Preparing Infants' Food (for ages 6 to 24 months) with some Fruits and Vegetables

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ABSTRACT

Infant foods play an important role in the growth stage of infants, through which they have the opportunity to discover different flavors and textures. Six formulae of infant food were prepared. Sprouted wheat, powdered milk, and artichokes were used as the main contents for their high nutritional value (control). Then, this study replaced 60% of sprouted wheat with carrots, broccoli, cantaloupe, pears, and pumpkins for formulae (2-6), respectively each kind alone. Chemical composition, inulin some nutrients were evaluated. Also, sensory evaluation, fatty acid content, and amino acid compared to daily recommended intake were evaluated. Results showed that broccoli formula (3) had the highest levels of nutrients. Cantaloupe formula (4) had the highest level of inulin (114mg/100g DM). Pumpkin fruit caused to increase in Se (11.36ppb) compared with other vegetables and fruits under study. Sensory evaluation showed that carrot and pumpkin formulae had high scores for all characters. Meanwhile, broccoli and cantaloupe formulae had low scores. The major percent of fatty acid was palmitic acid and oleic acid in all formulae. On the other hand, broccoli formula (3) had the highest percentages of linoleic acid and α – linolenic acid. All six formulae of infant food contained essential amino acids individually. Food and protein efficiency ratios (PER) of formula 6 Pumpkin scored the highest value. All six formulas provided sufficient amounts DRI_s of protein, calcium Ca, and magnesium Mg formulas for infants age under study.

Keywords: *infant food – Artichoke - Vegetables – Fruits – full-fat milk.*

INTRODUCTION

Infants need more nutrition and energy for growth and development after 6 months of delivery and between 6 and 24 months than at any other time in their lives. Additionally, the nutrients in breast milk would no longer be sufficient to support rapid growth. So, starting at six months, complementary foods are crucial for a growing child **(Feng et al., 2022).** Also, breastfeeding should be continued even after the introduction of complementary food, since it provides proteins with high biological value and supplies (**Lind et al., 2019; Padarath et al., 2020**). Moreover, WHO and UNICEF recommended that nutritionally adequate and safe complementary feeding start after 6 months of age with continued breastfeeding up to 2 years of age or beyond as reported by **WHO, (2009).**

Complementary feeding should be given in amounts, frequency, and consistency, using a variety of food to cover the nutritional need of the growing child while maintaining breastfeeding (**Bhandari and Chowdhury 2016**) While non-breastfed children need extra foods which can provide half of their energy needs (6-12 months) and provide a third between (12-23months). So, these infants need to be fed a large number of foods containing high-quality nutrients that would otherwise be covered by breast milk. This can be achieved by giving extra meals and a large quantity of origin animal foods or nutrient supplements if animal-origin food is not available (**WHO, 2005**). According, **Bhandari and Chowdhury,** (**2016**) reported that the standard of complementary feeding depends on the amount and frequency appropriate for age, food diversity through staples, animal sources foods, dairy products, pulses, fat or oil, and the range consumption of colored fruits and vegetables.

Fruit and vegetables are an important part of a healthy diet. It helps infants to grow and support body functions and physical, mental, and social well-being at all ages. Whereas; it could help prevent malnutrition status (under-nutrition, micronutrient deficiency, overweight, and obesity) and reduce the risk of non-communicable diseases (**Afshin *et al.*, 2019; WHO and FAO, 2005**). Fruits and vegetables are rich in Vitamin A, calcium, iron, and folate, which could be promoting good health, improved a child's immune system, and help protect against disease, both now and in the future (**Lock et al.,2005**).

The artichoke edible part (flower head) is one of the richest sources of high-quality inulin, fiber, and minerals. Also, it has dietary sources of polyphenols with high bio-availability compared to other vegetables (**Brat *et al*., 2006**), Phenolic compounds are very important substances for human nutrition since they are involved in the prevention of cancer cardiovascular diseases; osteoporosis, diabetes mellitus, and neurodegenerative diseases. (**Pandino et al., 2011, Clifford and Brown 2006**). With novel applications in functional meals, and has recently attracted fresh and expanding interest, Among the common edible plants, artichoke is a rich source of dietary antioxidants; therefore, it could be used in phytopharmaceutical applications **(Lattanzio et al., 2009; Ceccarelli et al., 2010).** Additionally, there are indications about inulin maybe has positive effects—on blood lipid composition, colon cancer prevention, and the makeup of the gut microbiota. Inulin has been shown to positively affect the composition of the gut microflora **(Hellwege et al., 2000).**

Several studies have suggested that increasing the consumption of plant food like broccoli decreases the risk of obesity, diabetes, heart disease, and overall mortality. It may also promote a healthy complexion and hair, increased energy, and overall lower weight. It is a very good source of dietary fiber, vitamins [pantothenic acid, vitamin B6, vitamin E, vitamin B1, and vitamin A (in the form of carotenoids)], minerals [manga-nese, phosphorus, potassium, and copper] and choline.

Broccoli is also a good source of vitamin B1, niacin, omega-3 fatty acids, protein, magnesium, zinc, calcium, iron, and selenium. Since broccoli is a powerhouse of antioxidants, which helps in maintaining healthy skin (**Deepmala et al., 2017**)

Pumpkin fruit (both pulp and seeds) are contained in polysaccharides, colors, amino acids, active proteins, and minerals (potassium, phosphate, and magnesium). As well as, it is a good supply of lipids, carotene, vitamins, and polysaccharides, such as pectin. Vitamins such as provitamin A carotenoids have both nutritional and health-protective value (**Fernández-López *et al*., 2020; Roongruangsri and Bronlund, 2015**).

Carrots are one of the most generally used vegetables for human nutrition, due to being rich in pro-vitamin A as β-carotene, minerals, and other valued nutrients, diet fortification with carrots is healthful and protective against various cancers (**von Lintig, 2012**).

