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NUTRITIONAL ASSESSMENT OF NEW SIX SCHOOL STUDENT FORMULAE BASED ON SOME CEREALS AND LEGUMES

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Abstract : The nutritional goal of the school student's food is to supplement the school diet with the major nutritional elements during his time in school as required by the needs of the student body and the elements of food during the study period.

One of the best school nutrition programs used is the preparation of cereal products supported by one of the sources of available protein from various types of cereals, legumes, oil seeds and skim milk.

The aim of this study is to prepare six nutritional formulae for school students from several available cereals and legumes including (wheat, corn, barley, chickpea, rice, lentil, sesame, soybean and peanut). The gross chemical composition as well as the caloric value of all formulae, in addition to mineral composition of these formulae was estimated. The amino acid composition and fatty acid composition were studied as well.

The proportion of crude protein in the formulae ranged between 11.45 to 25.52% on a dry basis for formulae F_1S, F_2T, respectively. Therefore,most of the studied formulae were a rich source of protein .

The proportion of crude fat in the formulae ranged between 6.75 to 14.51%, on a dry basis for formulae F_2T, F_2S, respectively.

While the carbohydrates was highest 71.89% (F_1T), in contrast to formula F2T which contained 54.14% of carbohydrates.

The highest caloric value (k.cal/100g dry weight) was (436.11) in formula F_2S followed by formula F_1S (433.92) then formula F_3S (432.57) .

The studied formulae had high values for the elements calcium, magnesium, potassium and phosphorus. Concerning iron values were higher than the recommended daily allowances for students.

Data indicated that the values of essential amino acids (threonine, isoleucine, leucine, phenylalanine and lysine) in all studied formulae were equal or higher than recommended by the (FAO/WHO/UNU ,1985).

Data revealed that all the six studied formulae had relatively high proportions of oleic and lenoleic acids. On the other hand, their contents of lenolenic were very low.

Formulae (F_2S, F_2T, and F_3T) had the highest values of lenolenic acid (3.7, 2.2, and 1.1%) of the total fatty acids, respectively.

In general ,the right combinations of cereals and legumes provided a good balance of nutrients and minerals for school students.

Key words: student formulae , cereals, legumes.

Introduction

Generally, most school students suffer from protein-energy malnutrition in developing countries. By introducing school food of good quality and quantity at the right time and in the right proportions, the incidence of protein energy malnutrition could be avoided to a large extent.

Food legumes are a major source of dietary protein to all the people as well as for vegetarians in developing countries where there might be inadequate availability of animal protein. Legumes are also used as a complement to carbohydrate staples such as cereals, root and tuber crops because their combination provides a good balance of amino acids (Doughty and Walker, 1982). Major recommendation of nutrition in school includes a reduction in the consumption of fat, sugar and salt and an increase in consumption of fiber (Lund *et al*., 1990).

Efforts to improve the health and nutritional status of growing children had focused primarily on the production of nutritious low-cost supplementary foods and their acceptability and shelf life (Dahiya and Kapoor, 1993b).

Cereals had been considered as important crops for thousands of years. They provided vitamins, minerals, complex carbohydrates "starch and dietary fiber" and other substances important for good health. The principal cereal crops are wheat, maize, rice, and barley. Legumes occupy an important place in human nutrition especially for low-income groups of people in developing countries (Tharanathan and Mahadevamma 2003).

McGuire (1991) showed that food quantity was not always the issue, but food quality contributed to continued prevalence of malnutrition..

Cieslik and Sikora (2001) mentioned that minerals content of Daily Food Rations in primary school student (6-12 yr.) was as follows: Ca levels around 800-1100 mg/DFR (67-92% of recommended daily intake [RDI]). Fe intake averaged 16.7-23 mg/DFR (104-144% of RDI), Zn intakes 14.8-19.1 mg/DFR (102-131% of RDI) and Cu intakes 1.5-2.3 mg/DFR (100-115% of RDI)., Weekly intakes of Cd and Pb by students eating in these canteens averaged 308 and 998 µg/person, which did not appear to be a threat to health.

The energy intakes of males and females were not sufficient. Further more, regardless of gender, consumption of Ca and Fe was very low. Results suggested that females should be given meals which enhanced absorption of Fe, and that effective strategies were required to enhance the intake of nutrient rich foods in elementary school students (6-12 yr) (Ro., 2003).

