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EVALUATION OF PREPARED DIFFERENT VEGETARIAN FORMULAS

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ABSTRACT

Interest in vegetarian diets is growing due to their healthy benefits. In this study, twelve vegetarian diets were formulated from different vegetables such as cauliflower, green pea, green bean and green squash with different protein sources such as faba bean, chickpea and soybean flour as well as some other fixed ingredients. The twelve vegetarian diets which performed as ready-to-use and ready-to-eat were analyzed for their proximate composition, caloric value, minerals content, vitamins, phyto-pigments and antioxidant activity. In addition, the microbiological attributes such as total viable count, coliform group, *Escherichia coli* and molds and yeasts were enumerated. Moreover, all vegetarian diets were subjected to sensory evaluation using 7-hedonic scale toward (appearance, texture, taste, odor, juiciness, and overall acceptability) with 40 panelists.

Results of composite analysis indicated 67.52 to 73.54, 29.82 to 35.88, 2.63 to 3.29, 5.91 to 8.26, 7.06 to 13.64 and 40.46 to 54.12% for moisture, crude protein, lipids, ash, crude fiber and carbohydrates contents in fresh diets, respectively. After frying, moisture ranged from 42.56 to 54.23% and lipids ranged from 19.72 to 26.76%. Accordingly, crude protein, ash, crude fiber and carbohydrates contents ranged from 18.60 to 25.62, 4.97 to 7.27, 5.86 to 12.86 and 33.57 to 49.28%, respectively. All formulated vegetarian diets were rich in the minerals content. Significant differences ($P<0.05$) were found between macro- and micro-nutrients content of both fresh and fried vegetarian diets. All fresh formulas exhibit appropriate content of vitamin C, chlorophyll a, b and carotenoids which basically depends on the ingredients. Frying process dramatically influenced vitamin C, chlorophyll a, b and carotenoids contents. The lost were 91.02, 79.84, 55.79 and 15.14%, respectively. Significant differences ($P<0.05$) were found in total phenolic compounds content and the antioxidant activity among the most prepared formulas in either fresh or fried vegetarian diets. In addition, the highly consumer acceptability of prepared vegetarian diets confirmed that chickpea formulas were best prepared vegetarian diets. Significant differences ($P<0.05$) in the overall acceptability mean value were found between chickpeas formulas and other formulas. The total viable count of fried diets was very low comparing to the fresh formulas. Whereas no coliform groups, *Escherichia coli* and molds and yeasts have been detected. Finally, the possibility of producing healthy vegetarian diet formulas using common vegetable kinds and protein sources could provide promising approach for improving the traditional meals and human health.

Keywords: Vegetarian diet, vegetables, proximate composition, sensory evaluation, carotenoids, antioxidant activity.

INTRODUCTION

Our food choices do not only affect our own health, but also the health of our ecosystems as well. However, ready-to-eat meat and processed meat consumption have been associated with increase the risk of many diseases. Recently, researchers from the Harvard School of Public Health have found that eating processed meat such as bacon, sausage or processed deli meats was associated with a 42% higher risk of heart disease and a 19% higher risk of type 2 diabetes (Micha *et al.*, 2010).

In the recent years, the meat substituting industry was highly encouraged to reduce the meat consumption and thereby reduce the risk of related disease. Purely, substituting consumption of meat by alternative protein rich products made from plant proteins, so-called Novel Protein Foods, would be an attractive option (Jongen and Meerdink, 2001). However, consumption of meat substitute products as a meal component are still very low compared to meat and poultry products, therefore it is not yet considered as absolute alternative for meat to the majority of consumers, except for vegetarians (PVE, 2003). Just recently in the nineties, new meat substitute products such as Tivallw or Quornw became widely available in Europe (Davies & Lightowler, 1998 and McIlveen *et al.*, 1999).

Traditional vegetarian products such as tofu and tempeh have been consumed for centuries in Asian countries. The term 'vegetarian' is not very straight forward, but it generally describes a range of diets that avoids animal flesh (meat, fish and poultry), with varying degrees of restriction (Silverstone, 1993 and British Nutrition Foundation, 1995). A vegetarian is a person who consumes a diet consisting mostly of plant-based foods including fruit, vegetables, legumes, nuts, seeds, and grains. Whereas, vegetarian diets have been classified in four main types: (1) lacto-ovo vegetarian that eats dairy foods and eggs but not meat, poultry or seafood, (2) lacto-vegetarian that eats dairy foods but not eggs, meat, poultry or seafood, (3) ovo-vegetarian that eats eggs but not dairy foods, meat, poultry or seafood and (4) vegan that does not eat any animal products including meat, poultry, seafood, eggs and dairy foods (Marsh *et al.*, 2009).

Vegetarian diets are not only associated with a decreased frequency of meat consumption but also with a particular belief or lifestyle (Kenyon & Barker, 1998; Worsley and Skrzypiec, 1998 and Kalof *et al.*, 1999). Once appropriately vegetarian diets are often associated with a number of health advantages, including lower blood cholesterol levels in adults and children (Krajcovicova-Kudlackova *et al.*, 1997), lower risk of heart disease (Fraser, 1999), lower blood pressure levels and lower risk of hypertension and type 2 diabetes (Sacks & Kass, 1988 and Micha *et al.*, 2010). Vegetarians tend to have a lower body mass index (BMI) and lower overall cancer rates. Vegetarian diets tend to be lower in saturated fats and cholesterol, and have higher levels of dietary fiber, magnesium, iron and potassium, vitamins C, E and folate, carotenoids, flavonoids and other phytochemicals (Chiplonkar *et al.*, 1999 and Fung *et al.*, 2004). These nutritional differences may explain some of the health advantages of those following a varied, balanced vegetarian diet.

Several commonly consumed vegetables such as cauliflower, green pea, green bean, spanish and green squash were favorable for Egyptian consumers over the years ago. Thus, the objective of this study is a trial to prepare different vegetarian diets from commonly consumed vegetables where saving the meat consumption and increasing the health benefits. The chemical, nutritional, phytochemical, sensory microbiological and characteristics were evaluated. Also, the potential applicability on home and industrial scales to produce ready to use and ready to eat products was studied.

MATERIALS AND METHODS

Materials:

Vegetables sources such as fresh cauliflower (*Brassica oleracea*), green pea (*Pisum sativum* L.), green bean (*Phaseolus vulgaris*) and green squash (*Cucurbita pepo*). Protein sources such as faba bean (*Vicia faba* L.), chickpea (*Cicer arietinum* L.) and defatted soybean (*Glycine max* L.) flour (48% protein and 6% fat). Otherwise, tomato paste (22% TSS), wheat flour (72%), salt and sodium bicarbonate were obtained from local supermarket at Tukh, Qaluobia, Egypt.

Fresh onion and garlic, fresh coriander, dill, parsley and traditional species mixed as [30% pepper, 30% cumin, 20% relish (Boharat), 10% dry coriander and 10% dried chilies] were obtained from spices supermarket at Tukh, Qaluobia, Egypt.

Preparation of different vegetarian ingredients:

All vegetables were sorted and prepared (green leaves of cauliflower were removed then edible part was cut), (green pea was peeled), (end parties of green bean were removed then chopped in 2 cm pieces) and (end parties of green squash was removed and chopped in 1 cm pieces). All prepared vegetables were washed and blanched for appropriate time (5, 4, 5 and 4 min, respectively) using live steam blancher then cooled down using cold water and kept until use under freezing conditions.

Peeled faba bean and unpeeled chickpea were washed and soaked in water for 12 hr then excessive water was drained and chickpea was peeled. Rehydrated faba bean and peeled chickpea were grounded for 3 min using kitchen machine grounder (SIEMENS, type CNCM11ST Germany), while defatted Soybean was rehydrated with water as (1:1.25; w:w).

Additional ingredients such as potato and carrots were terminated, washed, chopped in 1 cm pieces then blanched using live steam blancher for 7 min then immediately cooled down using cold water, peeled and homogenized to a pureed consistency with a kitchen machine. Fresh white egg was separated away from the egg yolk then cooled until use. Fresh onion and garlic were peeled, washed then chopped immediately before the manufacturing of vegetarian diets. Fresh coriander, dill and parsley were washed, teared to shreds then mixed as 60, 20 and 20%, respectively, to prepare the green leafy vegetables mix. The internal seeds of fresh green pepper were removed and the edible part was washed and crushed.