Germination is commonly used to promote the bioavailability of important nutrients. Maybe enzymes are produced or activated during the germination process resulting in the degradation or generation of valuable elements (**Marti et al., 2017**).. As well as, the germination process was proven to decrease crude fat material, slightly increase protein content, and high-rise vitamin content (especially vitamins A and E). The improvement in total phenolic compounds and antioxidant activity was increased. In addition, the increase in catechin found in these sprouts is encouraging due to their nutraceutical applications (**Francis et al., 2022**). Also, the germination process improves the bioactive compounds and functional properties of wheat flour. The improvement of the nutritional quality will help the consumers to get the benefit of germinated wheat (**Verma et al., 2021**).

This investigation aimed to study increasing the quantity and variety of vegetables and fruit intake for infants (6 – 24 months). As well as increasing the nutritional value of infant food such as minerals and vitamins.

MATERIAL AND METHODS

***Materials*:**

Fresh fruits; pear (*Pyrus communis*), pumpkin (*Cucurbita moschata*) and cantaloupe (*Cucumis melo*), vegetables [artichoke (*Cynara cardun-culus*), carrot (*Daucus carota*) and broccoli (*Brassica oleracea*)] and powder milk were obtained from the local market in Giza, Egypt. Wheat grain (Egypt 2) was obtained from the Institute of Crops Field, Agriculture Research Centre, Giza, Egypt.

***Preparation of raw samples*:**

The whole wheat grain was cleaned and washed. Then, it was soaked in water (1:2; W/V) for 12 hours and drained water. Then, the soaked wheat grain was allowed to germinate under a wet muslin cloth for 36 hours. After that, the sprouted wheat grains were put in a covered stainless-steel pool with water (1:1, W/V). Then, it was cooked on a moderate flame. The minimum cooking time was to reach a similar tenderness for adequate palatability and taste according to Egyptian eating habits **(Salem *et al.*, 2014).**

The edible parts of both vegetables and fruits were cleaned, washed, cut into slices (1cm), and blanched by submerged in boiling water for a minute. Then, drain water and dry in an oven at 45±5 °C overnight.

All dried materials were milled to a fine powder and sieved on 100 mesh. Finally, packaged in polyethylene bags and stored in a deep freezer (-18°C) until used.

***Preparation of infant food*:**

infant food samples were prepared according to **Bahlol *et al.*, (2007).** First, this investigation was worked on preformulate to reach a better percentage of ingredients by sensory evaluation with some modification in the formula. Second, sprouted wheat, powdered milk, and artichokes were used as the main contents for their high nutritional value (control). Then, this study replaced 60% of sprouted wheat with carrots, broccoli, cantaloupe, pears, and pumpkins for formulae (2-6), respectively each kind alone. Then, all samples were evaluated for the effectiveness of formula taste. Ingredients used for infant food were tabulated in a table (1)

Chemical analysis:

The chemical composition of samples including moisture, protein, ash, and fat was determined according to **AOAC (2005).** While total Carbohydrate was calculated by difference.

Total carbohydrate (%) =100- (protein% +fat% +moisture% + Ash%)

The energy value of the samples was calculated using the appropriate factor as described by **(FAO/WHO, 1985)** as the following equation:

Total calories = 4 (protein) + 4(carbohydrates) + 9 (fat).

***Determination of inulin and phytochemical compounds*:**

Inulin content was determined as recommended by **Prosky and Hoebregs (1999).** Total phenols were determined calorimetrically using Folin–Ciocalteu reagent (as Gallic acid) according to **Singleton *et al.*, (1999).** The total flavonoid was determined (as Quercetin) according to **Marinova *et al.*, (2005).** The antioxidant activity was determined using the free radical, 2,2- diphenyl- 1-picrylhydrazyl (DPPH) as a reagent according to **Cuendet *et al.*, (1997).** Also, antioxidant activity was determined using Azinobis-3-ethylbenzothia-zoline- 6- sulfonic acid (ABTS) according to **Olszowy and Dawidowicz (2018).**

Determination of minerals:

The minerals iron (Fe), magnesium (Mg), potassium (K), zinc (Zn), calcium (Ca), phosphorous (P), selenium (Se), and sodium (Na) were digestion by using a microwave digestion system (Multiwave Go Plus) and determined by using microwave plasma Atomic Emission Spectroscopy (MP-AES) (model 4210, Agilent) made in Malaysia according to **A.O.A.C (2019).**

Determination of fat-soluble vitamins (A, D_3, and E):

Fat-soluble vitamins (A, D_3, and E) were determined using HPLC according to **(Nöll (1996); Pare (1995); Pyka and Sliwiok, (2001)),** respectively**.**

Determination of vitamin C (Ascorbic acid) and β-carotene:

Vitamin C was determined using **AOAC, (2005)**. β-carotene was estimated according to **Okonkwo (2009)**

Determination of amino acids:

The system used for amino acids analysis was a High-Performance Amino Acid analyzer (HIPAA; Biochrom 30). EZChrom; software was used for data collection and processing. **(FAO/WHO/UNU, 2007)** reference amino acid pattern for children 6 to 24 months old was used to calculate the essential amino acid score. The protein efficiency ratio (PER) was calculated using the regression equation proposed by **Alsmeyer *et al*. (1974);**

PER= -0.684+0.456(Lucien)-0.047(Proline).

Biological Value (B.V) was calculated consistent with the equation of **Mitchel and block (1946);**

B. V= 49.9+10.53 (PER)

Determination of fatty acids:

Fatty acids were determined by Gas Chromatographic (GC). Fatty acid methyl esters were prepared from total lipids by using the rapid method according to the method of **ISO; 12966-2 (2017).** The fatty acid content was monitored by the atherogenic index (AI),

AI=(C12+4*C14+C16)/∑unsaturated fatty acids

calculated by the Ulbricht and Southgate formula cited by **Stajić *et al* (2011).**

Comparison of the nutrients with daily recommended intakes (DRIs):

The nutrient contents in prepared infant food were compared to DRIs as reported by the National Academy of Science (1998) and the Food and Nutrition board (2011).