Habib and El-Bagoury (1999) studied the nutritional status of 145 randomly chosen primary school children aged from 7 to 10 years (75 girls and 70 boys) from Tanta, Gharbia Governorate. They found that the total caloric and protein intakes for girls were 2510 kcal/day and 67.8 g/day (39.1% from animal sources); respectively. On the other hand, the total caloric and protein intakes for boys were 2613.9 kcal/day and 79.4 g/day (42.9%from animal sources), respectively.

Abd El-Ghany and Shaheen (2000) carried out a nutritional survey in Minufia Governorate using 80 randomly chosen school children (40 children of 6-12 years and 40 children of 13-18 years). Results showed that the mean caloric intake for children with ages from 6 to12 years were 2318.5 for boys and 1619.2 kcal/day for girls, while protein intake was 66.7 g/day (38.9% from animal sources) for boys and 64.3 g/day (50.7% from animal sources) for girls. On the other hand, the mean caloric intake for boys and girls with ages from 13 to 18 years was 2076.3 and 1601.1 kcal/day; respectively and the mean protein intake for boys was 77.6 g/day (45% from animal sources) and for girls it was 62.2 g/day (47.9 % from animal sources).

Morsi *et al.* (2002) carried out a nutritional survey using 176 randomly selected school children (82 boys and 94 girls) from seven Bedouin regions in North Sinai. Results showed that the total caloric intake for boys and girls from 10 to 14 years, ranged from 918.4 to 1383.5 kcal/day and from 965 to 1361.4 kcal/day.; respectively.

Therefore, the present investigation was performed in an attempt to design new nutritious school student formulae based on some cereals and legumes.

Materials and Methods

Materials:

Source of samples

The following different varieties of cereal grains and legume seeds were procured from Agronomy Department, Collage of Agriculture, Assiut University, Egypt, during 2004-2005 season .

Wheat (*Tritium aetivum*): Giza-164 variety

Corn (*Zea maize*): single cross 10 variety

Lentils (*Lens esculenta*): Giza-9 variety

Barley (*Hordeum vulgare*): Giza-123 variety

Peanut (*Arachis hypogaea* L.): Giza-5 variety and Sesame (*Sesamum indicum*): Giza-32 variety, were obtained from Shandaweel Research Station (Sohag) during 2004-2005 season.

Rice (*Oryza sayival*.): Riho variety, Soybean (*Glycine max* L.): Clarcks variety and Chick peas (*Cicer arietinum* L.): Giza-2 variety was obtained from Agriculture Research Center (Cairo) during 2004-2005 season .

Dry dates (Tamer) Balady variety, were obtained from Kharja Date Packing Factory during 2004-2005 season.

Preparation of samples:

Cleaning:

Cereal grains and legume seeds were manually cleaned of debris, dust and other foreign materials. Split and discolored seeds were discarded.

Wheat:

After cleaning, wheat grains were soaked in double amounts of distilled water for 18 hrs at 25 ºC. The presoaked grains were kept in trays lined with wet filter paper and allowed to germinate at ambinet temperature for 48 hrs. The germinated grains were dried at 55 ºC for 48 hrs.Then they were ground in a mill model Mikro-Feinmuhle-Culatti (MFC) according to Wahed et al. (1993) and Gahlawat and Sehgal (1993). The ground samples were stored in polyethylene bags at 4 ºC until required for analysis.

Corn:

Corn grains were washed, soaked in distilled water for 18 hrs and allowed to germinate at ambinet temperature for 48 hrs. The germinated grains were sun dried for 10 hrs. Then corn grains were derooted, kilned in an electric heater at 70 ºC for 15 min, and milled slightly to loosen the husk then milled in a mill model Mikro-Feinmuhle-Culatti (MFC). The ground samples were stored in polyethylene bags at 4 ºC until required for analysis according to Som *et al*. (1992).

Lentil:

After cleaning, lentil grains were soaked in distilled water for 12 hrs at 25 ºC using seed to water ratio 1:6 (w/v). Then the presoaked grains were washed twice by distilled water. The presoaked grains were kept in trays lined with wet filter paper and allowed to germinate at ambinet temperature for 72 hrs. The germinated seeds were cooked in distilled water until the seed became soft. Seed to water ratio 1:6 (w/v) was used. The cooked seeds were mashed and then dried at 60 ºC. Then seeds were minced and stored in polyethylene bags at 4 ºC until required for analysis according to AOAC (1990).

