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 F1S, F2T, 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 F2T, F3S, respectively.

While the carbohydrates was highest 71.89% (F1T), 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 F3S followed by formula F1S (433.92) then formula F2S (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 (F2S, F2T, and F3T) 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. Furthermore, 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 to 12 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 sativa*): 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 ambient 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 ambient temperature for 48 hrs. The germinated grains were sun dried for 10 hrs. Then corn grains were de rooted, 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 ambient 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 Griffith 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 ambient temperature for 12 hrs. The presoaked seeds were allowed to germinate for 72 hrs in the dark at ambient 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-(F₁S) skim milk (5 %); sucrose (5 %); dry dates (30 %); corn flour (40 %); peanut flour (20 %).

2-(F₂S) skim milk (5 %); sucrose (5 %); soybean flour (30 %); wheat flour (40 %); sesame flour (10 %); lentil (10 %).

3-(F₃S) skim milk (5 %); sucrose (5 %); barley flour (30 %); rice (20 %); peanut flour (20 %); chick pea flour (20 %).

4-(F₁T) skim milk (5 %); sucrose (5 %); dry dates (30 %); germinated corn flour (40 %); roasted Peanut (20 %).

5-(F₂T) skim milk (5 %); sucrose (5 %); cooked soybean flour (30 %); germinated wheat flour (40 %); roasted sesame flour (10 %); germinated sprouted lentil (10 %).

6-(F₃T) 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:

\[
\text{PER} = -0.684 + 0.456(\text{leucine}) - 0.047(\text{proline}) \, (\text{gm/100 gm protein})
\]

**Computation of Biological Value (BV):**

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

\[
\text{BV} = 49.9 + 10.53 \times \text{(PER)}
\]

**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 F1T and F2S, respectively.

The total protein of prepared student formulae varied between 11.45 and 25.52%. The least protein value was obtained for formula (F1S), while the highest protein value was obtained for formula (F2T).

The protein content of formula F1S (11.45%) was lower than protein content of formula F1T (13.57%). Likewise, the mean protein content of F2S (21.61%) was lower than protein content of F2T (25.52%); and protein content of F3S (15.81%) was lower than protein content of F3T (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 F₂T 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 F₂T (6.75%) and formula F₂S (14.51%). However, fat content of formula F₁S (11.36%) was higher than fat content of formula F₁T (6.99%); fat content of formula F₃S (14.51%) was higher than fat content of formula F₂T (6.75%); fat content of formula F₃S (11.21%) was higher than fat content of formula F₁T (9.23%).

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

<table>
<thead>
<tr>
<th>Estimates ( % )</th>
<th>Formulae</th>
<th>F₁S</th>
<th>F₂S</th>
<th>F₃S</th>
<th>F₁T</th>
<th>F₂T</th>
<th>F₃T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td></td>
<td>6.67</td>
<td>7.33</td>
<td>7.17</td>
<td>4.00</td>
<td>6.67</td>
<td>4.67</td>
</tr>
<tr>
<td>Crude protein</td>
<td></td>
<td>11.45</td>
<td>21.61</td>
<td>15.81</td>
<td>13.57</td>
<td>25.52</td>
<td>19.07</td>
</tr>
<tr>
<td>Ash</td>
<td></td>
<td>2.38</td>
<td>3.46</td>
<td>2.26</td>
<td>1.99</td>
<td>3.50</td>
<td>2.31</td>
</tr>
<tr>
<td>Crude fiber</td>
<td></td>
<td>3.34</td>
<td>5.64</td>
<td>3.61</td>
<td>5.55</td>
<td>10.09</td>
<td>4.95</td>
</tr>
<tr>
<td>Carbohydrate**</td>
<td></td>
<td>71.47</td>
<td>54.77</td>
<td>67.11</td>
<td>71.89</td>
<td>54.14</td>
<td>64.44</td>
</tr>
<tr>
<td>Caloric value (K.cal/100g)</td>
<td></td>
<td>433.92</td>
<td>436.11</td>
<td>432.57</td>
<td>404.75</td>
<td>379.39</td>
<td>417.11</td>
</tr>
</tbody>
</table>

* 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 F₂T followed by formulae F₂S, F₁S, F₃T, F₃S, and F₁T 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 F₁S and F₂T, 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 F₂T (54.14%) while formula F₁T 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 (F₁S) had the highest values of magnesium (1680), while formula (F₂S) had the highest values of manganese (4.15), calcium (1400) and potassium (850).