Sensory evaluation

Infant food mixtures were sensory evaluated according to **Metwalli *et al*.,**

(2011). Overall acceptability was calculated from the obtained scores of the evaluated attributes. Sensory evaluation was resulted in by ten panelists from the staff members of the Food Technology Research Institute at the Agricultural Research Center "ARC" including women who were mothers. The sensory evaluation was worked twice as a flowing: First tested; weighted a sample (10g) and put boiling water on it and wait 5 minutes for testing. Second, tested; the weighted sample (10g), added boiling water and put on mid-rates heat for 5 minutes. Then, a working taste test. Notice; each sample takes a water different from another sample. The scoring scheme was established for odor, taste, color, texture, and overall acceptance.

Statistical Analysis:

Statistical analyses were carried out by the SPSS 19 program. Data were expressed as means. The Statistical analysis was performed using a one-way analysis of variance followed by Duncan's tests as outlined by **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSION

The infancy stage is the transition stage to accepting a new food. It is facilitated by exposure in utero to flavors derived from the maternal diet and then through the flavors of breast milk termed 'chemo-sensory continuity' (**Marlier et al., 1998).** So, maternal intake of vegetables during both pregnancy and lactation periods is caused to promote familiarity with some vegetable flavors (**Nekitsing and Hetherington, 2022**). On the other hand, solid foods are offered at around 6 months of age during complementary feeding (CF), the infant is already familiar with specific odor and flavor components of the maternal diet which they favor over other odors (**Marlier and Schaal, 2005**).

The first formula of infant food in this study contained sprouts of wheat, full-fat milk powder, and dried artichoke powder as control. Then, 60% of sprouted wheat was replaced by carrots, broccoli, cantaloupe, pears, and pumpkins each kind alone for formulae (2-6), respectively. The results are shown **in table (2).** Generally, vegetables and fruits caused to decrease in protein content, except broccoli caused to increase in protein. Also, it's caused to increase in fat content, except pear caused to decrease in fat. Broccoli formula (3) had an increasing rate in protein, fat, fiber, and energy (21.25%, 43.63%, 36.96, and 1.32%), respectively, and decreased in carbohydrates (16.84%) compared with control. There is a highly significant difference between treatments ($p<0.05$). Carrot formula (2) had a great decrease in protein (26.42%). While the pear formula (5) decreased fat and ash (4.715 and 5.47%) compared control formula. Cantaloupe formula (4) had the lowest content of fiber (5.32%).

Results in the same table (2), showed that inulin in infant formulae. Cantaloupe formulae (4) had the highest contents of inulin (114mg/ 100 g). Pear formula (5) had the lowest content of inulin (75mg/ 100g) there is a significant differences between treatments ($p<0.05$). The results of inulin content might be due to artichoke powder being added as basic content. It is rich in inulin content with the highest degree of polymerization known in plants **(Lattanzio *et al.*, 2009).** Also**,** Inulin has been shown to positively affected the composition of the gut microflora **(Hellwege et al., 2000).**

Some mineral content results are shown in table (3). Generally, the vegetables and fruits in this study caused to rising of minerals except for Phosphorus P and Selenium Se were decreased. Cantaloupe formula (4) had the highest contents of Iron Fe, Sodium Na, Zinc Zn, Magnesium Mg, and Potassium K (mg/100g), 144.31, 250.70, 118.67, 13.95, and 73.86%, respectively compared to formula control. Pumpkin formula (6) had the highest contents of Ca, P, and Se (197.56, 0.50, and 354.4 % respectively) compared to the formula control. **Romani *et al.*, (2006)** evaluated artichoke flower heads and resulted in them being a rich source of minerals, showing, in particular, K and Ca contents of 360 and 50 mg/100 g. These results are in the line with **Liu (2013)** who reported that fruits and vegetables have bioactive compounds such as vitamins (e.g., A, E, K, and folic acid), minerals (e.g., Ca, K, and Zn) and phytochemicals (flavonoids and carotenoids) which producing health benefit effects.

Phytochemicals contents for prepared formulae:

The high antioxidant in the diet has been associated with a reduced risk of pediatric migraine (**Ariyanfar *et al.*, 2019**). It improved the antioxidant status of lipid and glucose homeostasis in obese children (**Ebeid *et al.*, 2018**). The antioxidant compounds could decrease epithelial cell damage and lipid peroxidation (**Rasaee *et al.*, 2021**). Roasting, bleaching, drying, and pasteurization as thermal processing procedures could be harmful to bioactive compounds **(Sanchez et al., 2020).**

Results in table (4) showed that, the affective of vegetables and fruits under study on some phytochemicals such as β-carotene, total phenols, total flavonoids, and antioxidant activity by (DPPH and ABTS).

Generally, all prepared formulae were rich in phytochemicals (vitamins, total phenols, and total flavonoids) and it's had a high percentage of antioxidant activity. Broccoli formula (3) had the highest contents of vitamin soluble fat (4.20, 14.45, and 2.02 mg/100g) for vitamins A, E, and D. Cantaloupe formula (4) had the lowest content of vitamin soluble fat (2.56, 7.43 and 1.5 mg/100g), A, E, and D, respectively. Carrot and broccoli formulae were a high content of beta carotene (0.21 and 0.19 mg/100g).

Vitamin C (Ascorbic acid) participates in several metabolic functions, such as the synthesis of collagen, elastin, and norepinephrine. Also, is improved to increase the bioavailability of iron absorption **(Figueroa-Méndez, and Rivas-Arancibia, 2015).** Differences between vitamin C content in prepared formulae as the addition of vegetables and fruits. The pumpkin formula (6) had the highest level of vitamin C. followed by the broccoli formula (3). The control formula had a minimum content of vitamin C (447.33mg/100g).