Preparation of different vegetarian formulas:

Twelve fresh vegetarian diet formulas were prepared from the previously prepared ingredients according to formulas presented in Table 1. Two kilograms from each formula were prepared using kitchen machine mixer on speed 2 for succession 2 min.

Each ready-to-use vegetarian diet formula was packaged in 2 polyethylene bags as (0.5 kg for chemical analysis of fresh diet and 1.3 kg for frying process and chemical analysis of fried samples), while 0.2 kg was packaged in sterilized glass jar under sterilization conditions for the microbiological analysis. The big part of prepared vegetarian diet was kept under freezing conditions homogeny of all ingredients for 12-18 hr, while other parties were subjected immediately for the chemical and microbiological analysis.

Table 1. Vegetarian formulas from different prepared fresh vegetarian diet ingredients*.

Ingredients	Fresh vegetarian diets formulas (%) percentage											
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Vegetables												
Blanched cauliflower	30	30	30	–	–	–	–	–	–	–	–	–
Blanched green pea	–	–	–	30	30	30	–	–	–	–	–	–
Blanched green bean	–	–	–	–	–	–	30	30	30	–	–	–
Blanched green squash	–	–	–	–	–	–	–	–	–	30	30	30
Protein sources												
Soaked peeled faba bean	20	–	–	20	–	–	20	–	–	20	–	–
Peeled soaked chickpea	–	20	–	–	20	–	–	20	–	–	20	–
Rehydrated soybean flour (1:1.25, w:w)	–	–	20	–	–	20	–	–	20	–	–	20
Other ingredients												
Blanched potato puree	15											
Wheat flour (72%)	10											
Blanched carrot puree	5											
Egg white	5											
Green leafy vegetables mix #	5											
Fresh onion	3											
Tomato paste (22% TSS)	3											
Fresh green pepper	2											
Salt	1											
Fresh garlic	0.5											
Dried spices*	0.4											
Sodium bicarbonate	0.1											

***: All mentioned raw materials were obtained on fresh status from the local markets at Tukh, Qaluobia, Egypt.**

#: Green leafy vegetables mix (60 % coriander, 20% dill, and 20 %parsley)

***: Traditional species were obtained from spices supermarket and mixed as (30% paper, 30% cumin, 20% relish (Boharat), 10% dry coriander and 10% dried chilies).**

Ready-to-eat vegetarian diets preparation:

Ready-to-eat vegetarian diets were left for thawing at room temperature then mixed with mentioned sodium bicarbonate amount immediately before frying. The vegetarian diet paste was shaped using especial frame and wide knife which designed especially for this purpose (Fig. 1). Appropriate amount of each prepared vegetarian paste was put into the frame, terminated then cut with knife in sequence for (10x1x0.8 cm) directly in sun flower oil-deep frying skillet. The vegetarian bars were fried at

180-200°C for 5 min in medium heated oil with constant stirring. After frying, vegetarian bars were removed using Vinaigrette handful (kitchen tool) then the excessive oil was absorbed on kitchen paper.

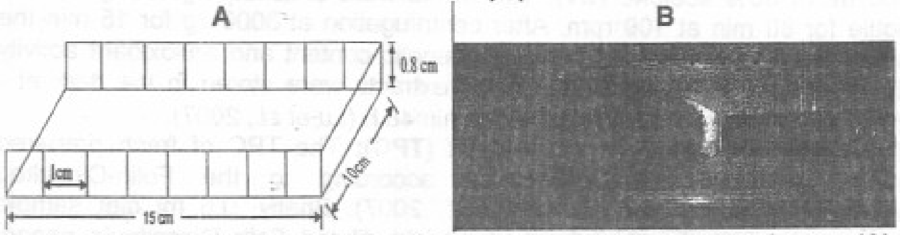

Fig. 1. Geometrical dimensions of vegetarian diets shaping frame, (A): sketch view for frame dimensions (B): live picture view including the cutting knife and frame.

Analytical methods:

Chemical composition: Both fresh and fried vegetarian diets were subjected to chemical analysis. Moisture, lipids, crude protein, crude fibre and ash contents were determined according to AOAC (2000). Carbohydrates content was calculated by difference according to (Merrill and Watt, 1973). The results of the proximate analysis were calculated on dry matter.

Caloric value: the caloric value of different fresh and fried vegetarian diets was calculated basically on the crude protein, lipids and carbohydrates data according to Gebhardt and Thomas (2002).

Minerals content: Sodium, potassium, calcium contents were determined in both prepared fresh and fried vegetarian diets using Atomic Absorption Spectrophotometer, while magnesium, iron, copper, manganese and zinc contents were determined by flame photometry method (Baruah and Borah, 1998). Standard colorimetric method was employed for phosphorus (Thimmaiah, 1999).

Ascorbic acid: The ascorbic acid content, in different vegetarian diets before and after cooking, was determined by using 2,6-dichlorophenol-indophenol titrimetric method according to the AOAC (2000).

Chlorophyll a, b and carotenoids:

Ten grams fresh or fried sample were mixed with 50 ml of 85% acetone in dark bottle and left to stand for 15 hours at room temperature. The mixture was then filtered through glass wool into a 100 ml volumetric flask and made up to volume by 85% acetone solution. The pigment analysis was performed immediately after the solutions were prepared using CE599 universal Automatic Scanning Spectrophotometer at 440, 644 and 662 nm using 85% acetone as a blank (Raghuramulu *et al.*, 1983). The chlorophyll a, b and carotenoids were calculated according to the following equations:

$$\text{Chlorophyll a} = \{(9.784 \,.\, E_{662} - 0.99 \,.\, E_{644}) \,.\, V.\ 100\}/m$$

$$\text{Chlorophyll b} = \{(21.462 \,.\, E_{644} - 4.65 \,.\, E_{662}) \,.\, V.\ 100\}/m$$

$$\text{Carotenoids} = \{(4.695 \,.\, E_{440} - 0.268 \,.\, (5.134 \,.\, E_{662} + 20.436 \,.\, E_{644}) \,.\, V.\ 100\}/m$$

Where:
- E_{662}, E_{644}, E_{440} are the absorbance
- V is the volume of the solvent
- m is the sample weight

Preparation of vegetarian formulas extract: Proper samples of fresh and fried prepared vegetarian diets were hardly mixed by a laboratory mixer with 100 ml of 80% acetone (v/v). The mixes were shacked vigorously in dark bottle for 80 min at 100 rpm. After centrifugation at 3000 *xg* for 15 min the supernatant was collected for total phenolic content and antioxidant activity determination. To avoid oxidation, all extracts were stored in the dark at -20°C and analyses were performed within 48 h (Lu *et al.*, 2007).

Total phenolic compounds content (TPC): The TPC of fresh prepared vegetarian diets was determined according to the Folin-Ciocalteu spectrophotometric method (Lu *et al.*, 2007). Briefly, 0.5 ml diet sample extract was mixed with 2.5 ml of 10-fold diluted Folin-Ciocalteu's phenol reagent and allowed to react for 5 min. Then 2 ml of 7.5% Na_2CO_3 solution was added and the final volume was made up to 10 ml with distilled water. After 1 h of reaction at room temperature, the absorbance at 760 nm was measured. The measurements were compared to a standard curve of prepared gallic acid (GA) solution, and the total phenolic content was expressed as milligrams of gallic acid equivalents (GAE) per gram of dry weight (mg of GAE g^{-1} of dw).

Antioxidant activity: 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of fresh or fried vegetarian diets was determined according to the method of Gaulejac *et al.* (1998) modified by Lu *et al.* (2007). Every extract from fresh diets (0.1 ml) was added to 2.9 ml of $6x10^5$ µmol methanolic solution of DPPH. The absorbance at 517 nm was measured after the solution had been allowed to stand in the dark for 60 min. The Trolox calibration curve was plotted as a function of the percentage of DPPH radical scavenging activity. The final results were expressed as micromoles of Trolox equivalents (TE) per gram of dry weight (µmol TE g^{-1} of DW).

