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# Protein-rich food mixtures for feeding the young in Egypt
# 1. Formulation

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Considerable amount of work has been carried out during recent years on the development of protein-rich food mixtures for feeding the young in developing countries (1–8). All food mixtures prepared by different authors use, in one way or another, milk or one of its products as the main source of protein in their preparations. In Egypt, as in many other developing countries, the production of milk is not sufficient to supply the needs of the population (9, 10). Milk production is seasonal, it is not available at least for some time during the year. For that reason, efforts have been made to use protein-rich vegetables in preparation of food mixtures suitable for feeding infants and pre-school children (9–12).

Inspite of the fact that so many formulae of protein-rich food mixtures were suggested by many schools, none of them were commercially successful, either because they are not formed from available foods, which are within the economic abilities of the populations, or they are not acceptable by mothers and children and are not in agreement with the existing food habits.

Trials were made for the preparation of food mixtures based on popular dishes that are easily prepared and well liked by most of the Egyptians. An example of such recipes are Fayesh, Belila, Kishk and Koshari. These popular dishes together with other legumes and cereals were introduced in our designed food mixtures. The following nutritional studies were undertaken on such mixtures.

## Experimental
## Materials and methods

The ingredients used in this study are: cereals including rice and wheat; legumes including lentils, chick pea; fenugreek, soybean and sunflower; oil seeds such as sesame and peanut flour; tubers: potato flakes; skim milk and yeast.

Some of our ingredients were either cooked or processed before use. These are polished rice, decorticated lentils and chick peas.

Cooking in water was done in a pressure cooker. Rice and wheat were cooked for 10 minutes, lentils for 20 minutes and chickpeas for 30 minutes. The cooked ingredients were left to cool, spread on trays at one centimeter depth, then left to

dry in an air-drying oven at 60 °C till dry. The chickpea seeds were dropped in boiling water for 2 minutes before cooking in order to remove the seed coat.

After cooking and drying, all ingredients were ground to fine powder in a mechanical grinder and stored in polyethene bags for analysis and for use in preparation of mixtures.

Lime roasted chickpeas were purchased from the local market. It has a golden yellow colour, rich in protein and calcium.

Peanut seeds were also purchased from the local market. They were roasted in drying oven at a low temperature, then left to cool. Peanut kernels (decorticated seeds) were ground into a thick paste using an electric blender. The peanut butter obtained was pressed in a hydraulic press to get rid of most of the oil. The dry cake obtained was washed several times with ether. A fine peanut flour was obtained, left in air for one hour, then a current of hot air was passed over the defatted peanut flour till it became free from any traces of ether.

Crushed sesame seeds (tehena or sesame porate) were purchased from the local market. Oil was separated from tehena by filtering it through a Buchner funnel using vacuum. The cake was pressed in a hydraulic press. Oil left in the cakes was removed, and sesame flour was prepared as described before in the preparation of the peanut flour.

*Other food commodities used in preparation of protein-rich food mixtures*

Among the popular dry food commodities used in our study are Kishk and Fayesh. They are rich in protein and are consumed by a large sector of the population. Kishk and Fayesh were home-made especially for our work.

Kishk is a fermented wheat-milk mixture, very common in most of the Arab world. It is a very popular food in upper Egypt. It is made of Laban Zeer (condensed sour milk) and wheat grains. The method of preparation of Kishk is described before by Morcos (13).

Fayesh is a home-made popular cake used in upper Egypt. It is prepared from white wheat flour, milk powder and fat.

*Determination of macronutrients*

The following analyses were undertaken on each one of the ingredients used in the preparation of all the food mixtures. Moisture, protein, fat, ash, fiber, calcium, phosphorus and iron were determined according to the O.A.A.C. (14). Total carbohydrates were determined by difference.

*Determination of amino acids*

The amino acid patterns and contents of each of the test ingredients were determined after being hydrolysed with 6N-HCl, according to Khan and Baker (15). Measured amounts of the acid hydrolysates were spotted on Whatman No. 1 filter paper. Ascending paper chromatography technique was carried out using the buffered method of Levey and Chung (16). Under these conditions of hydrolysis, tryptophan was completely oxidised, and cystein and methionine so damaged that accurate estimation of these amino acids following hydrolysis was impossible. This effect of protein hydrolysis in the presence of large quantities of carbohydrates has been noticed by Lewis (17, 18), who observed that methionine was partially oxidised to its sulphoxides and cystine almost completely lost. The loss of cystine is possibly due to its combination with reducing sugars, consequently methionine, cystine and tryptophan have had to be assayed separately by different techniques.

Cystine and methionine were oxidised with performic acid, then determined according to the method of Jamalian and Pellet (19). The colorimetric method of Blauthi, Charezinski and Berbec (20), was followed for estimation of tryptophan in the alkali hydrolysate.