Moreover, all formulae were a low level of β- carotene content. Carrot and broccoli formulae had 0.21 and 0.19 mg/100g, respectively. During processing micronutrients in fruits and vegetables are firstly degraded because of the first stage of tissue breakdown during cutting, blending, or crushing. Microscopic studies reported that, within the chloroplasts, β-carotene can be either in a crystalline form or partially solubilized in lipid droplets as a function of vegetables **(Vásquez-Caicedo *et al*., 2007**). According, **Pénicaud, *et al*., (2011)** reported that there is an effect of food composition on β-carotene degradation such as water activity, acidity, lipid unsaturation, and interaction between β- carotene and other antioxidants particularly vitamins (E and C) and metals (iron and copper).

All infant food formulae were a good source of total phenols and total flavonoids. Pear formula (5) had the highest total phenols content and lowest flavonoid content. Broccoli formula (3) had the largest level of total flavonoids. Concerning antioxidant activity (%), vegetables and fruits caused to increase in antioxidant activity compared with the control formula. Broccoli formula (3) had the highest level of DPPH. Carrot formula (2) had the highest level of inhibitor of ABTS. There are highly significant differences between formulae ($p<0.05$). These results agree with **Lattanzio et al., (1994) and Ceccarelli et al., (2010)** who found that Both leaves and heads of the artichoke were a high level of phenolic components like apigenin and luteolin glycosides. According, **(Deepmala *et al*., 2017)** reported that broccoli has a powerhouse of antioxidants and nutrients like vitamin C and minerals such as copper and zinc.

Sensory evaluation scores of infant foods, (before and after cooking for 5 minutes):

The results of sensory evaluation for prepared infant food formulae (before and after cooking) are shown in Table (5). The results showed an average likeness of the formulated infant foods with respect to taste, aroma, color, mouth feel, consistency, and overall acceptability.

Taste is an important parameter when evaluating the sensory attribute of food. The product might be appealing and have high energy density but without good taste, such a product is likely to be unacceptable. Appearance is an important attribute in food choice and acceptance. Aroma is an integral part of the taste and general acceptance of the food before it is put in the mouth. It is therefore an important parameter when testing the acceptability of formulated foods **(Muhimbula *et al.*, 2011).**

Sensory evaluation for prepared infant food formulae (before or after cooking for 5 minutes) showed that the cooking process improved sensory properties. Carrot and pumpkin formulae which had a yellow or orange color had high scores for appearance, color, aroma, and taste. While broccoli and cantaloupe formulae had a green color and had a low score. Broccoli formula (3) had the worst score for taste and other properties. This result may be due to the broccoli flavor and it is not widely consumed. The results are in agreement with **Mennella *et al*., (2017)** who found that mixed vegetable juice (carrot, celery, and beet), introduced mothers to know the affective on their child's acceptance or not. They also said, thus, introduction in the earlier months during lactation had a greater effect than exposure in later months. Formulae that had the color yellow were a high acceptable may be due to β-carotene content. Whereas, β-carotene is an important component of the organoleptic quality of food, not only because of its color but also due to it has the role of aroma compounds such as nor isoprene and monoterpene during fruit ripening (**Lewinsohn et al., 2005**).

Fatty acids composition:

Gas-liquid chromatography (GLC) technique was employed to identify fractions of fatty acids for prepared infant food formulae. Relative percentages of the identified fatty acids are shown in **Table (6).** Generally, the results showed that the major percent was for palmitic acid (saturated fatty acid) and oleic acid (unsaturated fatty acid) in all formulae. Broccoli formula (3) had palmitic acid (24.47%) more than oleic acid (16.23%). While cantaloupe formula (4) was oleic acid (33.14%) higher than palmitic acid (21.09%). On the other hand, the Broccoli formula (3) had the highest percentages of linoleic acid (C18:2n6) and α – linolenic acid (C18:3n3). Linoleic acid is regarded as necessary in food because it is involved in the synthesis of arachidonic acid as a precursor, and substrate for eicosanoid synthesis and has a role in gene regulation **(Ou *et al.*, 2001).**

Moreover, alpha-linolenic acid (ALA) and omega6/omega 3 ratios have many benefits such as lowering blood cholesterol, aiding in blood glucose control, and blocking inflammation and has may help prevent or treat chronic diseases in which inflammation plays a role in chronic diseases like heart disease, stroke, diabetes, cancer, obesity, the metabolic syndrome, and Alzheimer disease **(Zhao *et al.*, 2004) and (Morris, 2009).** Alpha-linoleic acid (omega-3 fatty acids), which is essential in addition to fatty acids, plays a vital role in maintaining human health and the human body is unable to produce it **(Dehcheshmeh, et al., 2020).**

Results in the same table (6) showed that total unsaturated fatty acids were higher than saturated fatty acids in all formulae. So, the atherogenic index (AI) had less than 1. Cantaloupe formula (4) had the highest total percentage of unsaturated fatty acids and the lowest total saturated fatty acids. So, it had the highest level of ratio of unsaturated to saturated fatty acid (2.64). As well as, the atherogenic index (AI) was the lowest level (0.36). The ratio of unsaturated to saturated fatty acids is suitable for infants according to codex specification because it has an effect on nutritional properties and oxidative stability **(Gutirrez *et al*., 1999).** Also, foods with a greater ratio of unsaturated fatty acids relative to saturated fatty acids are preferred **(Coultate 2009).**

Amino acid composition

The data in table (7) showed that the amino acids were identified and the fractionation of infant food formula under study. Generally, all formulae contained 9 essential amino acids which have low contents compared with **FAO / WHO /UNU (2007)** pattern. Sulfur amino acids were the first limiting amino acid in all prepared infant food formulae. Carrots formula (2) had the highest contents of total essential, total non-essential amino acid, protein efficiency ratio (PER), and biological value (BV). Meanwhile, pear formula (5) had low contents of total essential and T non-essential amino acids, PER and BV.

Results in the same table (7) indicated that; glutamic acid was the major non-essential amino acid followed by aspartic acids in all prepared infant formulae. Also, proline as non-essential amino acid ranged between 3.14 to 4.91 g/16gN. Pear and pumpkin formulae (5 and 6) had a low. The (PER) whereas, 0.77 and 0.85.

