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Chemical and Nutritional Evaluation of Different Seed Flours as Novel Sources of Protein

[1]F. Samia El-Safy, [1]Rabab H. Salem and [2]M.E. Abd El-Ghany

[1]Department of Food Science and Technology,
Faculty of Home Economic, AL-Azhar University, Tanta, Egypt
[2]Department of Food Science and Technology,
Faculty of Agriculture, AL-Azhar University, Cairo, Egypt

Abstract: The present study was carried out to investigate the proximate composition, mineral content, functional properties, protein digestibility, amino acid composition and antinutritional factors of papaya, apple, watermelon, guava, orange, prickly pear, apricot and paprika seed flours. The results indicated that the studied seed flours considered an important new protein sources. All seed flour samples contained considerable amounts of P, Ca, Mg, K, Cu, Fe and Zn which made them potentials for future food supplements. The investigation showed that papaya, apple, watermelon, apricot and paprika seed flours are characterized with good functional properties, beside their high nutritive value which appeared from the amino acid contents of all tested seed flours. Therefore it can be used in food enrichment to compensate the shortage of certain amino acids. It was concluded that investigated seed flours can be used as an effective additives in foods such as meat and cereal products.

Key words: Seed Flours · Minerals Content · Functional Properties · Amino Acid Composition · Antinutritional Factors

INTRODUCTION

One of the most common problems in food processing is the disposal of the sub-products generated. This "waste material" produces ecological problems related to the proliferation of insects and rodents and an economical burden because of transportation to repositories, therefore strategies for the profitable use of these material are needed [1]. In the food processing industry, edible portions of fruits are processed into products such as puree, canned slices, juice and pickles, whereas seeds often will be discarded as waste since it is not currently utilized for commercial purposes [2], seeds are also promising source of useful compounds because of their favorable technological or nutritional properties [3].

Serious protein deficiencies and the high costs of animal protein sources have stimulated research on developing new sources of protein from unexploited sources or wastes and by-products [4]. The papaya seed is currently a waste product as it is often discarded after eaten or processing, whereas seeds constitute 22% of the waste from papaya puree plants [5], papaya seeds are recently gaining importance due to its medicinal value, since it recently had been used in curing sickle cell diseases, poisoning related renal disorder [6] and as anti-helminthes [7]. Also, increasing growth of orange processing industries result in producing large quantities of orange seeds as by-product necessitate the determination of the potential of orange seed utilization in human and /or animal diets [8]. In this context, Shams El-Din and Yassen [9] used guava seeds as an additional source of fiber in cookies.

This study was undertaken to assess chemical composition, mineral content, functional properties, *in vitro* protein digestibility, amino acids profile and antinutritional factors and functional properties of papaya, apple, guava, orange, prickly pear, paprika and watermelon, apricot seed flours to create new use for these seed flours as untraditional protein source in food products with low cost since the production of seed flours is a simple process (by sun drying or dehydration

Corresponding Author: F. Samia El-Safy, Department of Food Science and Technology,
Faculty of Home Economic, AL-Azhar University, Tanta, Egypt.

at low temperature) which change these wastes (seeds) to useful and nutritive protein sources which are acceptable as food and nutritional supplements [8, 9].

MATERIALS AND METHODS

Materials: Papaya fruits (*Carica papaya L.*), apple fruits (*Malus sylvestris*), mature fresh watermelon (*Citrullus vulgaris*), mature orange (*Citrus sinensis*), prickly pear fruits (*Opuntia ficus indica*), apricot (*Prunus armeniaca*) and Paprika (*Capsicum annuum*) were purchased from local market in Alexandria, Egypt, while guava (*Psidium guajava*) seeds as by-products (wastes) were obtained from Edfina Company for Preserved Foods, Alexandria, Egypt.

All currently used chemicals were obtained from Sigma Chemical Co.