Ten protein-rich baby food mixtures, $AN_{70}$, $AN_{71}$ ----- $AN_{79}$ were formulated on the basis of the analysis of the ingredients. The macronutrients of the suggested mixtures were also determined. The prepared formulated food mixtures were stored in polyethane bags under refrigeration for further nutritional studies (table 1).

## Results

Table 1 shows the macronutrients content of raw ingredients. Dry yeast contains the highest percentage of protein (43.0 %), while rice contains the lowest amount of protein. Legumes come in between where their protein content ranges from 33.5 % in soybean to 19.0 % in chick pea. Table 2 shows the macronutrients content of cooked ingredients. Tables 3, 4 and 5 show the contents of roasted ingredients (peanut, chick pea and sesame) and the prepared ingredients (Fayesh and Kishk). Table 6 shows the essential amino acid content of different ingredients used in the formulation of our protein-rich food mixtures. Sesame flour is rich in sulphur-containing amino acids (289 mg/gN). Parboiled wheat and sesame are the poorest sources of lysine. Table 7 shows the macronutrients content of the formulated food mixtures. Their protein content ranges from 23.2 % to 17.7 %.

## Discussion

For the preparation of our food mixtures some legumes and only seeds commonly cultivated in the country were used. The mixtures were prepared on the basis of the fact that legumes are deficient in sulphur-containing amino acids (methionone and cystine), whereas cereals are deficient in lysine. Mixing legumes with cereals raised the nutritive value of the mixtures. It was found that treatment of such protein sources by heat either through boiling, roasting, cooking or autoclaving caused a marked improvement in their taste. Some of the ingredients used in the formulation of the food mixtures were heat-treated before being used in order to get rid of their antinutritional factors, to raise their digestibility and to make their constituent amino acids more available as it was advised before (21–25). This was confirmed by the preliminary panel test.

Chemical analysis proved that such treatments have little effect on the percentage of nutrients found in these ingredients, which is in accordance with the results reached before (26, 27). The protein content of our formulated mixtures ranged from 17.7 to 23.2 g %, which is in agreement with the recommendations of The United Nations for the protein requirements for children (28).

Concerning the protein quality of our formulated food mixtures, they are considered to be a supplement to the ordinary diet given to the children in Egypt, which is poor in protein. Defatted sesame flour was incorporated in all the formulated mixtures in order to raise their level of sulphur-containing amino acids and to make their pattern of amino acids near to the provisional amino acid pattern recommended by the FAO (29), as it is already known that sesame flour is the richest source of sulphur-containing amino acids in all seeds.

Table 1. Formulated protein-rich food mixtures.

| No. | Mixture | Ingredients | g/100 g |
|---|---|---|---|
| 1 | AN 70 | Polished rice | 40 |
| | | Decorticated lentils, cooked | 30 |
| | | Defatted sesame flour | 20 |
| | | Skimmed milk powder | 10 |
| 2 | AN 71 | Polished rice | 35 |
| | | Roasted chick peas, dehulled | 30 |
| | | Maize flour | 10 |
| | | Defatted sesame flour | 10 |
| | | Skimmed milk powder | 15 |
| 3 | AN 72 | Parboiled wheat | 60 |
| | | Roasted chick peas, dehulled | 18 |
| | | Dry yeast | 2 |
| | | Defatted sesame flour | 10 |
| | | Skimmed milk powder | 10 |
| 4 | AN 73 | Fayesh | 60 |
| | | Roasted chick peas, dehulled | 20 |
| | | Defatted sesame flour | 10 |
| | | Skimmed milk powder | 10 |
| 5 | AN 74 | Fayesh | 70 |
| | | Defatted soy flour | 10 |
| | | Defatted sesame flour | 10 |
| | | Skimmed milk powder | 10 |
| 6 | AN 75 | Parboiled wheat | 50 |
| | | Cooked chick peas | 20 |
| | | Defatted sun flower kernels | 10 |
| | | Defatted sesame flour | 10 |
| | | Skimmed milk powder | 10 |
| 7 | AN 70 | Fayesh | 30 |
| | | Cooked decorticated lentils | 15 |
| | | Cooked polished rice | 20 |
| | | Cooked chick peas | 15 |
| | | Defatted sesame flour | 20 |
| 8 | AN 77 | Cooked dried potato flakes | 40 |
| | | Cooked chick peas | 20 |
| | | Defatted sesame flour | 30 |
| | | Skimmed milk powder | 10 |
| 9 | AN 78 | Maize bread containing 5% fenugreek flour | 50 |
| | | Defatted soy flour | 25 |
| | | Dry yeast | 5 |
| | | Skimmed milk powder | 20 |
| 10 | AN 79 | Kisk | 50 |
| | | Maize flour baked with | 20 |
| | | Fenugreek flour | 15 |
| | | Cooked decorticated lentils | 5 |
| | | Skimmed milk powder | 10 |