Comparison of the nutrients in table 2,3 with DRIs:

Data in table (8) showed that, percentage of DRIs /100g infant formulae for some daily nutrients. All infant formulae are given less than one-tenth of the Fe requirements for infants (6-24 months). Except for cantaloupe formula (4) which had 10% of Fe requirements. While infant food formulae prepared are given more than 100% of protein requirements for infants (6-24 months). The fat content in the infant formula is providing less than 50% of the fat requirements for infants (6 – 24 months). Carbohydrates content in the infant food formula is provided for infants (6 -12 months) between 50% to ≤ 100% of the carbohydrate requirement. But infant formulae are providing infants (13 – 24 months) less than 50% of the carbohydrate requirement.

Both the control and pumpkin formulae are given less than 100% of Zn requirements for infants, but other formulae are given more than 100% of Zn requirements for infants (6- 24 months). Additionally, vegetables and fruits caused to increase in Ca content. So, all infants' food formulae are given more than 100% of Ca requirements for infants except control formula (1) is given less than (90.91%) of Ca requirements for infants (13 – 24 months). As well as, complementary formulas are given more than 100% of P requirements for infants (6- 12 months), but they are given a range between 50 to ≤ 100% of P requirements for infants (13 – 24 months). The infant food formulae provide more than 100% of K requirements for infant (6 – 12 months), except the control formula which provide less than (92.25%) of K requirements for infant (6 -12 months). While the infant food formulae are providing less than 50% of K requirements for infants (13 – 24 months). **WHO (2003)** advises eating at least five servings (400 g) of fruits and vegetables (F&V) per day to maintain good health. **Uusiku et al., (2010)** reported that in Sub-Saharan Africa, however, daily intakes are below 200 g, and it is estimated that inadequate F&V consumption is responsible for 27% of deaths.

Cost of formulated infant food formulas:

The cost of infant food formulae prepared and commercial products (hero baby) were roughly calculated as shown in Table (9). The costs were estimated without wages, rent, machinery and equipment, transportation, taxes, advertisement, and maintenance. The price of infant food formula prepared was suitable for the low national income in Egypt and less than those of commercial products. From estimating the cost, it may be concluded that these products could be produced for children's gardens (kindergarten), exported, and could be for homemade

CONCLUSION:

The broccoli formula had a high nutritional content, while it gave lower levels of acceptance than the rest of the formula, which resulted in working on developing the taste of broccoli and incorporating it into other mixtures to reduce its unpalatable taste of it. This formula can produce to infant day after day or daily in small quantities.

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Table (1): Ingredient for infant food formulae (g/100g):

Ingredient	**Formulae**					
	(1)	(2)	(3)	(4)	(5)	(6)
Sprouts wheat grains	50	20	20	20	20	20
Milk powder	30	30	30	30	30	30
Artichoke	20	20	20	20	20	20
Carrot	-	30	-	-	-	-
Broccoli	-	-	30	-	-	-
Cantaloupe	-	-	-	30	-	-
Pear	-	-	-	-	30	-
Pumpkin	-	-	-	-	-	30

Table (2): Chemical composition of prepared infant food (g/100g):

Items	**Formula**					
	Control (1)	**Carrot (2)**	**Broccoli (3)**	**Cantaloupe (4)**	**Pear (5)**	**Pumpkin (6)**
Moisture (g/100g)	8.79[c]±0.47	8.96[bc]±0.39	9.34[b]±0.11	9.93[a]±0.15	9.32[b]±0.05	10.08[a]±0.53
Protein(g/100g)	24.38[b]±0.76	17.94[d]±1.51	29.56[a]±0.18	20.23[c]±0.11	21.00[c]±1.63	21.69[c]±1.82
Fat (g/100g)	5.73[bc]±1.02	6.96[ab]±0.45	8.23[a]±0.16	6.54[bc]±0.53	5.46[c]±1.04	6.42[bc]±0.96
Ash (g/100g)	3.84[c]±0.31	5.09[a]±0.18	5.25[a]±0.31	5.24[a]±0.09	3.53[c]±0.25	4.45[b]±0.50
Fiber (g/100g)	5.79[c]±0.16	6.82[b]±0.19	7.93[a]±0.30	5.32[c]±0.26	6.09[bc]±0.48	8.17[a]±0.33
Total carbohydrate (g/100g)	57.08[b]±0.42	61.05[a]±2.19	47.62[c]±0.38	47.03[c]±0.71	60.69[a]±0.84	57.36[b]±3.28
Inulin (mg/100g)	103.00[a]±0.01	103.00[a]±0.01	85.00[b]±0.01	114.00[a]±0.01	75.00[b]±0.01	107.00[a]±0.01
Energy (Kcal)	378[ab]±4.49	379[ab]±1.43	383[a]±1.18	372c±1.95	376[bc]±4.18	374[bc]±2.80