Formula (F₃S) had the highest value of calcium (1400), while formula (F₂T) had the highest values of sodium (200) and phosphorus (793.1). On the other hand formula (F₁T) 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 (F₂S), (F₁S) and (F₁T) had the same values of sodium (50).

Table (2) revealed that formulae (F₁S) and (F₁T) had the same values of sodium (100),
Meanwhile formulae \((F_3S)\), potassium (550); and \((F_1T)\); 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).

<table>
<thead>
<tr>
<th>Formulae</th>
<th>Minerals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fe</td>
</tr>
<tr>
<td>(F_1S)</td>
<td>20.45</td>
</tr>
<tr>
<td>(F_2S)</td>
<td>42.10</td>
</tr>
<tr>
<td>(F_3S)</td>
<td>27.62</td>
</tr>
<tr>
<td>(F_1T)</td>
<td>27.95</td>
</tr>
<tr>
<td>(F_2T)</td>
<td>22.02</td>
</tr>
<tr>
<td>(F_3T)</td>
<td>45.07</td>
</tr>
</tbody>
</table>

**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 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 \((18.06 \, g/100 \, g \, protein)\) of total essential amino acids.

Moreover, formula \((F_2S)\) had the highest level of total non essential amino acids \((74.95 \, g/100 \, g \, protein)\). 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 School student Formulae and FAO /WHO /UNU (1985) suggested patterns of human amino acid requirements.

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>Formulae</th>
<th>FAO/WHO/UNU (1985)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F₁S</td>
<td>F₂S</td>
</tr>
<tr>
<td>Essential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threonine</td>
<td>2.08</td>
<td>1.65</td>
</tr>
<tr>
<td>Valine</td>
<td>3.65</td>
<td>2.34</td>
</tr>
<tr>
<td>Methionine</td>
<td>1.54</td>
<td>0.62</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>2.69</td>
<td>1.93</td>
</tr>
<tr>
<td>Leucine</td>
<td>7.73</td>
<td>4.34</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>4.68</td>
<td>2.66</td>
</tr>
<tr>
<td>Lysine</td>
<td>2.50</td>
<td>2.58</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>1.67</td>
<td>1.94</td>
</tr>
<tr>
<td>Total E.A.A</td>
<td>26.54</td>
<td>18.06</td>
</tr>
<tr>
<td>Non-essential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Histidine</td>
<td>2.09</td>
<td>1.49</td>
</tr>
<tr>
<td>Arginine</td>
<td>7.09</td>
<td>3.86</td>
</tr>
<tr>
<td>Serine</td>
<td>4.71</td>
<td>1.92</td>
</tr>
<tr>
<td>Glutamic acid</td>
<td>24.75</td>
<td>13.77</td>
</tr>
<tr>
<td>Proline</td>
<td>3.88</td>
<td>1.83</td>
</tr>
<tr>
<td>Alanine</td>
<td>4.20</td>
<td>23.18</td>
</tr>
<tr>
<td>Cystine</td>
<td>1.59</td>
<td>1.09</td>
</tr>
<tr>
<td>Tyrosine</td>
<td>2.69</td>
<td>1.44</td>
</tr>
<tr>
<td>Glycine</td>
<td>4.53</td>
<td>22.19</td>
</tr>
<tr>
<td>Total non E.A.A</td>
<td>64.61</td>
<td>74.95</td>
</tr>
<tr>
<td>E.A.A./nonE.A.A</td>
<td>41.08</td>
<td>24.09</td>
</tr>
</tbody>
</table>

* 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 (F₁S) and 54.07 for formula (F₂T).

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 (F₁S) 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 (F₂S) 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 lysine and threonine was the second.

In formula (F₃S) when whole egg and human milk were used as the reference protein, the first limiting amino acid was methionine and threonine was the second.

In formula (F₁T) 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 threonine was the second limiting amino acid.

In formula (F₂T) 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 (F₃T) 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.

<table>
<thead>
<tr>
<th>Essential Amino Acid (mg/g)</th>
<th>FAO/WHO/UNU (1985)</th>
<th>Formulae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>School child</td>
<td>Adult</td>
</tr>
<tr>
<td>Threonine</td>
<td>126</td>
<td>81</td>
</tr>
<tr>
<td>Valine</td>
<td>112</td>
<td>117</td>
</tr>
<tr>
<td>Methionine</td>
<td>99</td>
<td>153</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>126</td>
<td>117</td>
</tr>
<tr>
<td>Leucine</td>
<td>198</td>
<td>171</td>
</tr>
<tr>
<td>Phenylalanine</td>
<td>99</td>
<td>171</td>
</tr>
<tr>
<td>Lysine</td>
<td>198</td>
<td>144</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>40</td>
<td>45</td>
</tr>
</tbody>
</table>

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 F₁S, F₂S, F₃S, F₁T, F₂T, and F₃T, respectively.