Barley:

Barley grains were soaked, germinated and dried as mentioned in wheat, then milled slightly to loosen the husk. The dehulled grains were ground in the aforementioned mill. The barley meal was stored in polyethylene bags at 4 ºC until analysis according to Gahlawat and Sehgal (1993).

Peanut:

Peanut seeds were decorticated, and then roasted in a forced-air oven at 160 ºC on a metal tray. Experimental roasting times based on development of aroma and flavor" lasted about 45 mins. according to the method described by Grifftth et al (1998). Roasted peanut seeds were milled after cooling using blender, and then defatted twice by stirring for 30 mins with ice cold acetone then removal of residual acetone then dried. The defatted flour obtained was stored in polyethylene bags at 4 ºC until analysis.

Sesame:

Sesame seeds were washed, and then sun dried for 4 hrs. The seeds were roasted in a forced-air oven at 160 ºC on a metal tray for 30- 45 mins. Until the aroma and flavor were developed. The roasted seeds were then milled to produce a high viscosity paste, defatted twice by stirring for 30 mins. with ice cold acetone as previously reported for peanut and stored in polyethylene bags at 4 ºC until analysis.

Rice:

Rice was washed, soaked for 2 hrs and sun dried for 8 hrs, heated for 10 min at 60 ºC and pulverized. After milling as previously mentioned, the obtained flour was kept in polyethylene bags at 4 ºC until analysis according to Som *et al*. (1992).

Soybean:

Cleaned seeds were soaked in mixed salt solution (2.5% sodium chloride, 1.5% sodium bicarbonate, and 0.5% sodium carbonate, all w/v, in distilled water) for 12 hrs at 37ºC using seed to water ratio of 1:5 (w/v). The unimbied water was discarded and the soaked seeds were rinsed twice in distilled water. The rinsed soaked seeds were cooked in distilled water for 25 mins until the seeds became soft. The water level was kept (three times the weight of dry seeds) during cooking as to cover the legume samples.

The cooked seeds were mashed and then dried in a hot air oven at 55 ºC for 4 hrs. The dried samples were then ground, and defatted twice by stirring for 30 mins with ice cold acetone. The defatted sample was stored in polyethylene bags at 4 ºC until analysis (Kheir, 1990).

Chick pea:

The cleaned seeds were washed, and then soaked in distilled water at ambinet temperature for 12 hrs. The presoaked seeds were allowed to germinate for 72 hrs in the dark at ambinet temperature, then dried at 45 ºC for 48 hrs. The germinated dried seeds were dehulled, derooted then milled as above-mentioned. Chick pea flour was stored in polyethylene bags at 4 ºC until analysis according to Dahiya and kapoor (1993a) method.

Dates:

Date samples were taken at random and transmitted to the laboratory for analysis. Pits were removed from date fruits, and then the flesh were cut into small pieces and minced just before analysis according to Ramadan(1990).

Preparation of Student Formulae:

The proportions of these ingredients (cereal, legumes and skim milk) were selected in such a way that each formula could provide 2500 kcal/day according to Insel et al(2002.). The following developed formulae were designed:

1-(F_1S) skim milk (5 %); sucrose (5 %); dry dates (30 %); corn flour (40 %); peanut flour (20 %).

2-(F_2S) skim milk (5 %); sucrose (5 %); soybean flour (30 %); wheat flour (40 %); sesame flour (10 %); lentil (10 %).

3-(F_3S) skim milk (5 %); sucrose (5 %); barley flour (30 %); rice (20 %); peanut flour (20 %); chick pea flour (20 %).

4-(F_1T) skim milk (5 %); sucrose (5 %); dry dates (30 %); germinated corn flour (40 %); roasted Peanut (20 %).

5-(F_2T) skim milk (5 %); sucrose (5 %); cooked soybean flour (30 %); germinated wheat flour (40 %); roasted sesame flour (10 %); germinated sprouted lentil (10 %).

6-(F_3T) skim milk (5 %); sucrose (5 %); germinated barley flour (30 %); treated rice (20 %); roasted peanut (20 %); germinated chick pea (20 %).