Table 2. Macronutrients of raw ingredients.

| Sample | Moist. g% | Prot. g% | Fat g% | Ash g% | Fibre g% | Carbo. g% | Calc. mg% | Phosp. mg% | Iron mg-% |
|---|---|---|---|---|---|---|---|---|---|
| Lentils | 9.5 | 24.13 | 1.10 | 2.10 | 1.40 | 61.77 | 80 | 280 | 7.1 |
| Rice | 8.0 | 6.70 | 0.41 | 0.50 | 0.50 | 83.89 | 76 | 111 | 1.5 |
| Chick peas | 9.3 | 19.00 | 4.90 | 2.70 | 4.40 | 59.70 | 151 | 277 | 7.5 |
| Sunflower seeds | 5.2 | 25.00 | 52.40 | 4.30 | 4.20 | 8.90 | 125 | 840 | 5.7 |
| Fenugreek | 7.0 | 29.00 | 4.90 | 3.27 | 7.20 | 48.03 | 186 | 420 | 22.0 |
| Soy beans | 10.2 | 33.50 | 20.30 | 4.80 | 5.10 | 26.00 | 209 | 605 | 6.5 |
| Maize | 10.0 | 10.00 | 4.50 | 1.12 | 2.00 | 73.30 | 12 | 245 | 2.0 |
| Whole wheat | 10.2 | 11.50 | 2.00 | 1.29 | 2.60 | 72.41 | 30 | 320 | 3.5 |
| Skimmed milk | 3.0 | 35.90 | 0.80 | 8.00 | 0.00 | 52.30 | 1.3 | 1.0 | 0.6 |
| Dry yeast | 9.62 | 43.03 | 0.15 | 4.88 | 0.00 | 42.32 | 44 | 1.3 | 16.1 |

Table 3. Macronutrients of cooked ingredients.

| Sample | Moist. g% | Prot. g% | Fat g% | Ash g% | Fibre g% | Carbo. g% | Calc. mg% | Phosp. mg% | Iron mg% |
|---|---|---|---|---|---|---|---|---|---|
| Parboiled wheat | 9.0 | 11.55 | 1.4 | 1.4 | 1.7 | 74.95 | 30 | 319 | 4.7 |
| Rice | 9.3 | 7.10 | 0.7 | 0.20 | 0.4 | 82.26 | 75 | 95 | 1.6 |
| Chick peas | 5.3 | 22.10 | 5.7 | 2.3 | 1.6 | 63.05 | 114 | 387 | 5.8 |
| Lentils | 5.3 | 23.50 | 1.2 | 2.2 | 1.3 | 66.40 | 78 | 285 | 7.0 |
| Dried potato flakes | 11.2 | 12.10 | 0.4 | 2.1 | 1.7 | 72.30 | 55 | 120 | 6.0 |

Table 4. Macronutrients in roasted ingredients.

| Sample | Peanut | Chick peas | Sesame |
|---|---|---|---|
| Moisture g% | 1.3 | 3.5 | 0.8 |
| Protein g% | 27.0 | 23.9 | 20.0 |
| Fat g% | 45.6 | 6.1 | 50.3 |
| Ash g% | 2.3 | 3.2 | 1.3 |
| Fibre g% | 3.0 | 2.8 | 5.0 |
| Carbohydrates g% | 20.8 | 60.6 | 22.6 |
| Calcium mg% | 50.0 | 649.0 | 1,500.0 |
| Phosphorus mg% | 376.0 | 637.0 | 614.0 |
| Iron mg% | 2.5 | 9.7 | 10.0 |

Table 5. Macronutrients in the special commodities (Fayesh and Kishk).

| Sample | Fayesh | Kishk |
|---|---|---|
| Moisture g% | 5.5 | 7.8 |
| Protein g% | 13.4 | 21.6 |
| Fat g% | 8.2 | 6.9 |
| Ash g% | 2.2 | 8.2 |
| Fibre g% | 2.4 | 2.5 |
| Carbohydrates g% | 68.3 | 53.0 |
| Calcium mg% | 170.0 | 54.0 |
| Phosphorus mg% | 570.0 | 412.0 |
| Iron mg% | 3.2 | 3.7 |

Table 6. The amino acid composition of different ingredients used in the preparation of formulated mixtures (mg/g N).