Methods

Experimental Treatments

Preparation of Materials: All seeds except apricot seed were manually separated from fruit pulps, cleaned, washed with distilled water, air dried, shelled manually to remove seed coats and the resulting kernels were dried at 50°C in an air oven. The dried kernels were milled in laboratory to pass through 60 mesh sieve. Apricot seeds were washed, sun dried for 3 weeks. The dried kernels were crushed by manual cracking, boiled for 30 min. in 0.1 % sodium carbonate and then soaked for 48 min. in distilled water to remove bitterness (detoxification). After that, brown skin was removed, dried at 50°C in air oven, milled in laboratory to pass through 60 mesh sieve. All resulting flours were packed into clean airtight polyethylene bags and kept at 4°C until utilization.

Analytical Methods

Chemical Analyses: Moisture content, crude protein (N x 6.25), ether extract, crude fiber and ash were determined according to AOAC [10], while carbohydrate was calculated by subtraction.

Amino Acids Content: Amino acids composition was determined according to Cohen *et al.* [11].

Mineral Contents: Ca, Mg, K, Na, Zn, Mn, Cu and Fe contents were determined by using Perkin Elmer Atomic Absorption Spectrophotometer (Mode 119 CL), while phosphorus content was determined by the method of A.O.A.C [12].

Functional Properties: Protein solubility (PS) was determined according to the method of Aluko and Yada [13]., Emulsifying capacity and emulsion stability determined according to the method of Ockerman [14], foaming expansion (FE) and foaming stability (FS), were determined according to the procedure described by sadeghi and Bhagya [15]. The water and oil absorption capacity was determined as described by Sosulski and McCurdy [16] and was expressed as the percentage of increase in the sample weight.

***In vitro* Protein Digestibility:** The *in vitro* protein digestibility was determined as described by Salgo *et al*. [17], protein digestibility was calculated from the following equation:

$$\text{Protein digestibility (\%)} = \text{digestible protein} / \text{Total protein} \times 100$$

Aninutritional Factors: Phytic acid was determined according to the method of Wheeler and Ferrel [18]. Tannins were determined by method described by Price *et al*. [19]. Trypsin inhibitor activity was determined according to the method of Kakade *et al.* [20], while oxalate was determined according to the method described by Falade *et al.* [21].

Statistical Analysis: Triplicate samples were statistical analyzed, using ANOVA test according to Steel and Torrie [22].

RESULTS AND DISCUSSION

Chemical Composition of Selected Seeds: Table 1 shows the proximate composition of tested seed and kernel flours. From Table 1 it could be observed that there were significant ($p< 0.05$) differences among the studied seed and kernel flours in their contents of crude protein, crude lipids, crude fiber, ash and carbohydrate. Regarding crude protein, apple, papaya and watermelon seed flours contained significantly ($p< 0.05$) higher levels of protein (30.11-33.79%) than other seed flours, Concerning lipids, orange, apricot and watermelon seed flours contained significantly ($p< 0.05$) higher levels (45.05-54.20%), which reflect the importance of such seeds for oil production. These results are in agreement with the foundations of Galal [23], Mabaleha *et al.* [24] and Alobo [25]. Also, from the same table it could be noticed that guava seeds had the highest amount of crude fiber (64%) therefore; guava seeds could be considered as a good source of dietary fiber while water melon and apricot seed flours showed

Table 1: Proximate chemical composition (%) of tested seeds

Parameter	Chemical composition (%) of tested seed flours (on dry basis)*							
	Papaya	Apple	Watermelon	Guava	Orange	Prickly pear	Apricot	Paprika
Crude protein	31.26±.11^{b}	33.79±.11^{a}	30.11±.32^{c}	7.90±.34^{g}	3.06±.32^{h}	16.60±.33^{f}	26.76±.11^{d}	25.33±.16^{e}
Crude Lipids	32.50±.02^{d}	30.73±.12^{e}	45.05±.12^{c}	16.20±.22^{g}	54.2±12^{a}	17.21±.11^{g}	51.26±.10^{b}	26.88±.07f
Crude fiber	5.19.±.11^{e}	8.32±.33^{d}	3.47±.009^{f}	64.67±.11^{a}	5.50±.08^{e}	49.60±.21^{b}	3.43±.0^{f}	33.83±0..31^{c}
Total ash	8.89±.21^{a}	3.66±.23^{c}	3.75±.11^{c}	0.96±.51^{e}	2.50±.23^{d}	3.14±.04^{c}	2.32±.11^{d}	5.42±1.12^{b}
Carbohydrate**	22.154±.11^{b}	23.50±.08^{b}	17.62±.02^{c}	10.27±.07^{e}	34.74±.01^{a}	13.45±.11^{d}	16.23±.05^{c}	8.54±.09^{f}