Generally, all the studied student formulae had medium A/E ratios for threonine, 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.

<table>
<thead>
<tr>
<th>Ratio</th>
<th>F₁S</th>
<th>F₂S</th>
<th>F₃S</th>
<th>F₁T</th>
<th>F₂T</th>
<th>F₃T</th>
</tr>
</thead>
<tbody>
<tr>
<td>PER</td>
<td>2.66</td>
<td>1.20</td>
<td>2.40</td>
<td>3.50</td>
<td>2.49</td>
<td>2.26</td>
</tr>
<tr>
<td>BV</td>
<td>77.09</td>
<td>61.73</td>
<td>74.36</td>
<td>85.94</td>
<td>75.31</td>
<td>72.89</td>
</tr>
</tbody>
</table>

The results indicated that formula (F₁T) had the highest values 3.5, 85.94 of (PER) and (BV), followed by formula (F₁S) having the following corresponding values 2.66 and 77.09; respectively. Meanwhile formulae (F₃S), (F₂T) and (F₁T) 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 (F₁T) (11.9%). and the least level in formula (F₂T) (7.1%).

Stearic acid had the highest level in formula (F₂S) (4.6%). and the least level in formula (F₁S) (2.3%).

Lenolenic acid had the highest level in formula (F₂S) (3.7%). and the least level in formula (F₁S) and formula (F₁T) (0.3%).

Arachidic acid had the highest level in formula (F₁T) (8.4%). and the least level in formula (F₂S) and formulae (F₂T) (0.4%).

Furthermore, Table (7) revealed that the mean values of saturated fatty acids (SFA) ranged from 10.5% to 23% for (F₁T) and (F₁T); respectively. While the mean values of USFA (Unsaturated Fatty Acids) ranged from 80.1% to 89.5% for (F₂S) and (F₂T); 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).

<table>
<thead>
<tr>
<th>Fatty acid</th>
<th>Carbon chain</th>
<th>F₁S</th>
<th>F₂S</th>
<th>F₃S</th>
<th>F₁T</th>
<th>F₂T</th>
<th>F₃T</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmitic</td>
<td>C16:0</td>
<td>10.0</td>
<td>10.5</td>
<td>11.5</td>
<td>11.7</td>
<td>7.1</td>
<td>11.9</td>
</tr>
<tr>
<td>Stearic</td>
<td>C18:0</td>
<td>2.3</td>
<td>4.6</td>
<td>2.7</td>
<td>2.9</td>
<td>3.0</td>
<td>2.7</td>
</tr>
<tr>
<td>Oleic</td>
<td>C18:1</td>
<td>53.6</td>
<td>33.7</td>
<td>43.4</td>
<td>47.5</td>
<td>55.4</td>
<td>43.0</td>
</tr>
<tr>
<td>Lenoleic</td>
<td>C18:2</td>
<td>31.6</td>
<td>47.0</td>
<td>36.1</td>
<td>34.5</td>
<td>31.9</td>
<td>37.0</td>
</tr>
<tr>
<td>Lenoleneic</td>
<td>C18:3</td>
<td>0.3</td>
<td>3.7</td>
<td>0.6</td>
<td>0.3</td>
<td>2.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Arachidic</td>
<td>C20:0</td>
<td>0.9</td>
<td>0.4</td>
<td>1.2</td>
<td>8.4</td>
<td>0.4</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Un1*</td>
<td>1.5</td>
<td>----</td>
<td>1.0</td>
<td>2.0</td>
<td>----</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Un2*</td>
<td>----</td>
<td>----</td>
<td>2.2</td>
<td>----</td>
<td>----</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>Un3*</td>
<td>----</td>
<td>----</td>
<td>1.1</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>SFA**</td>
<td></td>
<td>13.2</td>
<td>15.5</td>
<td>15.4</td>
<td>23</td>
<td>10.5</td>
<td>15.6</td>
</tr>
<tr>
<td>USFA***</td>
<td></td>
<td>85.5</td>
<td>84.4</td>
<td>80.1</td>
<td>82.3</td>
<td>89.5</td>
<td>81.1</td>
</tr>
<tr>
<td>SFA/USFA</td>
<td></td>
<td>0.15</td>
<td>0.18</td>
<td>0.19</td>
<td>0.28</td>
<td>0.12</td>
<td>0.19</td>
</tr>
</tbody>
</table>