Microbiological examinations:

Total viable count: Ten grams of either fresh or fried vegetarian diets were homogenized with 90 ml sterilize peptone water (pH 7±0.2) to make a first dilution then serial dilutions were carried out. One ml from each dilutants was pour-plated with Tryptic Glucose Yeast Agar (TGYA, Biolife code No. 4021452) in duplicate and incubated at 37°C for 48 hrs to enumerate total viable bacterial loads. Total coliform counts were enumerated using Violet Red Bile Agar (VRBA, Biolife code No. 442185) and incubated at 35°C for 24 hrs. *Escherichia coli* population were enumerated using Eosin Methylene Blue Agar (EMBA, Biolife code No. 40145012) and incubated at 37°C for 24 hrs. Results were expressed as CFU g^{-1} according to described method by (Kang *et al.*, 2003).

Moulds and yeasts: Molds and yeasts were counted according to the method described by Kottapalli & Wolf-Hall, (2008) using rose bengal chloramphenicol agar (RBCA, Biolife, cod. No. 4019912 and chloramphenicol antimicrobial supplement cod. No. 421840003). The plates were inoculated and incubated at 25°C for 5 days. The count was then calculated as CFU g^{-1} of fresh or fried vegetarian diets.

Sensory evaluation: Sensory evaluation of ready-to-eat vegetarian diets immediately after preparation was done. Forty panelists of the staff members and students of Food Science Department and other Departments, Faculty of

Agriculture, Benha University in the age range of 19 and 55 years were asked to evaluate the fried vegetarian bars toward (appearance, texture, taste, odor, juiciness, and overall acceptability). A 7-point hedonic scale (7 being like extremely, 4 like accepted and 1 being dislike extremely) was used to evaluate 12 vegetarian diets formulas to select the best formula for the wide scale production. Results were subjected to analysis of variance and average of the mean values of the aforementioned attributes and their standard error were calculated. The overall acceptability was expressed as percentage of obtained score from all attributes referred to the maximum score of these attributes (Wilson *et al.*, 1998).

Statistical analysis: The statistical analysis was carried out using ANOVA with two factors under significance level of 0.05 for the whole results using Microsoft Excel (2007) and Data were treated as complete randomization design according to Steel *et al.* (1997). Multiple comparisons were carried out applying LSD.

RESULTS AND DISCUSSION

Chemical composition of fresh and fried vegetarian formulas:

Chemical composition and caloric value of 12 prepared vegetarian diets formulas both fresh and fried are presented in Table (2). The moisture content of fresh prepared vegetarian formulas was ranged from a low of 67.52% in F5 to a high of 73.54% in F1, whereas a low of 42.65% in F4 to a high of 54.23% in F12 for fried diets were recorded. Significant differences ($P<0.05$) were found within each vegetable group and among the different groups as well as all formulas in fresh diets.

The same finding was observed after frying except the green squash group which noticed no significant difference ($P>0.05$) within the group. Such variation among the 12 formulas could be due to the different food ingredients of each formula and the cooking method used (Dashti *et al.*, 2001). As expected, the moisture content of deep-fried vegetable diets was reduced about 22.38 g/100 g when calculated on the overall mean of fresh and fried diets moisture contents.

The crude protein content of the 12 formulas varied from 29.82% in F4 to 35.88% in F12 and from 18.60% in F4 to 25.62% in F6 for fresh and fried diets, respectively (Table 2). Fried samples exhibit change in protein content which was around -11.07 g/100 g when calculated on the overall mean of fresh and fried diets. Significant differences ($P<0.05$) were found between soybean formulas and other protein sources formulas in green pea, green bean and green squash formulas, while this finding was not confirmed in cauliflower formulas. Over the four used vegetables, soybean formulas (F3, F6, F9 and F12) exhibit the highest protein content in fresh and fried formulas. The difference in protein content on dry matter in fresh formulas may be due to using different protein sources such as faba bean, chickpea, soybean, wheat flour, white egg and others as well as preparation method used (Messina *et al.*, 2004). In fried sample the variation could be due to increasing the fat content which was influenced by the cooking method.

Table (2): Chemical composition and caloric value of different fresh and fried prepared vegetarian formulas.

Vegetable kind	Protein source	Formula No.	Chemical composition (%)												Caloric value kcal/100 g wet weight	
			Moisture content		Crude protein*		Lipids*		Ash*		Crude fiber*		Carbohydrates*			
			Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried
Cauliflower	Faba bean	F1	a 73.54 ±0.10	cd 48.31 ±0.24	c 30.57 ±0.70	de 19.04 ±0.56	cde 1.33 ±0.13	ab 25.87 ±0.32	c 7.42 ±0.02	ef 5.24 ±0.07	cd 8.77 ±0.19	de 6.34 ±0.09	ab 51.91 ±0.70	bcde 43.51 ±0.31	e 88.83 ±0.28	cd 246.96 ±2.15
	Chickpea	F2	de 71.54 ±0.08	e 46.73 ±0.43	bc 32.31 ±0.68	de 19.45 ±0.69	cd 1.43 ±0.07	a 26.35 ±0.84	d 6.55 ±0.34	ef 5.29 ±0.04	cde 8.24 ±0.22	de 6.41 ±0.12	ab 51.47 ±0.94	cdef 42.50 ±0.58	b 97.31 ±0.27	bc 255.63 ±4.18
	Soybean	F3	a 73.53 ±0.13	f 44.64 ±0.15	ab 34.72 ±0.32	cd 20.68 ±0.59	a 3.29 ±0.23	a 26.76 ±0.87	a 8.20 ±0.06	de 5.69 ±0.03	c 9.11 ±0.52	de 6.47 ±0.42	c 44.68 ±0.52	de 40.40 ±0.73	de 90.54 ±0.34	ab 265.91 ±2.75
Green Pea	Faba bean	F4	f 70.07 ±0.03	f 42.65 ±0.53	c 29.82 ±1.02	e 18.60 ±0.23	c 1.75 ±0.13	a 26.36 ±0.88	d 6.61 ±0.04	f 4.97 ±0.15	cde 8.11 ±0.42	c 6.17 ±0.20	ab 53.71 ±0.97	bcd 43.90 ±0.87	a 102.82 ±0.20	a 276.40 ±3.56
	Chickpea	F5	h 67.52 ±0.06	de 46.84 ±0.69	c 30.93 ±0.95	bc 22.62 ±0.89	cd 1. 39 ±0.13	efg 20.47 ±0.90	e 5.91 ±0.00	ef 5.23 ±0.15	c 8.97 ±0.52	cd 7.66 ±0.58	ab 52.80 ±0.47	bc 44.02 ±1.27	a 110.82 ±0.68	de 236.82 ±4.94
	Soybean	F6	g 69.80 ±0.11	b 49.22 ±1.12	a 35.74 ±1.50	a 25.62 ±1.37	b 2.63 ±0.32	cdefg 21.28 ±1.07	c 7.36 ±0.03	b 6.67 ±0.23	a 13.64 ±1.04	a 12.86 ±1.24	d 40.63 ±2.10	g 33.57 ±1.48	b 98.01 ±1.13	fg 215.29 ±2.03
Green Bean	Faba bean	F7	b 72.37 ±0.16	cd 48.77 ±0.61	c 30.58 ±1.05	cde 20.87 ±1.59	cde 1.30 ±0.17	ab 25.73 ±1.34	c 7.29 ±0.05	de 5.49 ±0.10	b 11.28 ±0.24	c 8.68 ±0.20	b 49.55 ±1.20	f 39.23 ±0.81	de 90.18 ±0.75	d 239.30 ±2.45
	Chickpea	F8	e 71.34 ±0.04	bc 49.97 ±0.59	c 30.33 ±1.66	cde 20.16 ±0.58	cd 1.28 ±0.03	bcd 23.22 ±0.65	c 7.22 ±0.18	cd 5.87 ±0.07	b 10.59 ±0.28	c 8.80 ±0.21	b 50.58 ±2.10	cde 41.95 ±0.60	c 94.34 ±0.53	ef 226.27 ±1.33
	Soybean	F9	cd 71.87 ±0.10	b 50.95 ±0.88	a 35.40 ±0.99	b 22.89 ±0.63	ab 2.93 ±0.18	fg 20.11 ±1.20	a 8.26 ±0.04	bc 6.42 ±0.47	a 12.95 ±0.57	b 10.47 ±0.13	d 40.46 ±1.11	ef 40.11 ±1.71	d 91.51 ±0.65	g 210.12 ±6.09
Green Squash	Faba bean	F10	a 73.52 ±0.04	a 53.72 ±1.29	c 30.27 ±1.09	d 19.44 ±0.79	e 0.86 ±0.09	g 19.72 ±1.14	c 7.33 ±0.06	de 5.70 ±0.24	de 7.52 ±0.16	f 5.86 ±0.34	a 54.02 ±1.14	a 49.28 ±1.89	de 89.64 ±0.28	g 206.75 ±8.69
	Chickpea	F11	e 71.49 ±0.04	a 53.51 ±0.19	c 31.06 ±0.29	cde 20.63 ±0.86	de 1.12 ±0.11	de 20.66 ±0.68	d 6.64 ±0.10	cd 5.97 ±0.09	e 7.06 ±0.19	ef 6.11 ±0.10	a 54.12 ±0.45	ab 46.63 ±1.53	b 98.20 ±0.23	g 208.87 ±2.26
	Soybean	F12	e 71.53 ±0.26	a 54.23 ±0.54	a 35.88 ±0.61	ab 24.92 ±0.93	ab 3.00 ±0.25	ab 25.47 ±0.87	b 7.83 ±0.06	a 7.27 ±0.25	cd 8.63 ±0.38	c 7.89 ±0.54	c 44.66 ±0.62	g 34.45 ±1.38	b 97.95 ±1.58	g 211.79 ±3.97
LSD $_{(P<0.05)}$			0.33	2.03	2.89	2.58	0.51	2.72	0.51	2.72	1.35	1.37	3.39	3.50	2.05	12.27