Methods

Chemical methods:

Moisture, crude protein, oil, crude fiber and ash contents were determined according to the methods described by AOAC (1990).

Total carbohydrates were calculated by difference.

The caloric value was calculated according to Livesey (1995).

Determination of minerals content:

The samples were wet acid-digested using nitric acid and perchloric acid mixture .The amounts of iron, and manganese in the digested sample were determined using a GBC Atomic Absorption 906 A, as described in A.O.A.C (1990). Sodium and potassium were determined by a flame photometer 410; phosphorus was determined using colorimeter at 660 nm. Calcium and magnesium were determined by titration with version 0.0156 N according to Jackson (1967).

Amino acids composition:

Amino acids were determined according to the method described by Pellett and Young (1980) using Beckman Amino Acid Analyzer Mode 119 CL., at central Lab., Faculty of Agriculture, Alexandria University, Egypt.

Tryptophan was determined using spectrophotometer method as described by Sastry and tummuru (1985).

Computation of chemical score:

The chemical score was defined according to Bhanu *et al*. (1991).

Computation of A/E ratio:

The relationship between the content of an individual essential amino acid in food protein (A) and the total essential amino acid content (E) was calculated according to FAO (1965).

Computation of Protein Efficiency Ratio (PER):

Protein efficiency ratio was calculated using the equation mentioned by Alsmeyer *et al.* (1974) as follows:

PER = -0.684+0.456(leucine) – 0.047(proline) (gm/100 gm protein)

Computation of Biological Value (BV):

Biological value of protein (BV) was calculated according to the equation of Oser (1959) as follows:

BV = 49.9 + 10.53 (PER).

Determination of fatty acid content:

The methyl esters of fatty acids were prepared from aliquots of total lipids using 5 ml 3% H2SO4 in absolute methanol and 2 ml benzene as mentioned by Rossell *et al.* (1983). The methyl esters of fatty acids separated using HP 6890 GC (at Agriculture Research Center, Cairo, Egypt.). Peak identifications were established by comparing the retention times obtained with standard methyl ester. The areas under the chromatographic peak were measured with electronic integrator.

Results and Discussion

Gross chemical composition of the recommended school student formulae:

The mean values for the chemical composition of the planned student formulae based on studied cereals and legumes are shown in Table (1) .

The moisture content of the recommended formulae ranged from 4.00 to 7.33% for F_1T and F_2S; respectively.

The total protein of prepared student formulae varied between 11.45 and 25.52%. The least protein value was obtained for formula (F_1S), while the highest protein value was obtained for formula (F_2T).

The protein content of formula F_1S (11.45%) was lower than protein content of formula F_1T (13.57%). Likewise, the mean protein content of F_2S (21.61%) was lower than protein content of F_2T (25.52%); and protein content of F_3S (15.81%) was lower than protein content of F_3T (19.07%).

Such variations in protein content of the six studied formulae could be attributed to the variable compositional values of their ingredients from legumes and cereals.

Generally, the results indicated that all the studied formulae might be considered as rich sources of proteins.

Formula F_2T had the highest value of protein (25.52%) due to its relative high content of sesame recording (35.04%) of its content as protein, which agrees with Sato (2003).

On the other hand, the fat content among recommended student formulae varied between 6.75 and 14.51%, due to the varietal legumes and cereals variation.

The least fat value was obtained for formula F_2T (6.75%) and formula F_2S (14.51%). However, fat content of formula F_1S (11.36%) was higher than fat content of formula F_1T (6.99%), fat content of formula F_2S (14.51%) was higher than fat content of formula F_2T (6.75%); fat content of formula F_3S (11.21%) was higher than fat content of formula F_3T (9.23%).

Table (1): Gross chemical composition and caloric value of the recommended school student formulae (on dry weight basis)*

Estimates	Formulae					
(%)	F_1S	F_2S	F_3S	F_1T	F_2T	F_3T
Moisture	6.67	7.33	7.17	4.00	6.67	4.67
Crude protein	11.45	21.61	15.81	13.57	25.52	19.07
Crude oil	11.36	14.51	11.21	6.99	6.75	9.23
Ash	2.38	3.46	2.26	1.99	3.50	2.31
Crude fiber	3.34	5.64	3.61	5.55	10.09	4.95
Carbohydrate**	71.47	54.77	67.11	71.89	54.14	64.44
Caloric value (K.cal/100g)	433.92	436.11	432.57	404.75	379.39	417.11

* Mean of three replicates. ** Calculated by difference.