*****Each value in the row followed by the same letter isn't significantly different at ($p \leq 0.05$).***

Table 3: Minerals content of prepared infants' food

Items	Formula					
	Control (1)	**Carrot (2)**	**Broccoli (3)**	**Cantaloupe (4)**	**Pear (5)**	**Pumpkin (6)**
Fe (mg/100g)	1.67^{b}±.30	1.95^{b}±0.40	2.21^{b}±.25	4.08^{a}±.30	2.28^{b}±.40	2.27^{b}±.20
Ca (mg/100g)	454.55^{f}±4.50	813.84^{e}±3.20	859.38^{d}±2.40	1013.92^{b}±3.40	1000.00^{c}±4.5	1338.93^{a}±4.20
Na (mg/100g)	153.06^{f}±2.40	292.40^{b}±3.20	243.57^{c}±4.10	536.78^{a}±5.00	198.02^{d}±2.30	172.92^{e}±3.60
Zn (mg/100g)	2.41^{c}±.60	4.87^{ab}±.20	4.78^{ab}±.30	5.27^{a}±.20	4.36^{b}±.30	2.96^{c}±.10
P (mg/100g)	367.53^{b}±4.2	364.91^{b}±3.10	455.79^{a}±2.40	354.47^{c}±3.20	313.96^{d}±4.30	369.37^{b}±4.20
Mg (mg/100g)	90.45^{bc}±1.40	94.05^{b}±3.10	100.09^{a}±5.04	103.06^{a}±3.44	87.88^{c}±2.62	101.48^{a}±2.20
K (mg/100g)	645.73^{f}±2.40	944.74^{c}±4.10	932.44^{d}±3.60	1122.86^{a}±4.50	696.14^{e}±5.10	1089.03^{b}±7.20
Se (ppb)	2.50^{b}±.40	2.05^{bc}±.30	1.19^{c}±.20	1.49^{c}±.40	0.10^{d}±.04	11.36^{a}±1.10

***Each value in the row followed by the same letter isn't significantly different at ($p \leq 0.05$).*

Table (4): Phytochemicals contents for prepared infant food (dry weight)

Items	Formula					
	Control (1)	**Carrot (2)**	**Broccoli (3)**	**Cantaloupe (4)**	**Pear (5)**	**Pumpkin (6)**
Vit. A (IU/100g)	**12870**	**10593**	**13893**	**8448**	**9075**	**9075**
Vita. E (mg/100g)	**12.21**	**9.26**	**14.45**	**7.43**	**10.36**	**8.56**
Vita. D (mg/100g)	1.95	1.88	2.02	1.51	1.91	1.80
Vita. C (mg/100g)	447.33[e]±1.45	777.67d±1.45	1544.62[b]±2.3	784.32[d]±3.48	1112.50[c]±1.32	1780.00[a]±2.89
Beta carotene (mg/100g)	0.008[c]±0.01	0.21a±0.61	0.19[b]±0.68	0.006[c]±0.04	0.004[c]±0.01	0.003[c]±0.01
Total phenols (mg/100g)	5429.58[f]±2.95	4622.51c±3.28	6816.62[c]±3.3	5395.63[d]±2.95	7257.79[a]±4.23	6913.94[b]±7.36
Total flavonoids (mg/100g)	666.96[c]±4.04	626.93d±3.78	752.02[a]±6.58	693.19[b]±1.74	162.68[e]±5.03	660.81[c]±6.43
Antioxidant activity by DPPH (%)	92.50[d]±0.62	94.35bc±0.52	95.59[a]±0.12	95.23[ab]±0.84	95.32[ab]±0.36	93.37[cd]±0.91
Antioxidant activity by ABTS (%)	86.17[d]±1.15	92.51a±0.24	90.19[b]±0.13	88.86[c]±0.67	89.11[bc]±1.00	92.07[a]±0.11

* Each value in the column followed by the same letter is not significantly different at ($p < 0.05$)
SIU= µgx3.3

Table (5): Sensory evaluation scores of infant foods, (uncooked and cooked for 5 minutes).

Formula	Appearance	Texture	Color	Taste	Aroma	Overall acceptance
Samples before cooking						
Control (1)	$7.60^{a}\pm0.33$	$6.20^{a}\pm0.53$	$6.60^{abc}\pm0.45$	$6.00^{a}\pm0.42$	$7.00^{a}\pm0.42$	$33.40^{ab}\pm1.74$
Carrot (2)	$7.00^{abc}\pm0.42$	$6.80^{a}\pm0.38$	$7.60^{a}\pm0.26$	$6.00^{a}\pm0.51$	$6.00^{ab}\pm0.36$	$33.40^{ab}\pm1.69$
Broccoli (3)	$6.00^{c}\pm0.36$	$6.80^{a}\pm0.48$	$6.00^{bc}\pm0.29$	$5.60^{a}\pm0.26$	$5.60^{b}\pm0.26$	$30.00^{b}\pm1.47$
Cantaloupe (4)	$6.20^{bc}\pm0.13$	$6.20^{a}\pm0.32$	$5.80^{c}\pm0.24$	$6.80^{a}\pm0.44$	$6.60^{ab}\pm0.40$	$31.60^{ab}\pm1.34$
Pear (5)	$7.20^{ab}\pm0.38$	$6.40^{a}\pm0.33$	$7.00^{ab}\pm0.47$	$6.80^{a}\pm0.44$	$6.80^{a}\pm0.32$	$34.20^{ab}\pm1.37$
Pumpkin (6)	$7.60^{a}\pm0.40$	$7.40^{a}\pm0.26$	$7.60^{a}\pm0.49$	$7.00^{a}\pm0.59$	$6.80^{a}\pm0.32$	$36.40^{a}\pm1.58$
Samples after cooking for 5 minutes						
Control (1)	$8.20^{a}\pm0.38$	$7.40^{ab}\pm0.26$	$8.10^{ab}\pm0.17$	$7.90^{a}\pm0.37$	$8.00^{a}\pm0.44$	$39.60^{a}\pm1.16$
Carrot (2)	$8.00^{ab}\pm0.33$	$7.90^{abc}\pm0.34$	$8.70^{a}\pm0.21$	$7.90^{a}\pm0.37$	$8.00^{a}\pm0.42$	$40.50^{a}\pm1.38$
Broccoli (3)	$7.00^{b}\pm0.33$	$7.00^{c}\pm0.25$	$7.20^{c}\pm0.29$	$6.50^{b}\pm0.16$	$6.50^{b}\pm0.16$	$34.20^{b}\pm0.92$
Cantaloupe (4)	$7.90^{ab}\pm0.31$	$7.90^{abc}\pm0.34$	$7.50^{bc}\pm0.30$	$7.80^{a}\pm0.46$	$7.40^{ab}\pm0.42$	$38.50^{a}\pm1.43$
Pear (5)	$8.10^{a}\pm0.34$	$8.00^{ab}\pm0.25$	$8.40^{a}\pm0.30$	$7.30^{ab}\pm0.33$	$7.60^{ab}\pm0.42$	$39.40^{a}\pm1.58$
Pumpkin (6)	$8.10^{a}\pm0.31$	$8.40^{a}\pm0.26$	$8.60^{a}\pm0.37$	$8.30^{a}\pm0.51$	$7.90^{a}\pm0.43$	$41.30^{a}\pm1.68$