***: values were calculated on dry weight basis.**

Means with the same latter in the same column are not significant different (*P*>0.05)

Soybean formulated with different vegetables kinds showed the highest lipids contents (2.63 –3.29%) in fresh formulas (Table 2). While, formulated chickpea and faba bean with cauliflower, green pea, green bean and green squash exhibit the lowest lipids contents. This result exuded significant differences between all formulas. Cooking method influenced the lipids content in all fried diets which recorded 21.65 g/100 g more when compared with lipids content mean of fresh formulas. The vegetable kind influenced the increased oil amount which could be arranged as 24.31>21.18>20.78>20.29% for formulated cauliflower, green bean, green pea and green squash with different protein sources, respectively. This finding could be due to the performed structure of different vegetarian diets during preparation and shaping processes which basically depends on the vegetable kind.

Data presented in Table (2) showed that ash content ranged from 5.91% in F5 to 8.26% in F9 for fresh formulas while ranged from 4.97% in F4 to 7.27% in F12 for fried diets. Formulated different vegetables with rehydrated soybean flour exhibit the highest ash content than faba bean or chickpea formulas for each vegetable kind in fresh and fried diets. This may be due to increasing the ash content in rehydrated soybean flour compared to used faba bean or chickpea. Change rate in ash content has been observed after frying by 1.39 g/100 g calculated as general mean comparing fresh to fried diets on dry matter. This is due to increasing the lipids content in the fried diets.

In the same table, the crude fiber content in the 12 prepared formulas was ranged from 7.06% in F11 to 13.64% in F6 for fresh formulas while it was from 5.86% in F10 to 12.86% in F6 for fried diets. As previously found in ash contents formulated different vegetables with rehydrated soybean flour exhibit the highest fiber content compared to faba bean or chickpea formulas for each vegetable kind in fresh and fried diets. It seems to be similar with ash contents data in the change rate. After frying, 1.76 g/100 g in ash content has been changed as general mean comparing fresh diets. This is due to increasing the lipids content in the fried diets.

The carbohydrates content of 12 fresh and fried vegetarian diets varied from 40.46% in F9 to 54.12% in F11 for fresh formulas while it ranged from 33.57% in F6 to 49.28% in F10 for fried diets (Table 2). A versus trend of ash and crude fiber has been in carbohydrates content observed. Formulated vegetables with faba bean or chickpea showed highest carbohydrates content compared to rehydrated soybean flour formulas for each vegetable kind in both fresh and fried diets. As effect of increasing the lipids content 7.35 g/100 g carbohydrates content was changed.

The caloric value of food is considered an important issue allows the nutritionists to calculate the nutrition requirements. In Table 2, the caloric value of the different vegetarian diets formulas was calculated on wet weight basically depends on the chemical composition data. The caloric value was ranged from 88.83 kcal/100 g in F1 to 110.82 kcal/100 g in F5 in fresh formulas. While, it was ranged from 206.75 kcal/100 g in F10 to 276.40 kcal/100 g in F4 for fried diets formulas. Moisture reduction and lipids increases could increase the caloric value by 2.9 fold calculated basically on general mean comparing to fresh diets formulas. These results were i agreement with Gebhardt & Thomas, (2002).

It is highly recommended by many nutritionists the decrease of fat intake in the diet. One way to achieve this goal is through the method of cooking. For example, deep-frying can be changed to grilling which could lead to a drastic change in oil amount in the diet. However, no problem has been recorded from consumption of vegetable oils.

Minerals content of fresh and fried vegetarian formulas:

Mean of triplicates and standard error of minerals content (sodium, potassium, calcium, phosphorus, magnesium, iron, copper, manganese and zinc) in ppm for fresh and fried vegetarian diets formulas are given in Table (3). The minerals contents were changed after frying with different reduction rates. Formulated cauliflower with different legumes showed higher sodium content which remarked with F1 than formulated green Pea where the lowest content was recoded in F6. No significant difference ($P>0.05$) was found between the most of fresh formulas, this may be due to the fixed edible salt content which could be the major source of sodium element. After frying the sodium content was ranged from 681.09 ppm in F4 to 971.95 ppm in F11. Potassium content in formulated vegetables with different protein sources was ranged from a low of 613.76 ppm in F1 to a high of 786.41 ppm in F11. In fried samples, potassium content was changed with different reduction rates to a low of 312.47 ppm in F3 to a high of 708.24 ppm in F11. Significant differences ($P<0.05$) were found among either fresh or fried samples.

Formulated faba bean with different vegetables showed the highest calcium content in fresh prepared diets (F1, F4, F7 and F10). The same trend was also observed in fried samples except formulated green squash with the different protein sources where F12 recorded the highest calcium content inside this group. However, significant differences ($P<0.05$) were also found among both fresh and fried samples.

Phosphorus was also determined in both ready-to-use and ready-to-eat vegetarian diets and results were tabulated in Table (3). Formulated soybean flour with different vegetables seems to be having higher phosphorus content than other formulated protein sources with same vegetables. The same finding was also shown after frying of all formulas. Also, significant differences ($P<0.05$) were also found in phosphorus content among either fresh or fried samples.

Magnesium content of 12 vegetarian diet formulas was assayed before and after frying (Table 3). As previously shown, similar trend of calcium content was found with magnesium content in fresh prepared formulas, a trend which not confirmed after frying. No significant differences ($P>0.05$) were shown in magnesium content among the most of fresh and fried samples.

Iron content in different formulated vegetarian diets is given in the same Table, which was ranged from 2.27 ppm in F2 to 3.52 ppm in F4. While, it was ranged from 1.82 ppm in F3 to 3.03 ppm in F5 in fried samples.

Table (3): Minerals content of different fresh and fried prepared vegetarian formulas calculated on dry matter.