* Values are means ± standard deviation of triplicate trails.

** Carbohydrate was calculated by subtraction; Means with the same superscript are not significantly different at 5%

Table 2: Minerals contents of tested seed and kernel flours (mg/100g dry weight flour)

Mineral	Mineral contents of tested seed flours*							
	Papaya	Apple	Watermelon	Guava	Orange	Prickly pear	Apricot	Paprika
Calcium	42.89^{f}	210.00^{a}	86.75^{c}	172.36^{b}	36.56^{g}	58.50^{e}	67.12^{d}	172.13^{b}
Magnesium	2.34^{h}	510.00^{c}	1118.0^{a}	158.65^{f}	719.79^{b}	11.73^{g}	402.00^{e}	473.67^{d}
Potassium	25.13^{h}	650.00^{c}	598.95^{d}	895.11^{b}	145.11^{g}	280.28^{e}	210.13^{f}	1195.00^{a}
Manganese	1.12^{h}	3.60^{d}	10.20^{a}	1.38^{g}	2.12^{e}	6.13^{c}	1.56^{f}	8.67^{b}
Sodium	35.49^{f}	214.11^{b}	90.35^{c}	750.86^{a}	6.50^{h}	10.62^{g}	38.16^{d}	36.43^{e}
Copper	1.49^{f}	3.09^{c}	1.66^{f}	1.38^{g}	3.72^{b}	2.54^{e}	2.82^{d}	4.11^{a}
Iron	3.98^{g}	27.10^{a}	10.70^{e}	11.71^{d}	6.40^{f}	13.41^{c}	13.21^{c}	13.56^{b}
Znic	2.88^{e}	1.80^{f}	9.65^{b}	1.84^{f}	15.71^{a}	1.36^{g}	6.34^{d}	8.50^{c}
Phosphorus	578.8^{d}	666.50^{c}	1073.3^{b}	316.22^{f}	390.70^{e}	24.93^{h}	283.00^{g}	1119.33^{a}

* Means in the same row with different letters are significantly different ($p< 0.05$)

the lowest dietary fiber contents. Regarding the ash content papaya and paprika seed flours were contained the higher contents while guava seed flour contained the lowest ash content among the tested seed flours. Regarding carbohydrate content, guava seed flour exhibit the highest content, while paprika seed flour contained the lowest carbohydrate content among the tested seed flours.

Minerals Composition: Table 2 presents the mineral content of selected seed flours. Regarding calcium, apple, guava and paprika seed flours showed significantly ($p< 0.05$) higher contents when compared with all tested seed flour while, orange seed flour contained the lowest value. Concerning magnesium, paprika and apricot seed flours showed significantly ($p< 0.05$) higher values than all tested seed flours while, papaya showed the lowest value. Regarding potassium, paprika seed flour showed superior value, while papaya seed flour showed the lowest value when compared with other seed flours. Regarding manganese, water melon seed flour exhibit the highest value while papaya seed flour showed the lowest value among all tested seed flours. Concerning sodium content, guava seed flour showed the highest content while, orange seed flour contained the lowest value. Regarding copper contents of tested seed flours, all tested seed flours exhibit minor copper content ranged between (1.38-411 mg/100g). Regarding iron contents of the tested seed flours apple showed the highest value while papaya seed flour showed the lowest iron content. Concerning zinc contents of the tested seed flours, orange seed flour showed the highest value while apple seed flour contained the lowest zinc content. Regarding phosphorus, paprika and water melon seed flours showed higher contents than all tested seed flours while prickly pear exhibit the lowest value these results are in good agreements with the foundations of El-Adaway and Taha [26], Eyidemir and Hayta [27], Ozcan and Juhaimi [28]and Adesuyi and Ipinmoroti [29].