** Each value in the column followed by the same letter is not significantly different at ($p< 0.05$)*

Table (6): Fatty acid contents in infant food formulae (%):

Fatty acids		Formulae					
Name of acid	**N0. of C**	**Control (1)**	**Carrot (2)**	**Broccoli (3)**	**Cantaloupe (4)**	**Pear (5)**	**Pumpkin (6)**
Butyric acid	**C:4**	1.51	1.49	1.41	1.37	1.31	1.30
Caproic acid	**C:6**	0.70	0.45	0.49	0.45	0.43	0.41
Caprylic acid	**C:8**	0.44	0.31	0.41	0.43	0.31	0.26
Capric acid	**C:10**	0.74	0.62	0.56	0.46	0.98	0.44
Lauric acid	**C12:0**	1.29	1.05	1.26	1.29	1.12	1.31
Myristic acid	**C:14**	3.07	3.35	3.74	3.27	3.20	3.37
Pentadecnoic acid	**C15:0**	0.58	1.78	0.11	0.15	0.28	0.50
Palmitic acid	**C16:0**	28.54	18.70	24.47	16.23	29.60	26.32
Palmitolic acid	**C16:1**	0.33	0.81	0.82	0.29	0.30	0.49
Margaric acid	**C17:0**	0.26	3.03	0.21	0.12	0.28	1.17
Heptadecanoic acid	**C17:1**	0.07	4.30	0.16	0.04	0.04	0.03
Stearic acid	**C18:0**	6.14	5.67	3.67	4.03	5.14	6.26
Oleic acid	**C18:1**	29.85	26.28	21.92	33.14	30.53	31.53
Linoleic acid	**C18:2**	3.43	2.44	17.12	14.36	0.57	2.04
α- Linolenic acid	**C18:3n3**	1.99	3.12	5.52	4.57	3.07	2.06
Arachidic acid	**C20:0**	0.40	3.52	0.37	0.34	1.96	0.67
Eicosenioc acid	**C20:1**	0.39	3.72	0.70	0.15	1.63	0.34
Behenic acid	**C22:0**	1.27	0.36	0.16	0.31	0.23	0.56
Erucic acid	**C22:1**	15.00	16.00	13.64	13.00	12.02	16.00
Unknown		4.00	3.00	3.26	6.00	7.00	4.94
Saturated fatty acids		44.94	40.33	36.86	28.45	44.84	42.57
Unsaturated fatty acids		55.06	59.67	63.14	71.55	55.16	57.43
Unsat./Sat.		1.23	1.48	1.71	2.51	1.23	1.35
Atherogenic index (AI)		0.76	0.56	0.64	0.43	0.78	0.71

** AI; (C12+4*C14+C16)/∑unsaturated fatty acids*

Table (7): Identified Fractions of Amino acids for prepared infant food formulae (g/16g N).

Amino acid	Control (1)	Carrot (2)	Broccoli (3)	Cantaloupe (4)	Pear (5)	Pumpkin (6)	FAO/WHO/UNU reference protein	
							(0.5 1yr)	(1-2 yr)
Essential Amino acid								
Isoleucine (ILE)	2.58	3.07	2.88	2.47	2.14	2.12	3.2	3.1
Leucine (LEU)	4.51	5.41	5.01	4.35	3.53	3.69	6.6	6.3
Lysine (LYS)	6.48	4.40	4.36	3.41	2.95	2.95	5.7	5.2
Phenylalanine (PHE)	2.63	2.95	2.94	2.57	2.05	2.12		
Tyrosine (TYR)	2.01	2.34	2.17	1.93	1.48	1.66		
Total aromatic amino acids	4.63[b]	5.29[b]	5.11[b]	4.5[b]	3.53[b]	3.78[b]	5.2	4.6
Valine (VAL)	3.40	4.12	3.83	3.41	3.0	3.0	4.3	4.2
Threonine (THR)	2.22	2.68	2.67	2.13	1.81	1.89	3.1	2.7
Methionine	0.98	1.17	1.05	0.94	0.86	0.83		
Cystine (CYS)	0.35	0.56	0.51	0.54	0.43	0.37		
Total sulfur amino acids	1.11	1.73	1.52	1.48	0.29	1.20	2.8	2.6
Total essential amino acids	24.93	26.6	25.38	21.75	17.25	20.63		
Non-Essential Amino acid								
Histidine (HIS)	1.56	1.78	1.66	1.53	1.19	1.25	2	1.8
Alanine (ALA)	2.17	2.73	2.84	2.62	1.71	2.12		
Aspartic (ASP)	6.11	7.86	6.63	6.57	5.62	9.22		
Serine (SER)	2.71	3.01	2.98	2.62	2.10	2.31		
Glutamic (GLU)	12.02	12.60	11.50	11.07	7.91	9.64		
Glycine (GLY)	1.85	2.01	2.50	1.93	1.33	1.66		
Proline (PRO)	4.76	4.91	4.23	4.25	3.33	3.14		
Argnine (ARG)	2.99	3.29	3.28	3.06	2.00	2.31		
Total non-essential amino acids	34.17	38.29	31.62	33.65	25.19	31.65		
Total amino acids	59.1	64.89	56.98	55.4	42.44	52.28		
PER	1.15	1.55	1.40	1.10	0.77	0.85		
BV	62.00	66.24	64.66	61.48	58.00	58.86		

A - FAO/WHO/UNU/ reference protein for children 0.5 to 1 and 1 to 2 years of age (2007)   B- First limiting amino acid.

Table (8): Percentage (DRIs)/ 100g sample for some daily nutrients for infant (6- 24) months.