| Ingredient | Leucine + isoleuc. | Lysine | Phenyl-alanine | Tyrosine | Cystine | Methio-nine | Total S.A.A. | Threo-nine | Trypto-phan | Valine |
|---|---|---|---|---|---|---|---|---|---|---|
| Polished rice | 776 | 226 | 303 | 200 | 96 | 133 | 229 | 207 | 84 | 361 |
| Potato flakes | 613 | 299 | 251 | 81 | 37 | 81 | 118 | 235 | 103 | 292 |
| Lentils | 747 | 449 | 327 | 204 | 57 | 50 | 107 | 248 | 60 | 313 |
| Chick peas | 745 | 428 | 358 | 183 | 74 | 65 | 139 | 235 | 54 | 338 |
| Skim milk | 949 | 453 | 303 | 311 | 59 | 161 | 220 | 263 | 89 | 402 |
| Whole wheat | 621 | 179 | 282 | 187 | 159 | 94 | 253 | 183 | 68 | 276 |
| Parboiled wheat | 602 | 161 | 253 | 183 | 120 | 99 | 219 | 177 | 66 | 244 |
| Yeast | 865 | 565 | 303 | 259 | 56 | 100 | 156 | 340 | 69 | 459 |
| White bread | 668 | 130 | 304 | 145 | 159 | 91 | 250 | 168 | 67 | 258 |
| Sesame | 645 | 171 | 277 | 195 | 113 | 176 | 289 | 223 | 84 | 288 |
| Fenugreek | 699 | 362 | 251 | 183 | 87 | 74 | 161 | 205 | 115 | 241 |
| Soy flour | 770 | 399 | 309 | 196 | 83 | 79 | 162 | 241 | 80 | 300 |
| Sunflower | 668 | 225 | 278 | 118 | 93 | 119 | 212 | 230 | 85 | 317 |
| Kishk | 785 | 310 | 292 | 249 | 109 | 122 | 240 | 223 | 79 | 344 |
| Fayesh | 685 | 234 | 287 | 212 | 139 | 107 | 246 | 200 | 72 | 275 |

Table 7. Macronutrients present in formulated mixtures.

| Nutrients | AN 70 | AN 71 | AN 72 | AN 73 | AN 74 | AN 75 | AN 76 | AN 77 | AN 78 | AN 79 |
|---|---|---|---|---|---|---|---|---|---|---|
| g/100 g | | | | | | | | | | |
| Moisture | 6.8 | 6.2 | 6.6 | 5.1 | 5.6 | 5.8 | 6.2 | 5.4 | 6.8 | 6.3 |
| Nitrogen | 3.3 | 3.1 | 3.2 | 3.1 | 2.8 | 3.3 | 3.1 | 3.2 | 3.7 | 3.3 |
| Protein | 20.5 | 19.1 | 19.8 | 19.1 | 17.7 | 20.6 | 19.5 | 19.8 | 23.2 | 20.7 |
| Fat | 5.4 | 5.6 | 6.1 | 5.9 | 6.3 | 7.1 | 7.2 | 5.1 | 5.2 | 8.4 |
| Ash | 2.6 | 2.8 | 2.3 | 2.9 | 2.7 | 3.0 | 2.2 | 3.4 | 2.8 | 4.0 |
| Fibre | 2.1 | 1.8 | 2.0 | 1.9 | 2.3 | 2.2 | 2.1 | 2.6 | 2.0 | 2.3 |
| Carbo-hydrates[1] | 62.6 | 62.5 | 63.2 | 65.1 | 65.4 | 66.3 | 62.2 | 63.7 | 60.0 | 58.3 |
| mg/100 g | | | | | | | | | | |
| Calcium | 219 | 350 | 342 | 515 | 318 | 405 | 231 | 428 | 438 | 354 |
| Phosphorus | 320 | 414 | 500 | 705 | 612 | 425 | 231 | 433 | 458 | 331 |
| Iron | 5.1 | 5.4 | 6.1 | 6.8 | 3.2 | 4.8 | 4.8 | 6.7 | 4.1 | 5.2 |
| cal/100 g[2] | | | | | | | | | | |
| F. energy | 389 | 384 | 395 | 399 | 386 | 427 | 400 | 389 | 388 | 401 |

[1] Calculated by difference.
[2] By calculation; g carbohydrates = 4 cals., g protein = 4 cals. and g fat = 9 cals.

*Summary*

Ten protein-rich food mixtures were suggested. They are based on popular dishes which could be prepared simply at home. Such mixtures were prepared from seeds or legumes available in the local markets at reasonable prices. These ingredients are polished rice, decorticated lentils, defatted sesame flour, whole or roasted chick peas (dehulled), maize bread, sun flour kernels, fenugreek seeds, wheat (whole grains or parboiled grains), white wheat flour, defatted peanut flour, defatted sesame flour and dry yeast.

The protein content of such food mixtures ranged from 17.7 to 23.2 %, which is in agreement with recommended values.

Defatted sesame flour was incorporated in most of the mixtures in order to correct for their sulphur-containing amino-acids as it is already known that sesame is a rich source of sulphur-containing amino acids in comparison to other vegetable sources.

Further investigations are going on to determine the nutritive value of the formulated mixtures before feeding them to the children.

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