Vegetable kind	Protein source	Formula No.	Minerals content (ppm)																	
			Sodium		Potassium		Calcium		Phosphorus		Magnesium		Iron		Copper		Manganese		Zinc	
			Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried
Cauliflower	Faba bea	F1	a 1110.62 ±38.69	ab 784.13 ±18.13	bcd 613.76 ±15.86	def 433.37 ±10.02	abc 91.81 ±2.37	ab 64.83 ±1.50	de 116.29 ±3.00	de 82.11 ±1.90	a 101.26 ±2.62	bc 71.50 ±1.65	bcd 2.88 ±0.07	de 2.03 ±0.05	c 0.39 ±0.01	d 0.27 ±0.01	abcd 0.96 ±0.02	bc 0.68 ±0.02	def 1.21 ±0.03	ef 0.85 ±0.02
	Chickpea	F2	ab 1070.78 ±28.72	abc 868.01 ±20.60	de 519.80 ±13. 94	ef 421.37 ±9.71	h 31.45 ±0.64	d 25.49 ±1.19	f 76.19 ±2.04	e 61.77 ±2.89	c 67.05 ±1.80	c 54.36 ±2.54	d 2.27 ±0.06	e 1.84 ±0.09	c 0.35 ±0.01	d 0.28 ±0.01	e 0.65 ±0.02	c 0.52 ±0.02	efg 1.05 ±0.03	ef 0.85 ±0.04
	Soybean	F3	ab 1046.89 ±33.07	bc 725.29 ±15.78	e 451.02 ±14.25	f 312.47 ±6.80	def 63.97 ±2.02	c 44.32 ±0.96	b 223.71 ±5.07	c 154.99 ±3.37	bc 80.98 ±2.56	c 56.10 ±1.22	cd 2.63 ±0.08	e 1.82 ±0.04	b 1.16 ±0.04	c 0.81 ±0.02	de 0.78 ±0.02	c 0.54 ±0.01	g 0.83 ±0.03	f 0.58 ±0.01
Green Pea	Faba bea	F4	ab 906.06 ±37.43	c 681.09 ±22.73	abc 711.43 ±22.95	bcde 534.79 ±21.40	a 97.29 ±3.24	a 73.13 ±2.66	c 164.54 ±4.25	cd 123.68 ±9.58	a 114.11 ±8.49	ab 85.78 ±2.64	a 3.52 ±0.26	abcd 2.64 ±0.20	c 0.49 ±0.04	d 0.37 ±0.03	a 1.14 ±0.09	ab 0.86 ±0.07	ab 1.81 ±0.13	bc 1.36 ±0.11
	Chickpea	F5	ab 992.53 ±48.47	abc 882.16 ±33.81	abc 719.63 ±21.25	ab 639.61 ±28.01	fg 49.29 ±2.20	c 43.81 ±1.66	cd 143.93 ±3.25	cd 127.93 ±13.60	a 96.67 ±8.23	ab 85.92 ±3.14	ab 3.41 ±0.29	ab 3.03 ±0.32	c 0.52 ±0.04	d 0.46 ±0.05	abc 0.99 ±0.08	ab 0.88 ±0.09	a 1.91 ±0.16	a 1.70 ±0.18
	Soybean	F6	b 885.37 ±40.16	abc 805.30 ±32.55	cde 584.65 ±16.52	bcde 531.78 ±19.31	cd 78.31 ±3.55	a 71.22 ±2.53	a 282.46 ±6.81	a 256.92 ±19.96	a 102.33 ±4.64	ab 93.08 ±3.23	abc 3.48 ±0.16	a 3.16 ±0.25	ab 1.32 ±0.06	ab 1.20 ±0.09	abc 1.04 ±0.05	a 0.94 ±0.07	bcd 1.51 ±0.07	bc 1.37 ±0.11
Green Bean	Faba bea	F7	ab 902.65 ±33.50	c 679.90 ±25.42	abc 687.20 ±23.57	bcde 517.62 ±19.81	a 104.09 ±5.63	a 78.40 ±3.64	de 121.64 ±2.25	de 91.62 ±8.82	a 108.79 ±8.06	ab 81.94 ±1.88	ab 3.20 ±0.30	bcde 2.41 ±0.23	c 0.43 ±0.04	d 0.32 ±0.03	abc 1.02 ±0.09	ab 0.77 ±0.07	abc 1.68 ±0.16	bcd 1.26 ±0.12
	Chickpea	F8	ab 1081.82 38.32	abc 881.84 ±26.67	ab 758.68 ±20.54	ab 618.44 ±23.77	ef 62.32 ±2.97	bc 50.80 ±1.42	ef 106.45 ±2.49	de 86.77 ±7.64	ab 99.54 ±7.94	ab 81.14 ±2.06	ab 3.36 ±0.27	abc 2.74 ±0.24	c 0.50 ±0.04	d 0.41 ±0.04	abcd 0.94 ±0.07	ab 0.76 ±0.07	a 1.94 ±0.15	ab 1.58 ±0.14
	Soybean	F9	ab 942.74 ±28.64	bc 738.11 ±31.96	cd 600.02 ±17.26	cde 469.78 ±18.53	ab 90.90 ±4.64	a 71.17 ±3.87	ab 256.38 ±5.92	b 200.73 ±15.01	a 103.84 ±6.45	ab 81.30 ±3.13	abc 3.38 ±0.21	abcd 2.65 ±0.33	a 1.34 ±0.08	b 1.05 ±0.13	abc 0.98 ±0.06	ab 0.76 ±0.10	cd 1.48 ±0.09	cde 1.16 ±0.14
Green Squash	Faba bea	F10	ab 933.83 ±28.72	bc 728.15 ±24.02	ab 736.72 ±14.77	abcde 574.46 ±14.73	ab 94.16 ±1.89	a 73.42 ±2.44	de 122.35 ±2.45	de 96.40 ±5.77	a 110.90 ±2.22	ab 86.47 ±2.23	abc 2.94 ±0.06	cde 2.29 ±0.14	c 0.45 ±0.01	d 0.35 ±0.02	abc 0.99 ±0.02	ab 0.77 ±0.05	def 1.24 ±0.02	de 0.97 ±0.06
	Chickpea	F11	a 1079.22 ±43.30	a 971.95 ±36.21	a 786.41 ±17.98	a 708.24 ±32.82	gh 46.48 ±1.02	cd 41.86 ±3.71	ef 102.09 ±3.83	de 91.94 ±8.16	ab 97.35 ±5.42	ab 87.67 ±3.78	abc 2.92 ±0.25	abcd 2.63 ±0.23	c 0.50 ±0.04	d 0.45 ±0.04	cd 0.87 ±0.07	ab 0.78 ±0.07	cde 1.36 ±0.12	cd 1.23 ±0.11
	Soybean	F12	ab 978.39 ±36.37	ab 914.95 ±33.63	bcd 649.57 ±13.32	abc 607.45 ±22.08	bc 80.09 ±2.81	a 74.89 ±2.12	a 262.67 ±5.60	a 245.64 ±13.19	a 106.02 ±6.33	a 99.14 ±4.40	abc 3.13 ±0.30	abc 2.92 ±0.39	a 1.39 ±0.14	a 1.30 ±0.18	abcd 0.95 ±0.09	ab 0.89 ±0.12	fg 1.02 ±0.10	de 0.95 ±0.13
LSD $_{P \le 0.05}$			192.22	208.10	135.48	144.16	15.14	16.42	34.94	43.46	20.06	21.85	0.63	0.69	0.17	0.21	0.19	0.21	0.31	0.32

Means with the same latter in the same column are not significant different ($P>0.05$)

As observed previously, in phosphorus content in both fresh and fried sample formulated soybean with different vegetable exhibit higher copper content than formulated faba bean or chickpea (Table 3). Similar trend of this finding was also confirmed in copper content of formulated soybean with different vegetables after frying. Lowest copper content was recorded in F2 while the highest was in F12 of fresh formulas. In fried samples, the copper content was generally reduced where the low amount was recorded in F1 while the highest amount was recoded in F12. As mentioned with calcium data, formulated faba bean with different vegetables exhibit higher manganese content than chickpea and soybean in fresh formulas (Table 3). This result was not confirmed after frying because manganese content was changed in all fried sample with minus irregular trend. The lowest manganese content 0.52 ppm was recorded in F2 while the highest 0.94 ppm was in F6 in fried samples.

Zinc content was higher in formulated chickpea with green pea, green bean and green squash than formulated faba bean and soybean in fresh formulas. It was ranged from a low of 0.83 ppm in F3 to a high of 1.94 ppm in F8. In fried diets, chickpea formulas were demonstrated the highest zinc content among all diets. zinc content was reduced in all vegetarian diets after frying by different rates (Table 3).

Generally, some formulated vegetables with different protein sources demonstrated increases in some minerals content. This result may be basically depends on depression or increase of these minerals content in vegetable or protein sources. In addition to, the minerals content (DM) of different vegetarian diets had minus changes after frying in all prepared formulas. This may be due to the influence of frying method which could be increased the absorbed oil and consequently the lipids content increased (Table 2). These results were in agreement with (Agte1 *et al.,* 2000 and Borah *et al.,* 2009).