Items	DRIs	Control (1)	Carrot (2)	Broccoli (3)	Cantaloupe (4)	Pear (5)	Pumpkin (6)
Infants aged 6-12 months							
Protein(g)	11	221.64	163.09	268.73	183.91	190.91	197.18
Fat(g)	30	19.1	23.2	27.43	21.8	18.2	21.4
Carbohydrate(g/d)	95	60.27	64.26	50.13	61.12	63.88	60.38
Ca(mg/d)	270	168.35	301.42	318.29	375.53	370.37	495.9
P(mg/d)	275	133.65	132.69	165.74	128.90	114.17	134.32
Mg(mg/d)	75	120.6	125.4	133.45	137.41	117.17	135.31
Fe(mg/d)	40	4.18	4.88	5.53	10.20	5.70	5.68
Zn(mg/d)	3	80.33	162.33	159.33	175.67	145.33	98.67
K(mg/d)	700	92.25	134.96	133.21	160.41	99.45	155.58
Infant aged 13-24 months							
protein(g)	13	187.54	138	227.38	155.62	161.54	166.85
Fat(g)	19	30.16	36.63	43.32	34.42	28.74	33.79
Carbohydrate(g/d)	130	44.05	46.96	36.63	44.66	46.68	44.12
Ca(mg/d)	500	90.91	162.77	171.88	202.78	200	267.79
P(mg/d)	460	79.90	79.33	99.08	77.06	68.25	80.30
Mg(mg/d)	80	113.06	117.56	125.11	128.83	109.85	126.85
Fe(mg/d)	40	4.18	4.88	5.53	10.20	5.70	5.68
Zn(mg/d)	3	80.33	162.33	159.33	175.67	145.33	98.67
K(mg/d)	3000	21.52	31.49	31.08	37.43	23.20	36.30

Table (9): Cost of formulated infant food and commercial samples (Prices/100g):

Ingredient	Price for fresh (LE)	% of refuse	DM of **Kg** [a]	1	2	3	4	5	6	7
Sprouts wheat grains	10	--	1000	0.50	0.20	0.20	0.20	0.20	0.20	-
Milk powder	120	--	1000	3.60	3.60	3.60	3.60	3.60	3.60	-
Artichoke[c]	12	52	71	3.38	3.38	3.38	3.38	3.38	3.38	-
Carrot	5	5	100	-	1.50	-	-	-	-	-
Broccoli	10	20	96	-	-	3.13	-	-	-	-
Cantaloupe	6	54	54	-	-	-	3.33	-	-	-
Pear	12	22	127	-	-	-	-	2.84	-	-
Pumpkin	8	54	54	-	-	-	-	-	2.4	-
Sum price of 100g sample	-	--	-	7.48	8.68	10.31	10.51	10.02	9.58	-
25% of price gain	-	--	-	1.87	2.17	2.57	2.62	2.50	2.39	-
Commercial sample[d]	-	--	-	-	-	-	-	-	-	22
Total	-	--	-	9.35	10.85	12.88	13.13	12.52	11.97	22

[a] After preparing fruit or vegetables (peeling, removing any waste, and drying).
[b]1 kilo = 3 units of artichoke [c]ommercial made with vegetables
[d]Must add the price of gas electricity and water.

اعدادأغذية الرضع (من سن 6 إلى 24 شهرًا) ببعض الفواكه والخضروات

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الملخص العربي

تلعب أغذية أطفال دورا مهما فى مرحلة نمو الرضع حيث انه خلال تلك الفترة يبدأوا فى اكتشاف النكهات و القوام المختلف للأغذية. وفي هذة الدراسة تم اعداد 6 خلطات من الأغذية التكميلية المقدمه للرضع في تلك الفتره باستخدام القمح المنبت و اللبن المجفف وكذلك الخرشوف كمكونات أساسية فى الخلطات نظرا لاهميتهم الغذائية وخلال هذا البحث تم استبدال 60%من القمح المنبت بكلا من الجزر,البروكلى ,الكانتلوب, الكمثرى و القرع للخلطات من (2 - 6) على التوالى لكل نوع على حدى. و قد تم تقدير التركيب الكميائى , الأنولبين وبعض العناصر الغذائية كذلك تم اجراء تقييم حسى للخلطات و تم تقدير المحتوى من الأحماض الدهنية و الاحماض الأمينية و التى تمت مقارنتها بالمحتوى اليومى الموصى به للاطفال الرضع . و قد أظهرت النتائج أن البروكلى (خلطة 3)يحتوى على أعلى القيم فى معظم العناصر الغذائية, بينما الكانتلوب (خلطة 4)كان يحتوى على أعلى محتوى من الأنيولين (114 ملجم / 100 جم DM) بالمقارنة بالخضروات و الفاكهة المستخدمة فى البحث11.36ppb وجد أن نبات القرع يؤدى لزيادة عنصر السيلنيوم. التقييم الحسى أظهر أن خلطات الجزر و القرع حققت أعلى التقيمات لجمع الصفات بينما اعطت خلطة الكانتلوب و البروكلى أدنى التقيمات. يعتبر حامض البالمتيك و حامض الأوليك هما الحامضيين الأساسيين فى جميع الخلطات . على الجانب الأخر خلطة البروكلى (3) تحتوى على أعلى محتوى لحامض اللينوليك و ألفا لينوليك. و احتوت جميع التركيبات الستة للأغذية التكميلية على الأحماض الأمينية الأساسية بشكل فردي. وقد كان معدل كفاءة الغذاء و البروتين لخلطة رقم 6 أعطى أعلى القيم , وفي نهاية البحث ومن خلال النتائج وجد ان جميع الخلطات تمد الاطفال محل الدراسة باحتياجاتهم اليومية من البروتين وعناصر الكالسيوم و الماغنسيوم و الزنك

الكلمات الدالة : *اغذية الرضع– الخضروات – الفاكهة -حليب بودرة كامل الدسم*