Functional properties: Table 3 shows the functional properties of selected seed flours. Papaya, apple and watermelon seed flours had significantly ($p< 0.05$) higher water absorption capacity more than other seed flours, while the lowest value of water absorption was obtained by apricot seed flour. This related to the high contents of protein in papaya, apple and watermelon flours, which possess polar sites of amino acid residues which extensively appeared on the protein surface matrix and subsequently bind more water as reported by Yung and Khanzada [30]. Regarding fat absorption the highest value was obtained by orange seed flour followed by prickly

Table 3: Functional properties of tested seed and kernel flours

	Functional properties of tested seed flours							
Property	Papaya	Apple	Water-melon	Guava	Orange	Prickly pear	Apricot	Paprika
Water absorption capacity (g /g)	3.39^{b}	3.58^{a}	2.66^{c}	1.55^{f}	1.20^{g}	2.16^{e}	1.28^{g}	2.25^{d}
Fat absorption capacity (ml / g)	2.44^{e}	1.19^{g}	3.85^{c}	2.30^{f}	4.90^{a}	3.92^{b}	3.79^{c}	3.16^{d}
Emulsification capacity *	88.72^{b}	78.11c	98.4a	55.81d	50.96g	51.16f	53.66e	55.30d
Emulsification stability (%)	42.83c	43.60^{b}	44.00^{a}	39.52^{d}	36.60^{e}	18.13^{h}	33.76^{f}	19.22^{g}
Foam expansion (%)	17.33^{b}	13.60^{d}	18.15^{a}	11.60^{e}	11.72^{e}	14.21^{c}	11.86^{e}	13.23^{d}
Foam stability (%)	79.78	79.45	64.85	79.69	59.77	63.69	55.13	63.23
Protein solubility (%)								
in-Water distilled	23.31	24.2	24.10	22.60	23.11	22.13	23.16	25.60
in-sodium chloride (1.0 M)	80.22	79.30	78.85	79.71	76.81	77.41	80.13	78.76
In vitro protein digestibility (%)	80.69^{e}	77.49^{g}	91.23b	92.00^{a}	86.77^{d}	76.86^{h}	88.45^{c}	78.34^{f}

* ml oil / g protein, Means in the same row with different superscript are significantly different ($p< 0.05$)

pear and apricot, while the lowest value was obtained by apple seed flour, the variation in fat absorption capacity may be due to the variation in protein concentration, degree of interaction with water and oil and conformational characteristics, Butt and Batool [31].

Maximum emulsification capacity and stability were observed for watermelon kernel flour (98.4 ml oil / g protein) followed by papaya seed flour (88.72 ml oil/g protein) and apple seed flour (78.11 ml oil / g protein), whilst the lowest value (50.96 ml oil / g protein) was observed in orange seed flour, while the lowest emulsion stability was noticed for prickly pear seed flour, these results are in concordance with those reported by Alobo [25].

Concerning foaming expansion, watermelon and papaya seed flours exhibited the high foaming expansion values, where guava, orange and apricot seed flours were exhibit low foaming expansion values which may be due to the high fat contents, since fat act as an inhibitor of foaming as reported by Mittal and Kumar [32].

Regarding foaming stability, papaya, apple and guava seed flour exhibited the high foaming stability values, while the lowest foaming stability percent was obtained by apricot seed flour.

From the tabulated data, it could be noticed that protein solubility of all flour samples in sodium chloride (5%) were higher than in distilled water. This could be due to the fact that distilled water extracts only albumin, while sodium chloride extracts albumin and globulin [33].