Ascorbic acid, chlorophyll a, b and carotenoids content of fresh and fried vegetarian formulas:

Data in Table (4) shows the content of vitamin C (mg/100 g) in various formulated vegetables to produce 12 vegetarian formulas. The average of vitamin C content of fresh formulas was ranged from 18.55 in F5 to 30.91 mg/100 g in F2. All fresh formulas demonstrated appropriate content of vitamin C which basically depends on the ingredients. Of course, the major sources of vitamin C in these diets will be the unprocessed vegetables. However, the average levels of vitamin C were not high enough in fried samples which were influenced by the cooking method. No significant difference (P>0.05) in vitamin C was found in formulated each vegetable with different protein sources and other ingredients.

Result of chlorophyll (a and b) (mg/g) for fresh and fried vegetarian diets are given in Table (4). chlorophyll (a) was ranged from 10.84 mg/g in F9 to 15.45 mg/g in F7 in fresh formulas. Significant difference (P>0.05) was found in chlorophyll (a) content among the most prepared formulas. Cooking process was influenced the chlorophyll (a) content and reduction rate was observed in all fried diets. The chlorophyll a content was ranged from 1.47 mg/g in F3 to 3.16 mg/mg in F4 and F6 of fried samples.

Table 4. Ascorbic acid, chlorophyll a, b and carotenoids, total phenolic compounds and antioxidant activity of different fresh and fried prepared vegetarian formulas.

Veget-able kind	Protein source	Form-ula No.	Vitamin C (mg/100 g)		Chlorophyll (mg/g) a		Chlorophyll (mg/g) b		Carotenoids (mg/g)		Total phenolic compounds content (mg GAE/g)		Antioxidant activity (µmol TE/g)	
			Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried
Cauliflower	Faba bean	F1	bcd 27.28 ±1.39	de 1.36 ±0.27	ab 14.29 ±0.34	c 2.28 ±0.07	d 46.93 ±0.98	e 19.49 ±0.60	a 2.23 ±0.27	de 1.75 ±0.10	c 20.40 ±0.24	bc 17.93 ±0.30	bcd 33.35 ±4.79	b 65.87 ±0.80
	Chickpea	F2	b 30.91 ±3.68	abc 2.48 ±0.27	bc 13.27 ±0.26	d 1.50 ±0.16	de 44.20 ±0.46	e 19.95 ±0.19	a 2.37 ±0.13	bcd 1.89 ±0.05	ab 23.25 ±0.58	ab 18.81 ±0.31	e 25.54 ±3.14	bc 63.31 ±1.20
	Soybean	F3	bc 28.93 ±1.53	abc 2.53 ±0.49	bc 13.00 ±0.21	d 1.47 ±0.07	de 44.64 ±0.49	f 17.62 ±0.29	a 2.31 ±0.25	de 1.67 ±0.06	a 24.30 ±0.67	def 16.83 ±0.29	d 30.51 ±0.53	cd 60.07 ±0.35
Green Pea	Faba bean	F4	fg 21.03 ±1.31	e 1.23 ±0.25	c 12.55 ±0.16	a 3.16 ±0.08	f 38.58 ±0.98	d 23.38 ±0.71	a 1.75 ±0.36	e 1.60 ±0.10	efg 16.36 ±0.28	g 14.53 ±0.44	fg 20.18 ±3.68	de 58.90 ±1.22
	Chickpea	F5	g 18.55 ±2.16	cde 2.14 ±0.11b	c 12.95 ±1.04	ab 2.75 ±0.20	ef 41.36 ±0.46	cd 24.07 ±0.63	a 2.22 ±0.56	abc 2.06 ±0.10	de 17.58 ±1.20	h 12.55 ±0.26	e 24.64 ±2.18	e 55.64 ±1.11
	Soybean	F6	def 23.51 ±2.32	de 1.33 ±0.27	a 15.12 ±0.28	a 3.16 ±0.18	d 45.83 ±0.49	a 27.09 ±0.42	a 1.90 ±0.24	cd 1.88 ±0.05	[illegible] 21.35 ±0.33	g 14.99 ±0.43	a 40.06 ±5.69	de 58.27 ±0.95
Green Bean	Faba bean	F7	bcde 26.48 ±2.91	bcd 2.28 ±0.39	a 15.12 ±0.28	c 2.23 ±0.17	b 61.50 ±0.63	d 23.09 ±0.37	a 1.99 ±0.35	de 1.80 ±0.05	ab 22.51 ±1.20	cd 17.27 ±0.21	ab 36.05 ±8.76	b 62.56 ±1.02
	Chickpea	F8	a 36.97 ±3.79	abc 2.81 ±0.36	a 15.45 ±0.25	ab 2.84 ±0.23	c 57.40 ±0.62	bc 25.39 ±0.37	a 2.81 ±0.30	a 2.24 ±0.05	e 16.81 ±0.27	cd 17.75 ±0.05	bc 35.50 ±3.82	b 64.26 ±0.67
	Soybean	F9	bcde 27.07 ±2.45	abc 2.54 ±0.45	d 10.84 ±0.38	b 2.68 ±0.15	a 74.56 ±0.65	d 23.52 ±0.35	a 1.96 ±0.42	f 1.36 ±0.08	d 18.06 ±1.16	ef 16.52 ±0.14	bcd 33.57 ±1.22	ab 68.35 ±2.17
Green Squash	Faba bean	F10	ef 22.68 ±2.65	abc 3.11 ±0.25	a 14.84 ±0.56	bc 2.50 ±0.14	a 74.57 ±3.14	d 23.67 ±0.79	a 2.14 ±0.69	a 2.12 ±0.10	a 19.23 ±0.37	efg 16.05 ±0.38	cd 31.44 ±0.46	a 71.62 ±2.40
	Chickpea	F11	cde 24.85 ±2.98	abc 2.81 ±0.35	bc 13.06 ±0.72	c 2.14 ±0.16	c 51.43 ±0.84	d 23.19 ±0.67	a 2.42 ±0.08	ab 2.11 ±0.11	f 16.16 ±0.54	g 14.47 ±0.31	g 19.47 ±0.77	b 64.96 ±0.46
	Soybean	F12	def 24.47 ±2.84	a 3.45 ±0.43	d 10.97 ±0.19	ab 2.84 ±0.21	d 45.44 ±0.64	ab 26.49 ±0.50	a 2.09 ±0.24	d 1.69 ±0.03	cde 17.43 ±0.02	fg 14.53 ±0.39	efg 22.22 ±2.22	b 63.98 ±0.98
LSD $_{(P<0.05)}$			4.42	0.98	1.34	0.47	4.01	1.50	1.06	0.22	2.02	0.93	11.38	3.67

Means with the same latter in the same column are not significant different ($P>0.05$).

Frying the ready-to-use diets to produce ready-to-eat diets was affected the chlorophyll (a) content where 79.84% was influenced.

In the same Table, results of chlorophyll (b) (mg/g) for fresh and fried vegetarian diets are shown. Chlorophyll (b) was ranged from 38.58 mg/g in F4 to 74.57 mg/g in F10 in fresh formulas. Significant difference ($P<0.05$) was found in chlorophyll (b) content among the most prepared formulas. Frying process influenced the chlorophyll (b) content and reduction rate was showed in all fried diets. The chlorophyll (b) content was ranged from 17.62 mg/g in F3 to 27.09 mg/g in F6 of fried samples. Frying as cooking method influenced about 55.79% of chlorophyll (b) content when calculated basically on the general mean of fried samples data.

Table (4) shows the carotenoids content of 12 different prepared formulas after and before frying. All formulas seem to be not rich in the carotenoids in either fresh or fried diets. Formulated four different vegetables with three different legumes mixed with some fixed ingredients evolved carotenoids content in ranged from 1.39 mg/g in F9 to 2.37 mg/g in F2 for fresh formulas. While, it was ranged from 1.28 mg/g in F6 to 2.24 in F8 for fried samples. Formulated chickpeas with different vegetables showed the highest carotenoids content for fresh and fried diets among all formulas. This finding may be due to increasing the carotenoids content in chickpeas grains. These results are in agreement with Gautama *et al.* (2010).

Total phenolic compounds and antioxidant activity of fresh and fried vegetarian formulas:

Total phenolic compounds (TPC) and antioxidant activity of fresh and fried vegetarian diets are presented in Table (4).