A higher amount of fat (18%) had been reported in home cooked foods, formulated from processed food grains (Khan and Eggum, 1979).

According to Hudson (1987) and Salunkhe *et al.* (1992) using peanuts in weaning blend formulations increased fat providing a more concentrated caloric source rich in the essential fatty acid, (linoleic acid.).

The highest value of ash was found in formula F_2T followed by formulae F_2S, F_1S, F_3T, F_3S, and F_1T recording 3.50, 3.46, 2.38, 2.31, 2.26, and 1.99%.; respectively.

The ash content of legumes seeds decreased by abrasion because of the removal of seed coat and the outer part of cotyledon during the abrasion process (Singh *et al.* 1992)

The crude fiber content among recommended school student formulae varied between 3.34% and 10.09% for F_1S and F_2T, due to the varietal legumes and cereals variations.

Carbohydrate content among the formulae varied between 54.14 and 71.89%, due to the varietal legumes and cereals variations.

The least carbohydrate value was obtained for formula F_2T (54.14%) while formula F_1T contained the highest content of carbohydrate (71.89%) which could be attributed to its high content of both date and corn being rich in carbohydrates.

The calculated energy densities obtained for the recommended school student formulae ranged from 379.39 to 436.11 (kcal /100 g on dry weight basis).

Minerals content of the formulae:

Minerals content of the formulae (mg/100g on dry weight basis) are shown in Table (2) .Formula (F_1S) had the highest values of magnesium (1680), while formula (F_2S) had the highest values of manganese (4.15), calcium (1400) and potassium (850).

Formula (F_3S) had the highest value of calcium (1400), while formula (F_2T) had the highest values of sodium (200) and phosphorus (793.1). On the other hand formula (F_3T) had the highest values of iron (45.07).

Iron content of student formulae ranged between (20.45) and (45.07), while manganese content ranged between (1.8) and (41.5), calcium content ranged between (220) and (1400). Magnesium content ranged between (120) and (1680).

Sodium content ranged between (50) and (200), while potassium content ranged between (550) and (850), phosphorus content ranged between (563.6) and (793.1).

Likewise, it could be observed from Table (2) that formulae (F_2S), (F_3S) and (F_1T) had the same values of sodium (50).

Table (2) revealed that formulae (F_1S) and (F_3T) had the same values of sodium (100), Meanwhile formulae (F_3S), (F_3T); and formulae (F_1S) and (F_2T) had the same values of potassium (550); and (650); respectively.

Table (2): Mineral contents of the studied school student formulae (mg/100gm dry weight basis).

formulae	Minerals						
	Fe	Mn	Ca	Mg	Na	K	P
F_1S	20.45	1.80	1000	1680	100	650	605.30
F_2S	42.10	4.15	1400	120	50	850	751.40
F_3S	27.62	2.15	1400	480	50	550	563.60
F_1T	27.95	1.85	200	1200	50	650	605.30
F_2T	22.02	3.70	220	1320	200	650	793.10
F_3T	45.07	2.50	400	960	100	550	626.20

Amino acid content and protein quality of school student formulae:

Table (3) outlined the amino acid content of the studied student formulae.

It is clear from Table (3) that glutamic acid was the predominant amino acid for all studied student formulae followed by aspartic acid, except formula (F_2S).

Sulphur amino acids, methionine and cystine presented the lowest values among all amino acids for all the studied student formulae.

Results revealed that formula (F_1T) had the highest levels of valine, isoleucine, and leucine while formula (F_2T) had the highest levels of threonine, lysine, and tryptophan.

On the other hand, formula (F_2S) had the least levels of threonine, valine, isoleucine,leucine, and phenylalanine.

In addition, formula (F_1T) had the highest level of total essential amino acid (32.13 g/100 g protein). In contrast, formula (F_2S) had the least value (18.06 g/ 100g protein) of total essential amino acids.

Moreover, formula (F_2S) had the highest level of total non essential amino acids (74.95 g/ 100g protein). In contrast, formula (F_3S) had the least value (55.37 g/ 100 g protein) of total non essential amino acids.

Table (3): Amino acid content (g amino acid / 100g protein) of the Scool student Formulae and FAO /WHO /UNU (1985) suggested patterns of human amino acid requirements.