The highest *in vitro* protein digestibility value was obtained by of guava seed flour, while the lower values were obtained by prickly pear, apple and paprika seed flours which could be attributed to higher contents of trypsin inhibitor and tannin than other flours, these results were in accordance with the foundation of Nicanor *et al*. [34].

Amino Acids Composition: The protein quality of tested seed flours was evaluated according to its content of indispensable amino acids (IAAs), in comparison to the reference protein pattern of FAO/WHO [35], also the content of dispensable amino acids (DAAs) as shown in Table 4 while, amino acid scores were tabulated in Table 5. From the obtained data it could be observed that all tested seed flours contain adequate amount of leucine except orange seed flour which was deficient in it comparing with FAO/WHO protein pattern reference. Regarding isoleucine, prickly pear, apricot and paprika seed flours were contained adequate amount as compared with FAO/WHO protein pattern reference while the remained tested seed flours were deficient in isoleucine. Concerning methionine, guava seed flour was the only tested protein which contain highly adequate amount, while the remained tested seed flour were deficient as compared with FAO/WHO protein pattern reference. All tested seed flours were contained adequate amount of phenylalanine. Regarding lysine paprika, prickly pear, watermelon and papaya seed flour were contained adequate amount of lysine, while the remained tested seed flours were deficient as compared with FAO/WHO protein pattern reference. n concerning theroenine all tested seed flour except paparika seed flour are deficient in theroenine when compared with FAO/WHO protein pattern reference. Also, apricot and paprika seed flours were contained adequate amount of tyrosine while the remained tested flours were deficient when compared with FAO/WHO protein pattern reference. Apricot, guava, prickly pear and paprika were contained adequate amounts of valine while the remained tested flours were deficient when compared with FAO/WHO protein pattern reference. These results were in agreement with the fondations of El-Adaway and Taha [26], Nicanor *et al*. [34] and Azouz *et al.* [36]. Also, from the same data it

Table 4: Amino acids composition of some seed and kernel flours (g / 100g protein)

Amino acids	Papaya seed	Apple seed	Watermelon kernel	Guava seed	Orange seed	Prickly pear seed	Apricot kernel	Paprika seed	FAO/WHO(1993)
IAA*									
Leucine	7.76	6.72	5.82	6.11	3.94	7.36	3.45	5.61	4.9
Isoleucine	3.21	3.28	3.06	3.21	2.19	4.60	4.62	4.06	4.2
Methionine	1.34	0.92	1.29	4.09	1.12	0.65	1.22	1.18	2.2
Phenylalanine	3.44	4.21	4.52	2.83	3.06	3.75	6.78	4.32	2.8
Lysine	4.25	2.44	4.75	1.66	1.78	4.89	1.96	8.13	4.2
Threonine	2.88	2.56	3.41	3.92	1.86	1.31	0.91	4.95	4.0
Tyrosine	2.19	3.62	2.84	3.46	1.68	2.31	6.13	4.11	4.1
Valine	2.31	3.92	3.42	4.88	3.07	4.35	5.13	4.33	4.2
Cystine	1.21	1.44	1.42	2.18	1.10	1.01	1.24	1.82	-
Total IAA	28.59	29.11	30.35	31.33	19.80	30.23	31.44	38.51	30.5
DAA**									
Aspartic	7.51	8.21	5.69	6.12	5.48	7.66	12.92	15.12	
Glutamic	13.01	18.62	11.73	8.96	15.94	16.21	18.36	16.31	
Serine	3.12	3.59	4.26	7.03	2.39	6.16	5.44	6.42	
Proline	2.44	4.88	3.51	7.84	2.56	3.62	4.11	4.67	
Glycine	4.42	5.09	4.59	4.16	3.22	3.78	8.21	4.22	
Alanine	3.22	3.87	6.38	6.33	2.31	3.51	7.21	5.17	
Histidine	2.23	2.12	3.22	1.87	1.28	2.32	3.06	1.56	
Argnine	6.53	11.82	14.15	9.25	6.95	4.79	5.14	8.74	
Total DAA	42.48	58.20	53.53	51.56	40.13	48.05	64.45	62.21	
IAA / DAA	0.67	0.50	0.57	0.61	0.49	0.63	0.49	0.62	