Total phenolic compounds (mg GAE/g) of fresh prepared vegetarian formulas were ranged from a low of 16.16 mg GAE/g in F11 to a high of 24.30 mg GAE/g in F3, whereas a low of 12.55 mg GAE/g in F5 to a high of 18.81 mg GAE/g in F2 for fried diets were noticed. Significant differences ($P<0.05$) were found in TPC content among the most prepared formulas in either fresh or fried vegetarian diets.

The evolution of DPPH radical scavenging activity of various prepared vegetarian diet formulas was assayed using the DPPH free radicals before and after frying and given results in Table (4) referred to Trolox equivalent/g (µmol TE/g). The antioxidant activity was ranged from low of 19.23 µmol TE/g in F11 to high of 40.06 µmol TE/g in F6 for fresh formulas. The antioxidant activity increased after frying to be in range from 55.64 µmol TE/g in F5 to 71.62 µmol TE/g in F10 for fried samples. Significant differences ($P<0.05$) were found in the antioxidant activity among the most prepared formulas in either fresh or fried vegetarian diets. This difference may be basically depends on the vegetable and protein sources as well as some components which were performed during the frying process. In addition, increasing the oil content upon frying process could increase the antioxidant content of fried diets indirectly.

Microbiological quality attributes of fresh and fried vegetarian formulas:

The microbiological quality attributes of different prepared vegetarian diets on laboratory scale in both fresh and fried form calculated as CFU g^{-1} are shown in Table 5. The total viable count (TVC) of fresh vegetarian diets was ranged from a low of $1.40x10^4$ CFU g^{-1} in F9 to a high of $1.07x10^5$ CFU g^{-1} in F4, whereas the other prepared formulas were between these numbers. Formulated faba bean with different vegetables exhibit TVC load higher than formulated chickpea or soybean. This may be due to effecting of soaking process which could increase the microbial load thereby increasing the TVC of fresh diets. However, comparing these prepared diets with some traditional Egyptian food tamia powder, (Anon, 2007a) and frozen tamia paste, (Anon, 2007b) which could be quite similar to our products, the microbiological quality of all prepared formulas seems to be in harmony with these regulation. The TVC number was highly reduced after frying the fresh diets for 5 min in hot oil to be in range from a low of $5.35x10^1$ CFU g^{-1} in F11 to a high of $9.35x10^2$ CFU g^{-1} in F10. Unfortunately, no data of fried tamia or such prepared vegetarian formulas in the Egyptian Standards is regulated. coliform group was also counted in fresh prepared formulas to be in range from $3.25x10^2$ CFU g^{-1} in F9 to $1.25x10^3$ CFU g^{-1} in F11. This may be due to the effect of washing water and the unprocessed ingredients to increase the coliform group counts. Otherwise, after frying the coliform group could not be detected, this may be due to the efficient cooking method to reduce its number under the detection limit. The same finding could be found with *E. coli* count which ranged from $1.09x10^2$ CFU g^{-1} in F4 to $9.15x10^2$ CFU g^{-1} in F9. While, in fried samples no *E. coli* colonies have been detected. Moulds and yeasts have been enumerated in either fresh or fried prepared diets. The number of fresh formulas was ranged from $3.10x10^2$ CFU g^{-1} in F12 to $3.50x10^1$ CFU g^{-1} in F3. Also, as shown previously in coliform group and *E. coli* counts in fried samples, no moulds and yeasts have been observed.

Sensory evaluation of ready-to-eat vegetarian formulas:

Sensory evaluation of food products is an important criterion by which its consumer acceptability can be assessed (Samuel *et al.,* 2006). Edible vegetable is a vital component of human diet that should be eaten over the year. The sensory evaluation test on the 12 vegetarian diets, based on the seven-point Hedonic Scale showed that all prepared formulas recorded scores higher than 4 in all tested parameters and more than 70% in the overall acceptability (Table 6). No formulated vegetable with different protein sources has been rejected by all panelists. Appearance score was ranged from a low of 5.13 in F7 and F9 to a high of 6.53 in F2 formulas. Appearance mean value was recorded 25% between very good and excellent while 75% from all samples was recorded score between good and very good. Formulated chickpea with different vegetables showed higher recorded mean value of appearance than formulated faba bean or soybean. Taste mean value was ranged from 4.75 F9 to 5.78 in F2 where 75% of all formulas recorded score between good and very good while just 25% recorded score between acceptable and good. As previously noticed, the chickpea formulas showed better taste than faba bean and soybean formulas for each vegetable.

The same finding was observed for odor, texture juiciness of different prepared vegetarian diets. According obtained data of appearance, taste, odor, texture and juiciness the preferably of various prepared diets could be arranged as chickpea> faba bean> soybean formulas.

Table 5. Total viable, coliform group, *E. coli* and moulds and yeasts counts of different fresh and fried prepared vegetarian formulas.

Vegetable kind	Protein source	Formula No.	Total viable count		Coliform group		*E. coli*		Moulds and Yeasts	
			Fresh	Fried	Fresh	Fried	Fresh	Fried	Fresh	Fried
Cauliflower	Faba bean	F1	$7.95x10^4$	$3.95x10^2$	$6.40x10^2$	–	$1.15x10^2$	–	$1.80x10^2$	–
	Chickpea	F2	$5.00x10^4$	$6.60x10^1$	$7.80x10^2$	–	$2.48x10^2$	–	$2.75x10^2$	–
	Soybean	F3	$1.93x10^4$	$3.55x10^2$	$6.65x10^2$	–	$3.65x10^2$	–	$3.50x10^1$	–
Green Pea	Faba bean	F4	$1.07x10^5$	$8.90x10^2$	$1.22x10^3$	–	$1.09x10^2$	–	$3.75x10^2$	–
	Chickpea	F5	$2.65x10^4$	$7.85x10^1$	$1.05x10^3$	–	$8.75x10^2$	–	$4.10x10^1$	–
	Soybean	F6	$4.95x10^4$	$3.35x10^2$	$6.15x10^2$	–	$3.80x10^2$	–	$1.80x10^2$	–
Green Bean	Faba bean	F7	$3.65x10^4$	$7.00x10^2$	$9.90x10^2$	–	$7.70x10^2$	–	$1.85x10^2$	–
	Chickpea	F8	$5.75x10^4$	$4.35x10^2$	$8.95x10^2$	–	$5.25x10^2$	–	$2.55x10^2$	–
	Soybean	F9	$1.40x10^4$	$3.75x10^2$	$3.25x10^2$	–	$9.15x10^2$	–	$1.60x10^2$	–
Green Squash	Faba bean	F10	$1.06x10^5$	$9.35x10^2$	$8.95x10^2$	–	$4.80x10^2$	-	$2.00x10^2$	–
	Chickpea	F11	$4.25x10^4$	$5.35x10^1$	$1.25x10^3$	–	$5.40x10^2$	-	$1.90x10^2$	–
	Soybean	F12	$1.89x10^4$	$3.15x10^2$	$7.30x10^2$	–	$8.70x10^2$	-	$3.10x10^2$	–

– Not detected meaning.

Table 6. Sensory evaluation of different fried prepared vegetarian formulas.