Amino acid	Formulae						FAO/WHO/UNU (1985)		
(g/100g protein)	F_1S	F_2S	F_3S	F_1T	F_2T	F_3T	infant	Preschool child	School child
Essential									
Threonine	2.08	1.65	1.86	2.05	3.32	2.83	4.6	2.8	2.8
Valine	3.65	2.34	3.45	4.90	3.96	4.31	9.3	6.6	4.4
Methionine	1.54	0.62	0.51	1.34	1.31	2.15	6.6	5.8	4.4
Isoleucine	2.69	1.93	4.42	5.33	3.78	2.76	4.2	2.5	2.2
Leucine	7.73	4.34	7.12	9.61	7.28	6.85	7.2	6.3	2.2
Phenylalanine	4.68	2.66	5.43	4.64	3.71	4.16	4.3	3.4	2.8
Lysine	2.50	2.58	3.73	2.52	4.99	3.19	1.7	1.1	0.9
Tryptophan	1.67	1.94	1.98	1.74	2.15	2.12	5.5	3.5	2.5
Total E.A.A*	26.54	18.06	28.5	32.13	30.5	28.37			
Non-essential									
Histidine	2.09	1.49	2.0	2.99	2.02	2.20			
Arginine	7.09	3.86	6.27	6.98	4.93	6.86			
Aspartic acid	9.08	4.18	8.93	9.53	9.17	9.14			
Serine	4.71	1.92	3.59	3.86	3.68	3.19			
Glutamic acid	24.75	13.77	19.68	24.31	21.75	21.90			
Proline	3.88	1.83	3.29	4.07	3.13	3.71			
Alanine	4.20	23.18	2.83	4.55	3.77	3.53			
Cystine	1.59	1.09	1.75	1.61	1.93	1.56			
Tyrosine	2.69	1.44	3.65	2.22	2.26	2.31			
Glycine	4.53	22.19	3.38	4.32	3.77	3.79			
Total non E.A.A**	64.61	74.95	55.37	64.44	56.41	58.19			
E.A.A./nonE.A.A	41.08	24.09	51.47	49.86	54.07	48.75			

* E.A.A (Essential Amino Acid)

** non.E.A.A (non Essential Amino Acid)

The results of E.A.A. / non E.A.A. ratio ranged between 24.09 for formula (F_2S) and 54.07 for formula (F_2T).

Chemical score is one of the most convenient parameters in determining the protein quality. Chemical score as outlined in Table (4) based on the FAO/WHO/UNU scoring pattern (1985) indicated that in formula (F_1S) when whole egg and human milk were used as reference protein, the first limiting amino acid was lysine and threonine was the second.

In formula (F_2S) when whole egg was used as the reference protein, the first limiting amino acid was valine and threonine was the second limiting amino acid. But when human milk was used as reference protein, the first limiting amino acid was threonine and isoleucine and lysine was the second.

In formula (F_3S) when whole egg and human milk were used as the reference protein, the first was methionine and threonine was the second.

In formula (F_1T) when whole egg was used as the reference protein, the first limiting amino acid was phenylalanine and threonine and lysine was the second limiting amino acid. But when human milk was used as reference protein, the first limiting amino acid was lysine and threionine was the second limiting amino acid.

In formula (F_2T) when whole egg was used as the reference protein, the first limiting amino acid was methionine and valine was the second. But when human milk was used as reference protein, the first limiting amino acid was threonine and lysine, while isoleucine was the second limiting amino acid. In formula (F_3T) when whole egg was used as the reference protein, the first limiting amino acid was isoleucine and lysine was the second. But when human milk was used as reference protein, the first limiting amino acid was lysine and isoleucine was the second.

Table (5) illustrated A/E ratio between an individual essential amino acid content (mg) and total essential amino acid content (g) of studied student formulae as compared with FAO requirement patterns of school child and adult (1985).