* IAA, indispensable amino acids

**DAA, dispensable amino acids

Table 5: Amino acids scores of selected seed and kernel flours

	Amino acids scores of selected seed flours							
Amino acids	Papaya	Apple	Watermelon	Guava	Orange	Prickly pear	Apricot	Paprika
Leucine	161.67	140.00	121.29	127.29	82.08	153.33	71.88	116.88
Isoleucine	76.43	78.10	72.86	76.43	52.14	109.52	110.00	96.67
Methionine	60.91	41.82	58.64	185.91	50.91	29.55	55.45	53.64
Phenylalanine	122.86	150.36	161.43	101.07	109.29	133.93	242.14	154.29
Lysine	101.19	58.10	113.10	15.71	42.38	116.43	46.67	193.57
Threonine	72.00	64.00	85.25	98.00	46.50	32.75	22.75	123.75
Tyrosine	53.41	88.29	69.27	84.15	40.98	56.34	149.51	100.24
Valine	55.00	93.33	77.14	116.19	73.10	103.57	122.41	103.10

could be observed that paprika seed flour was contained the highest value of total indispensable amino acids content, while orange seed flour was contained the lowest total indispensable amino acids content.

Regarding total indispensable amino acids, paprika and apricot seed flour were contained higher contents the other tested seed flour, while orange seed flour exhibited the lowest value.

Antinutritional Factors: Antinutritional factors of studied seed flours are shown in Table 6. The high levels of phytic acid were noticed in papaya and apple seed flours (23.25 and 29.19 mg /100g sample, respectively, while the lowest level of phytic acid (1.28 mg /100g sample) was found in paprika seed flour. These findings are in good agreement with those reported by El-Adawy and Taha [26] for paprika seed flour. The problem with phytic acid in foods is that it can bind some essential minerals nutrients in the digestive tract and can result in mineral deficiencies. The high values of tannins were found in papaya, apple seeds and apricot kernel flours (10.60, 8.55 and 4.63 mg /100g sample, respectively). Adesuyi and Ipinmoroti [29] reported that the tannin ranges from 0.25-0.28% for papaya seed flour samples. Trypsin inhibitor unit ranged between 2.53 (TIU/mg protein) for prickly pear seed flour to 1.22 (TIU/mg protein) for guava seed flour. Trypsin inhibitor is heat labile and can be inactivated by heat treatment such as steaming and extrusion cooking Liener [37]. Also, obtained results showed that oxalate content was highly distributed in

Table 6: Antinutritional factors of selected seed and kernel flours (mg/100g dry weight flour)

Antinutritional factors	Papaya	Apple	Watermelon	Guava	Orange	Prickly pear	Apricot	Paprika
Phytic acid	23.25^{b}	29.19^{a}	2.63^{f}	8.65^{e}	10.71^{d}	13.22^{c}	3.44^{f}	1.28^{g}
Tannins	10.60^{a}	8.55^{b}	0.24^{f}	2.36	3.50^{d}	2.56^{e}	4.63^{c}	0.48^{f}
Trypsin inhibitors *	1.77^{b}	2.08^{a}	1.46^{c}	1.22^{c}	1.76^{b}	2.53^{a}	1.34^{c}	1.96^{b}
Oxalate	1.89^{d}	3.15^{b}	0.407^{f}	2.43^{c}	2.48^{c}	4.54^{a}	1.06^{e}	3.74^{b}

* TIU/mg protein

Means in the same row with different superscript are significantly different ($p< 0.05$)

prickly pear and paprika seed flours while the lowest value was obtained by watermelon. In general antinutritional factors and toxic substances found in nuts grains and seed can be minimized or eliminated by soaking. These inhibitors and toxic substances are enzyme inhibitors, phytates (phytic acid), polyphenols (tannins) and goitrogens as reported by Bajpai *et al.* [38].