Vegetable kind	Protein source	Formula No.	Appearance	Taste	Odor	Texture	Juiciness	Overall acceptability (%)
Cauliflower	Faba bean	F1	6.23^{ab} ±0.10	5.28^{cd} ±0.14	5.53^{ab} ±0.09	5.20^{bc} ±0.13	5.35^{abc} ±0.14	78.79^{bc} ±1.10
	Chickpea	F2	6.53^{a} ±0.08	5.78^{a} ±0.13	5.68^{a} ±0.12	5.70^{a} ±0.10	5.65^{a} ±0.11	83.79^{a} ±0.77
	Soybean	F3	5.80^{cd} ±0.10	5.08^{def} ±0.14	5.15^{cd} ±0.14	5.13^{bc} ±0.16	5.23^{bcd} ±0.14	75.36^{d} ±1.25
Green Pea	Faba bean	F4	5.55^{ef} ±0.12d	5.50^{abc} ±0.11	5.20^{bc} ±0.09	5.20^{bc} ±0.12	4.83^{d} ±0.12	75.07^{de} ±0.81
	Chickpea	F5	5.85^{cd} ±0.10	5.63^{abc} ±0.10	5.40^{a} ±0.12	5.63^{a} ±0.11	5.40^{abc} ±0.12	79.71^{b} ±0.98
	Soybean	F6	5.38^{efg} ±0.10	4.75^{f} ±0.15	5.08^{cde} ±0.13	5.15^{bc} ±0.12	4.98^{cd} ±0.14	72.36^{ef} ±1.13
Green Bean	Faba bean	F7	5.13^{g} ±0.10	5.10^{def} ±0.15	5.00^{cde} ±0.15	5.03^{bc} ±0.13	5.03^{cd} ±0.14	72.21^{ef} ±1.38
	Chickpea	F8	5.30^{efg} ±0.13	5.55^{abc} ±0.11	5.03^{cde} ±0.14	5.35^{ab} ±0.13	5.08^{b} ±0.14	75.14^{de} ±1.38
	Soybean	F9	5.13^{g} ±0.11	4.75^{f} ±0.15	4.80^{de} ±0.13	5.08^{bc} ±0.14	4.90^{d} ±0.13	70.43^{f} ±1.22
Green Squash	Faba bean	F10	5.58^{de} ±0.11	5.40^{bcd} ±0.17	5.43^{a} ±0.14	5.00^{bc} ±0.15	5.20^{bcd} ±0.15	76.00^{cd} ±1.29
	Chickpea	F11	6.00^{bc} ±0.13	5.68^{ab} ±0.10	5.50^{a} ±0.11	5.58^{a} ±0.12	5.28^{ab} ±0.11	80.07^{b} ±0.93
	Soybean	F12	5.25^{fg} ±0.12	4.85^{ef} ±0.15	4.78^{e} ±0.13	4.95^{c} ±0.15	5.15^{bcd} ±0.15	71.36^{f} ±1.30
LSD (P<0.05)			0.30	0.37	0.35	0.36	0.37	3.18

Means with the same latter in the same column are not significant different (*P*>0.05)

Comparing among formulated chickpea with different vegetables (F2, F5, F8 and F11), the cauliflower formulas (F2) recorded higher value that green pea, green bean and green squash. This may be due to the effect of cauliflower sensory characteristics which was highly familiar by most panelists. In addition, eating of green pea, green bean and green squash was highly habitual with tomato sauces. This is probably the reason for their high acceptability by the consumers in the sensory evaluation. The given overall acceptability by most panelists confirmed that chickpea formulas could be the best prepared vegetarian diets. The highest mean value was recoded for F2 followed by F11 and F5 then F8. Significant differences (P<0.05) in the overall acceptability mean value were found between chickpeas formulas and other formulas. No significant differences (P>0.05) was recorded between faba bean and soybean formulas except green Squash formulas significant differences (P>0.05) between them was found. The vegetables kind affected the mean values of sensory evaluation for different formulas when compared statistically. Significant differences (P<0.05) were found among chickpea formulas with different vegetables kind which has been generally accepted as edible vegetable in this community. This finding could be helpful to select the highly acceptable formulas for food plant application. Therefore, cauliflower, green pea, green bean and green squash are hereby recommended as edible vegetables, particularly during the summer season when other conventional vegetables are scarce, expensive or not available.

Conclusions

With the growing urbanization, changes in food habits should be occurred. The present results of prepared vegetarian diets could provide appropriate status of these healthy meals. The high antioxidant activity, phyto-pigments and vitamins could maximize the healthy benefits. Moreover, the rich content of macro- and micro-nutrients which will meet a big part of consumer caloric requirements. In addition, the highly consumer acceptability of prepared vegetarian diets could be an encourage motive for plant scale applications. Therefore, it is now imperative that such Egyptian standards for regulate ready-to-use and ready-to-eat vegetarian diets could be required. Many studies about formulate different vegetables with different protein sources to produce functional meals as well as microbiological quality and shelf-life stability should be investigated.

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تقييم خلطات غذائية نباتية مختلفة

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فى الأونة الأخيرة زاد الإقبال على تناول الأغذية النباتية لما لها من فوائد صحية هامة. وفي هذه الدراسة ، تم إعداد اثني عشر خلطة غذائية نباتية مختلفة باستخدام أنواع من الخضروات مثل: القنبيط، البازلاء الخضراء ، والفاصوليا الخضراء والكوسة الخضراء مع مصادر مختلفة من البروتين مثل: الفول البلدى المقشور والحمص المقشور ودقيق فول الصويا منزوع الدهن بالإضافة إلى بعض المكونات الغذائية الأخرى (بطاطس – دقيق القمح ٧٢% - جزر – بياض بيض – خضروات ورقية – بصل – مركز طماطم – فلفل أخضر – ثوم – ملح – توابل جافة – بيكربونات صوديوم). وقد تم تقييم الخلطات الغذائية النباتية الاثني عشر الجاهزة للاستخدام والجاهزة للتناول من حيث التركيب الكيماوى، القيمة السعرية (الحرارية)، ومحتواها من المعادن، وفيتامين ج، والكلوروفيل (أ، ب) والكاروتينات والمواد الفينولية الكلية ونشاطها كمضادات أكسدة. وبالإضافة إلى ذلك ، تم تقدير الحمل الميكروبى مثل: العد الكلى، وبكتريا القولون، الإيشيرشيا كولاى والفطريات والخمائر. وعلاوة على ذلك، كما تم إجراء التقييم الحسى للخلطات المعدة (من حيث: المظهر، القوام ، المذاق، الرائحة، العصيرية والقابلية العامة) بواسطة ٤٠ فرد (أعمار مختلفة ١٨-٥٥ سنة).

وأظهرت النتائج أن محتوى الخلطات الطازجة المعدة من الرطوبة، البروتين الخام، الدهون، الرماد، الألياف الخام والكربوهيدرات تراوحت بين ٦٧,٥٢ إلى ٧٣,٥٤ ، ٢٩,٨٢ إلى ٣٥,٨٨، ٢,٦٣ إلى ٣,٢٩، ٥,٩١ إلى ٨,٢٦، ٧,٠٦ إلى ١٣,٦٤ و ٤٠,٤٦ إلى ٥٤,١٢٪ على التوالي . بينما كان محتوى الخلطات المقلية كالتالى: الرطوبة من ٤٢,٥٦ إلى ٥٤,٢٣٪ والدهون من ١٩,٧٢ إلى ٢٦,٧٦٪. ، فى حين تراوح محتواها من البروتين الخام والرماد والألياف الخام والكربوهيدرات من ١٨,٦٠ إلى ٢٥,٦٢ ، ٤,٩٧ إلى ٧,٢٧ ، ٥,٨٦ إلى ١٢,٨٦ و ٣٣,٥٧ إلى ٤٩,٢٨٪ ، على التوالي. وكانت جميع الخلطات الغذائية النباتية غنية في محتواها من المعادن. أثرت عملية القلي بشكل كبير على محتوى الخلطات الغذائية النباتية من: فيتامين (ج) ، والكلوروفيل أ، ب والكاروتينات. وكان معدل الفقد فيها ٩١,٠٢ ، ٧٩,٨٤ ، ٥٥,٧٩ ١٥,١٤٪ على التوالي. وكان هناك فرق معنوى في إجمالي محتوى المركبات الفينولية ونشاطها كمضادات أكسدة في الوجبات النباتية سواء كانت طازجة أو مقلية. وبالإضافة إلى ذلك ، أظهرت نتائج التقييم الحسى أن الخلطات الغذائية النباتية المعدة باستخدام الحمص كانت أفضل الخلطات بوجه عام. وكان هناك فرق معنوى بين الخلطات المعدة باستخدام الحمص كمصدر للبروتين وباقى الخلطات المعدة باستخدام الفول البلدى أو دقيق فول الصويا وإن كانت جميع الخلطات مقبولة حسيا. وكان الحمل الميكروبى للخلطات المقلية قليلا جدا مقارنة بالخلطات الطازجة. بالإضافة إلى ذلك لم يتم العثور على بكتريا القولون، الأيشيرشيا كولاي والفطريات والخمائر فى الخلطات المقلية. وأخيرا من خلال النتائج المتحصل عليها فإنه يمكن إنتاج خلطات غذائية نباتية صحية باستخدام الخضروات المختلفة ومصادر مختلفة من البروتين وإعدادها على نطاق تجارى مما يفتح رؤى جديدة لتحسين الوجبات التقليدية والصحة العامة للمستهلك.

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