Table (5): A/E ratio (mg essential amino acid /g of total essential amino acids) of the studied school student formulae**.**

Essential Amino Acid(mg/g)	FAO/WHO/UNU (1985)		Formulae					
	School child	Adult	F_1S	F_2S	F_3S	F_1T	F_2T	F_3T
Threonine	126	81	78	91	65	64	109	100
Valine	112	117	138	130	121	152	130	152
Methionine	99	153	58	34	18	42	43	76
Isoleucine	126	117	101	107	155	166	124	97
Leucine	198	171	291	240	250	309	239	241
Phenylalanine	99	171	176	147	191	144	122	147
Lysine	198	144	94	143	131	78	164	112
Tryptophan	40	45	63	107	69	54	70	75

From such results it could be noticed that all the studied student formulae were considered as a rich source of valine (138, 130, 121, 152, 130, and 152); leucine (291, 240, 250, 309, 239, and 241); and tryptophan (63, 107, 69, 54, 70, and 75) for F_1S, F_2S, F_3S, F_1T, F_2T. and F_3T; respectively.

Generally, all the studied student formulae had medium A/E ratios for threionine, isoleucine, and phenylalanine. And a low A/E ratio for methionine and lysine.

The protein efficiency ratio (PER) and biological value (BV) of the studied student formulae, were calculated from amino acids content and equations of both Alsmeyer *et al.* (1974) and Oser (1959). The results are shown in Table (6).

Table (6): Computation of protein efficiency ratio (PER) And biological value (BV) of school student formulae.

Ratio	F_1S	F_2S	F_3S	F_1T	F_2T	F_3T
PER	2.66	1.20	2.40	3.50	2.49	2.26
BV	77.09	61.73	74.36	85.94	75.31	72.89

The results indicated that formula (F_1T) had the highest values 3.5, 85.94 of (PER) and (BV), followed by formula (F_1S) having the following corresponding values 2.66 and 77.09; respectively. Meanwhile formulae (F_3S), (F_2T) and (F_3T) had very close values of PER and BV.

These values of PER and BV had the highest comparing with the values recorded by Sayed (2000).

Fatty acid content of studied school student formulae:

The values for fatty acid content of the studied student formulae are shown in Table (7).

It could be noted from Table (7) that oleic and lenoleic acids had the highest values of the fatty acids of all the studied student formulae. Meanwhile, palmitic acid represented the highest level in formula (F_3T) (11.9%). and the least level in formula (F_2T) (7.1%).

Stearic acid had the highest level in formula (F_2S) (4.6%). and the least level in formula (F_1S) (2.3%).

Lenolenic acid had the highest level in formula (F2S) (3.7%). and the least level in formula (F_1S) and formula (F_1T) (0.3%)

Arachidic acid had the highest level in formula (F_1T) (8.4%). and the least level in formula (F_2S) and formulae (F_2T) (0.4%).

Furthermore, Table (7) revealed that the mean values of saturated fatty acids (SFA) ranged from 10.5% to 23% for (F_2T) and (F_1T); respectively. While the mean values of USFA (Unsaturated Fatty Acids) ranged from 80.1% to 89.5% for (F_3S) and (F_2T); respectively.

Such findings partially agree with Sayed (2000) due to the variations in the ingredients of the studied student formulae.

Table (7): Fatty acid content of the studied school student formulae (% of total fatty acids).

Fatty acid	Carbon chain	F_1S	F_2S	F_3S	F_1T	F_2T	F_3T
Palmitic	C16:0	10.0	10.5	11.5	11.7	7.1	11.9
Stearic	C18:0	2.3	4.6	2.7	2.9	3.0	2.7
Oleic	C18:1	53.6	33.7	43.4	47.5	55.4	43.0
Lenoleic	C18:2	31.6	47.0	36.1	34.5	31.9	37.0
Lenoleneic	C18:3	0.3	3.7	0.6	0.3	2.2	1.1
Arachidic	C20:0	0.9	0.4	1.2	8.4	0.4	1.0
	Un1*	1.5	----	1.0	2.0	----	1.0
	Un2*	----	----	2.2	----	----	2.1
	Un3*	----	----	1.1	----	----	----
SFA**		13.2	15.5	15.4	23	10.5	15.6
USFA***		85.5	84.4	80.1	82.3	89.5	81.1
SFA/USFA		0.15	0.18	0.19	0.28	0.12	0.19

* Un1, Un2, Un3 = Unknown 1, Unknown 2, and Unknown 3.

** Saturated Fatty Acid. *** Un saturated Fatty Acid.

In conclusion the nutritional evaluation of the six recommended school student formulae revealed that these mixtures were of a high nutritive value containing appreciable amounts of nutrients and minerals.