Finally it could be concluded that investigated seed flours can be used as an effective additives in foods such as meat products, doughnuts, pancakes and in stabilizing colloidal food systems, whereas water and oil binding properties are of prime importance, also these seed flours may be used in food enrichment to compensate the shortage of certain amino acids with regarding removing of antinutritional factors or avoiding use these proteins, when affect the mineral content of the food which added to it.

REFERENCES

1. Hussein, A.M.S., M.M. Kamil and G.F. Mohamed, 2011. Physicochemical and sensorial quality of semolina defatted guava seed flour composite pasta. J. Amer. Sc., 7(6): 623-629.
2. Ajila, C.M., K.A. Naidu, S.G. Bhat and R. Prasada, 2007. Bioactive compounds and antioxidant potential of mango peel extract. Food Chem., 105: 982-988.
3. Schieber, A., F.C. Stintzing and R. Carle, 2001. By-products of plant food processing as a source of functional compounds-recent developments. Trends Food Sci. and Techn., 12(11): 401-413.
4. Perumal, S., B. Klaus and P.S.M. Harinder, 2001. Chemical composition, protein fractionation, essential amino acid potential and antimetabolic constituents of an unconventional legume, Gila bean (*Entada phaseoloides* Merrill) seed kernel. J. Sci. Food, Agric., 82(2): 192-202.
5. Marfo, E.K., O.L. Oke and O.A. Afolabi, 1986. Some studies on the proteins of Carica papaya seeds. Food Chem., 22(4): 267-277.
6. Imaga, N.O.A., G.O. Gbenle, V.I. Okochi, S.O. Akanbi, S.O. Edeoghon, V. Oigbochie, M.O. Kehinde and S.B. Bamiro, 2009. Antisickling property of Carica papaya leaf extract. African J. Biochem. Res., 3: 102-106.
7. Okeniyi, J.A.O., T.A. Ogunlesi, O.A. Oyelami and L.A. Adeyemi, 2007. Effectiveness of dried Carica papaya against Human intestinal parasitosis: A pilot study. J. Med. Food, 10: 194-196.
8. Akpata, M.I. and P.I. Akubor, 1999. Chemical composition and selected functional properties of sweet orange (*Citrus sinensis*) seed flour. Plant Foods Hum. Nutri., 54: 353-362.
9. Shams El-Din, M.H.A. and A.A.E. Yassen, 1997. Evaluation and utilization of guava seed meal (*Psidium guajava* L.) in cookies preparation as wheat flour substitute. Nahrung, 41: 344-348.
10. A.O.A.C., 2000. Official Methods of Analysis. 17th ed. of the association of official analytical chemists. Gaithersburg M D. USA.
11. Cohen, S.A., M. Mewyes and T.L. Travin, 1989. The Pico Tag Method. In A manual of advanced techniques for amino acid analysis, Millipore, USA.
12. A.O.A.C., 1990. Official methods of analysis (15th ed.). Washington, DC: Association of Official Analytical Chemists.
13. Aluko, R.E. and R.Y. Yada, 1993. Relationship of hydrophobicity and solubility with some functional properties of cowpea (*Vigna unguiculata*) protein isolate. J. Sci. Food Agric., 62: 331-335.
14. Ockerman, H.W., 1985. Quality Control of Postmortem Muscle Tissue, 2nd edn, 2, The Ohio State University, Columbus.
15. Sadeghi, M.A. and S. Bhagya, 2009. Effect of Recovery Method on Different Property of Mustard Protein. World Journal of Dairy and Food Sciences, 4(2): 100-106.
16. Sosulski, F.W. and A.R. McCurdy, 1987. Functionality of flour, protein fraction and isolate from field peas and faba bean. J. Food Sci., 52: 1010-1014.