*  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.
References


Griffith, L.D.; M.E. Castell-Perez, and M.E. Griffith. 1998. Effects of blend and processing method on the nutritional quality of weaning foods made from select


التقييم الغذائي لست تركيبات غذائية جديدة لتنمية طلاب المدارس

تمكّن السيد يوسف، ماجدة عبد الحميد أحمد سليم، هشام زكريا توفيق
قسم علوم وتقنية الأغذية - كلية الزراعة - جامعة أسيوط.

يعتبر الهدف الرئيسي من أغذية طلاب المدارس هو العملية تدعيم وجبة الطالب داخل المدرسة بالدرجة الأولى. يتناول هذا الهدف إذاً من الضروري أن تكون جميع أسطوانات طلاب المدارس تلك التي يستخدم في تحضيرها منتجات الحبوب المدعومة بواسطة أحد مصادر البروتين المتاحة والثمينة، خاصة تلك المصادر التي تكون بالبودرة، والفواكه والشاي والشاي الخضراء.

وقد هدفت هذه الدراسة إلى تحقيق ستة تركيبات غذائية جديدة لأطفال وطلاب المدارس محضرة من بعض الحبوب والبقوليات (القمح، الذرة، الشعير، الأرز، فول الصويا، السمسم، الحمص، البروتينات، الشاي) بالإضافة إلى البلح، والمتوفرة في صوره خام ومتعممة وتبنيها.

كما 다نتلنت الدراسة تقدير التركيب الكيميائي للغذاء لجميع التركيبات الغذائية التي تم تجهيزها من حيث البروتين والدهن والألياف والمواد وكذلك الكربوهيدرات والقيمة السعرية والتركيب المغذي لهذا بالإضافة إلى تقديم كل من الأحماض الأمينية والأحماض الهيدروكربونية والكربوهيدرات.

ويمكن تلخيص النتائج كما يلي:
- تراوحت نسبة البروتين الخام في التركيبات الغذائية تسترة المحضرة ما بين 11.45% - 25.52% على أساس الوزن الجاف وذلك للفورمولات F1S، F2T، على التوالي. ولهذا فإن معظم الفورمولات المحضرة تعتبر مصدر غذاء غني بالبروتينات بمقارنتها بالمواصفات.
- أوضحت النتائج أن التركيبات الغذائية قد سجلت محتوى من النزيف الخام تراوح ما بين 6.75 – 14.50% وذلك للفورمولات F2T، F3T على التوالي.
- سجلت التركيب F1T أعلى قيمة من الكربوهيدرات وكانت 71.89%. وعلى النقيض سجلت التركيب F1S كانت الفورمولات F2S، F3S محتوية على نسبة 54.14% من الكربوهيدرات.
- تقلل من تركيب F1S، F2T، F3S أقصى قيمة سعرية (كمال جالوري/100 جم جاف) (436.11) ونكتهن الفورمولات F3S، (433.92) ثم الفورمولات F2S، (432.57).
- وجد أن جميع التركيبات الغذائية المدرسية قد احتوت على قيم متوافقة بالنسبة لعناصر الكالسيوم، والمغنيسيوم والبوتاسيوم والفسفور.
- أما بالنسبة للحديد فقد احتوت جميع التركيبات على قيم متوافقة من هذا العنصر. فلم تتجاوز تلك الموصى بها في المعدلات اليومية للطفل.
دلت نتائج الأحماض الدهنية ارتفاع محتوى التركيبات الستة المدروسة من الأحماض الدهنية الأوليك واللينوليك، بينما تبين انخفاضاً محتواها من الحامض الدهني الリンولينيك.

وُجد أن التركيبات (F₁T، F₁S، F₂T، F₂S) احتوت على أعلى قيم لحامض اللفونولينيك حيث بلغت هذه القيم (1,1 – 2,2 - 3,7) من الأحماض الدهنية الكلية على الترتيب.

بصفة عامة فإن التركيبات الغذائية المحضرة من خلطات بعض الحبوب والبقوليات توفر وجبات غذائية متنوعة لطلاب المدارس من حيث احتوائها على العناصر الغذائية اللازمة لهم.