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التقييم الغذائي لست تركيبات غذائية جديدة لتغذية طلاب المدارس محضرة من بعض الحبوب والبقوليات

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يعتبر الهدف الرئيسي من أغذية طلاب المدارس هو عملية تدعيم وجبة الطالب داخل المدرسة بالدرجة الأولى بالعناصر الغذائية الرئيسية خلال فترة تواجده بالمدرسة وذلك لما يتطلبه جسم الطالب من احتياجات سعرية وعناصر غذائية أثناء فترة الدراسة.

ويعتبر من أفضل برامج تغذيه طلاب المدارس تلك التي يستخدم في تحضيرها منتجات الحبوب المدعمة بواسطة أحد مصادر البروتين المتاحة وتشتمل هذه المصادر على مختلف أنواع البقوليات والحبوب والبذور الزيتية واللبن الفرز.

وقد هدفت هذه الدراسة إلى تحضير ستة تركيبات غذائية جديدة لأطفال وطلاب المدارس محضرة من بعض الحبوب والبقوليات(القمح. الذرة. الشعير. الأرز. فول الصويا. السمسم. الحمص. الفول السوداني. العدس) بالإضافة إلي البلح. والمتوفرة في صوره خام والمعاملة والمتميزة برخص ثمنها.

كما تناولت الدراسة تقدير التركيب الكيميائي العام لجميع التركيبات الغذائية التي تم تجهيزها من حيث الرطوبة والبروتين والدهن والألياف والرماد وكذلك الكربوهيدرات والقيمة السعرية والتركيب المعدني لها، هذا بالإضافة إلي تقدير كل من الأحماض الأمينية والأحماض الدهنية.

ويمكن تلخيص النتائج كما يلي:

* تراوحت نسبة البروتين الخام في التركيبات الغذائية الستة المحضرة ما بين 11.45 – 25.52% على أساس الوزن الجاف وذلك للتركيبات F_1S، F_2Tعلى التوالي. ولهذا فأن معظم الفورمولات المدروسة تعتبر مصدرا غنيا بالبروتين بمقارنتها بالمواصفات.

* أوضحت النتائج أن التركيبات الغذائية قد سجلت محتوى من الدهن الخام تراوح ما بين6.75– 14.51 % وذلك للفورمولات F_2T ، F_2Sعلى التوالي.

* سجلت التركيبه F_1T أعلى قيمة من الكربوهيدرات وكانت 71.89%. وعلى النقيض كانت الفورمولا F_2T محتوية على نسبة 54.14% من الكربوهيدرات.

* سجلت التركيبه F_1Sأعلى قيمة سعريه (كيلو كالوري/ 100 جم جاف) (436.11) وتلتها الفورمولا F_2S (433.92) ثم الفورمولا F_3S (432.57).

* وجد أن جميع التركيبات الغذائية المدروسة قد احتوت على قيم مرتفعة بالنسبة لعناصر الكالسيوم والماغنسيوم والبوتاسيوم والفسفور.

أما بالنسبة للحديد فقد احتوت جميع التركيبات على قيم متقاربة من هذا العنصر فاقت تلك الموصى بها في المعدلات اليومية للطلاب.

* دلت نتائج التركيب الحامضي الأميني للتركيبات الستة المدروسة أن محتواها من الأحماض الأمينية الضرورية (ثريونين، ايزوليوسين، ليوسين، فينيل الانين، ليسين) قد تفوقت في المحتوى عن القيم الموصي بها بواسطة (1985).FAO/WHO/UNU.

* دلت نتائج الأحماض الدهنية ارتفاع محتوى التركيبات الستة المدروسة من الأحماض الدهنية الأولييك واللينوليك، بينما تبين انخفاض محتواها من الحامض الدهني اللينولينيك.

* وجد أن التركيبات (F_2S، F_2T، F_3T) احتوت علي أعلي قيم لحامض اللينولينيك حيث بلغت هذه القيم (1,1 – 2,2- 3,7) من الأحماض الدهنية الكلية علي الترتيب .

بصفة عامة فان التركيبات الغذائية المحضرة من خلطات بعض الحبوب والبقوليات توفر وجبات غذائية متزنة لطلاب المدارس من حيث احتوائها علي العناصر الغذائية اللازمة لهم.