17. Salgo, A., K. Granzler and J. Jecsai, 1984. Simple enzymatic methods for predication of plant protein digestibility. In R. Lasztity and M. Hidvegi, Proc. Int. Assoc. Cereal Chem. Symp Budapest: Akademiai Kiado, pp: 311-321.
18. Wheeler, E.I. and R.E. Ferrel, 1971. A method for phytic acid determination in wheat and wheat fractions. Cereal Chem., 48: 312-316.
19. Price, M.L., S.V. Scoyoc and L.G. Butter, 1978. A critical evaluation on the vanillin reaction as an assay for tannin in sorghum grain. J. Agric. Food Chem., 26: 1214-1218.
20. Kakade, M.L., J.J. Rackis, J.E. McGhee and G. Puski, 1974. Determination of trypsin inhibitors activity of soy products: A collaborative analysis of an improved procedure. Cereal Chem., 51: 376-383.
21. Falade, O.S., A.F. Dare, M.O. Bello, B.O. Osuntogun and S.R.A. Adewusi, 2004. Varietal changes in proximate composition and the effect of processing on the ascorbic acid content of some Nigerian vegetables. J. Food Tech., 2: 103-108.
22. Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of statistics. New York: McGraw-Hill.
23. Galal, I.M.I., 1992. Chemical Valuation and Utilization of Some Wastes from Caning Industry. M.Sc. Thesis, Faculty of Agriculture Ain Shams University, Cairo Egypt, pp: 36-40 and 46-48.
24. Mabaleha, M.B., Y.C. Mitei and S.O. Yeboah, 2007. A comparative study of the properties of selected melon seed oils as potential candidates for development into commercial edible vegetable oils. J. Am. Oil Chem. Soc., 84: 31-36.
25. Alobo, A., 2003. Proximate composition and selected functional properties of defatted papaya (*Carica papaya* L.) kernel flour. Plant Foods for Hum. Nutr., 58: 1-7.
26. El-Adawy, T.A. and K.M. Taha, 2001. Characteristics and composition of different seed oils and flours. Food Chem., 74: 47-54.
27. Eyidemir, E. and M. Hayta, 2009. The effect of apricot kernel flour incorporation on the physicochemical and sensory properties of noodle. African J. Biotech., 8(1): 085-090.
28. Ozcan, M.M. and F.Y. Juhaimi, 2011. Nutritive value and chemical composition of prickly pear seed (*Opuntia ficus indica* L.) growing in Turkey. Int. J. Food Sci. Nutr., 62(5): 533-536.
29. Adesuyi, A.O. and K.O. Ipinmoroti, 2011. The nutritional and functional properties of the seed flour of three varieties of *Carica papaya.* Curr. Res. Chem., 3(1): 70-75.
30. Yung, C.M. and G. Khanzada, 1987. Functional properties of determined oat protein isolates. J. Food Sci., 52: 1583.
31. Butt, M.S. and R. Batool, 2010. Nutritional and functional properties of some promising legumes protein isolates. Pakistan J. Nutr., 9(4): 373-379.
32. Mittal, K.L. and P. Kumar, 2000. Emulsion, foams and thin films. Marcel Dekker, Inc., New York, USA.
33. Moure, A., J. Sineiro, H. Dominguez and J.C. Parajo 2006. Functionality of oil seed protein products. Food Res. Int., 39: 945-963.
34. Nicanor, A.B., A.O. Moreno, A.L.M. Agula and G.D. Ortiz, 2001. Guava seed protein isolate: functional and nutritional characterization. J. Food Biochem., 25(1): 77-90.
35. FAO/WHO, 1993. Food and Agriculture Organization of United Nations. Amino acid content of food and biological data on proteins. FAO Nutrition studies, pp: 28.
36. Azouz, A., A.M. El-Gharably and E.M. Rizk, 2009. Chemical composition and characterization of oil and defatted cake of apricot kernels. Annals Agric. Sci., 54(2): 373-383.
37. Liener, I.E., 1994. Implications of antinutritional components in soybean foods. Crit. Rev. Food Sci. Nutri., 34: 31-67.
38. Bajpai, S., S. Aparna and M.N. Gupta, 2005. Removal and recovery of antinutritional factors from soybean flour. Food Chemistry, 89: 497-501.