b135.82±0.55
A3	ab9.04±0.09	ab8.25±0.12	bc14.33±0.12	b0.54±0.02	b128.45±0.62
A4	ab9.50±0.12	ab8.50±0.11	ab16.36±0.16	ab0.66±0.03	b129.40±0.72
A5	ab9.33±0.8	b7.95±0.11	bc14.14±0.09	a0.55±0.01	b131.92±.81
A6	a10.16±0.08	ab8.31±0.09	ab15.97±0.14	ab0.66±0.02	b136.34±0.75
A7	ab9.72±0.11	a8.83±0.11	a15.28±0.08	b0.75±0.02	b136.51±0.60
A8	ab10.64±0.07	a9.22±0.11	bc18.26±.13	ab0.70±0.04	a145.53±0.62
A9	ab9.47±0.10	ab8.99±0.07	bc13.94±0.07	ab0.68±0.04	b130.32±0.51
A10	a10.43±0.10	a9.56±0.07	b15.59±0.11	a0.89±0.02	b132.61±0.71
LSD value	*1.548	*1.437	*2.577	*0.361	*8.27

*(P<0.05)

Table 4 : The effect of the addition of grown- legumes on the sensory evaluation of children's food mixes.

Coefficient	Medium ± Standard error					
	Flavor	Consistency	Property	Color	General acceptance	Total
A	a15.8	a16.7	ab14.09	a15.3	a14.7	a77.3
A1	ab14.4	a13.6	ab14.4	b11.0	a13.8	b67.2
A2	a15.2	a14.1	ab13.5	b11.7	a12.6	b67.1
A3	a16.0	a13.7	ab13.6	ab13.0	a14.5	b70.8
A4	ab14.2	a14.0	ab14.0	b11.2	a13.2	b66..6
A5	ab14.8	a13.0	ab13.4	ab14.6	a14.0	b69.8
A6	ab14.5	a12.4	ab13.5	ab13.5	a13.3	b68.2
A7	ac12.3	a14.5	c11.2	ab13.1	a13.0	bc64.1
A8	ac12.5	a14.1	ab12.4	ab13,5	a13.3	bc65.8
A9	ac12.0	a14.1	ab15.1	ab13.5	a13.8	b68.36
A10	c10.2	a13.0	ab12.4	b12.4	a12.4	c60.4
LSD value	*3.017	NS2.81	*2.75	*2.09	NS 2.94	*5.39

of fenugreek). As for protein, the results indicate that there were significant differences between the coefficients, to which have been added the ratio of 10% of the legume compared to the coefficient. A (control coefficient) A8 coefficient (addition of 10% of grown-soy bean) the highest protein content of 2.54 and the less ratio was 2.12 in (A6) coefficient (adding 10% germinated chick peas). There were non- significant differences in fat ratio in the coefficients except (A8) treatment (adding 10% germinated soy bean).

The increase in the percentage of ash, fiber, protein and fat can be attributed to the high content of these components in the legumes grown, which included lentils, chickpeas, mung, soybeans and fenugreek, giving a positive indication of increasing the nutritional value of baby food mixes. Since there are no studies similar to or close to the present study, the results of the current study cannot be compared to previous studies, especially with regard to chemical composition.

Table 3 shows the effect of the addition of legumes grown in the mineral content of the children's food mixtures, which included calcium, magnesium, phosphorus, iron and potassium, respectively. The results indicate that the mineral elements were significantly higher (P <0.05), the (A8) coefficient (adding 10% germinated soy bean) recorded the highest ratios of calcium, phosphorus and potassium and there values were 10.64, 18.26 and 145.53 respectively compared with the control coefficient, which were 8.4, 12.31 and 127.51, respectively while (A10) coefficient (adding 10% germinated

Table 5 : Microbial mass of baby's food mix in preparation and after storage of 72 hours is (zero), at refrigerator temperature measured by colony formation unit.

Coefficient	When preparing (Zero)	After 24 hours	After 48 hours	After 72 hours
A	1	65	282	1500
A1	0	50	278	2280
A2	0	78	387	2080
A3	0	92	387	2080
A4	1	78	392	1950
A5	2	82	264	3800
A6	0	88	282	3620
A7	0	78	290	3200
A8	1	90	288	2400
A9	0	32	232	2370
A10	0	82	211	2390

fenugreek) recorded the highest ratios of iron and magnesium in which they were 0.89 and 9.56 respectively compared with the control coefficient in which they were 0.43 and 7.5, respectively.

It is known that infant foods should be varied in content and have many nutrients, especially iron, phosphorus, calcium, potassium and magnesium, which have an effect on the growth of children especially at this age where the body needs the process of construction and development.

Table 4 shows sensory evaluation results of kid's foods mixtures. These results referred to presence of non- significant differences ($p<0.05$) between the different coefficients in consistency and general acceptance properties, while flavor property showed significant differences and (A3) coefficient (adding 5% germinated mung bean) superior significantly on the rest coefficients and it got 16 degrees out of 20 degrees and got the second order between the treatments and its total degrees was 70.7 out of 100 degrees. Smell property got significant superiority ($p<0.05$) in A9 coefficient (adding 5% germinated fenugreek) on the other coefficients, with the score of 15.1 in the fourth order between the coefficients with total degrees reached 68.36.

Based on the reported results and the values set out in table 3, coefficients can be arranged in descending order from the most preferred to the least favored as follows:

A_{10}, A_7, A_8, A_4, A_2, A_1, A_6, A_9, A_5, A_3, A

When looking carefully at the order of coefficients, it is noted, in the order of preference for the first three coefficients, except for the coefficient of A (control), they obtained the highest number of points that the addition of 5% of legumes was better than the addition of 10% of grown legumes, in terms of sensory properties, that comes because, some legumes are particularly have a strong test, especially the fenugreek and soybeans, as they have been shown to have an effect on taste and aroma, especially when added in the percentage of 10% to the mix, as the fenugreek and soybeans are characterized by their strong taste and aroma.

Table 5, it is noted from the table that all coefficients are free of any microbial contamination in preparation, that because of following the health conditions during manufacturing, as well as exposure to cooking and temperature was sufficient to kill any microbial contamination can occur, but after storage of 24 hours at refrigerator temperature, microbial numbers increased and was also within the limits allowed for human consumption, but it was later observed increasing in microbial numbers after increasing the storage period 48 and 72 hours in the refrigerator and became unfit for human consumption ,as laboratory-prepared soup of children is free of any preservative materials so cannot be stored more than 24 hours, it should be given immediately after preparation for the safety of special children.

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