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Evaluation of Protein Quality, Phytochemical Characterization and the Effect of Soaking and Roasting Processes on Raw Apricot Kernels

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Abstract

The aim of the study was to assess the protein quality of raw apricot kernels and study the effect of soaking and roasting processes on the bioavailability of the treated samples. Raw apricot (prunus armeniaca) kernels were subjected to roasting, soaking and soaking followed by roasting processes. Chemical composition, mineral content, phytochemical characterization, amino and fatty acids analysis of treated kernels meals were performed. Protein quality (biological value, digestibility and net protein utilization) was conducted using male albino rats.

The quality of the extracted oils was judged by measuring peroxide value, free fatty acids and iodine value. GC-MS analysis of treated kernels meals and extracted oils was included in the study.Biological value of raw apricot kernels (RAK), roasted kernel (RK), soaked kernels (SK) and roasted soaked kernels (RSK) meals were of 79.34, 49.14, 72.94 and 64.66%, respectively. True digestibility ranged from 94.0, 77.14, 93.65 and 85.33%, respectively.

Net protein utilization recorded 74.58, 37.91, 68.31 and 55.17, respectively.The results indicated that crude protein was 31.45, 37.15, 27.1 and 26.7%, respectively.

The tested samples had high fat content valued 31.07, 17.25, 35.05 and 38.91%, respectively. Fibers ranked for 11.4, 15.6, 17.51 and 19.04%, respectively.Carbohydrate amounted to 17.3, 21.9, 13.94 and 9.73%, respectively. Raw and roasted kernels had maximum phosphorous content of 6109 and 6963 ppm, followed by soaked kernels (2645) and roasted soaked kernels (2327). All samples were packed with iron (48.55-60.15 ppm), zinc (33.49-54.30 ppm) and copper (9.46-15.8 ppm). Amino acids profile ascertained that glutamic was the most abundant recording 6.51, 6.66, 6.08 and 5.77%, respectively. Total antioxidant capacity of the roasted kernels was 2301, followed by raw kernels (1127), soaked kernels (190) and finally roasted soaked kernels 311.3 mg AAE/100g. Ferric reducing antioxidant power (FRAP) increased by increasing the concentration mediating a high reducing ability of all type of kernels.

Total phenols accounted for 13.68, 26.48, 17.06 and 18.64 mg GAE/100g, respectively and flavonoid content were 6.12, 10.52, 5.67 and 8.14 mg QE/100g, respectively. Qualitative determination of glycosides ensured its presence in the raw and treated kernels. Soaked kernels had the low concentration of tannin (0.57%) considered as anti-nutrient factor.GC-MS analysis of RAK and RK revealed the existence of amygdalin at 2.47and 0.83%, respectively. Whereas, SK and RSK were free from amygdalin. The extracted oils had peroxide value of 23.17, 5.79, 1.67 and 2.34 Meq o_2 /Kg oil, respectively. Free fatty acid valued 2.66, 0.12, 7.3 and 6.58%, respectively. Iodine value registered 106.13, 106.5, 106.43 and

105.19 mg KOH/g, respectively. Fatty acid profile ensured that oleic acid was the most abundant in all tested oil samples accounted for 60.82, 60.54, 60.54 and 61.49%, respectively. Linoleic acid was the second major fatty acid valued 25.94, 26.06, 26.07 and 26.13%, respectively. GC-MS analysis ensured the presence of several structural related bioactive compounds in the extracted oils. It can be concluded that raw and treated apricot kernels are good sources of protein, fat and fiber and considered as natural antioxidants packed with iron, zinc, phosphorous and copper. Thus, kernels served as potential sources for use in several food industries.

Introduction

The main production areas of apricots *(Prunus armeniaca)* are the Mediterranean and Middle East. ***(FAOSTAT, 2013)*** stated that the production of apricot in Egypt was 98.772 tones. Apricot kernels are byproducts of the apricot processing industry ***(Tuncel et al., 1998).*** Apricot kernels had poor palatability and often discarded causing serious waste disposal and environmental pollution.

Two main varieties of apricot kernels can be easily differentiated, sweet and bitter. Bitter kernels is a good source of amygdaline, which is about 4.5%–6.5% of dry kernels ***(Femenia et al., 1995).*** The oil of bitter kernels (53%) is used in cosmetics and aroma perfume ***(Hallabo et al., 1975)*** or as a cheaper substitute of bitter almond oil. Bitter apricot kernels can be used as a substitute of bitter almonds, a more expensive kernel, to produce “persipan” a material used in confectionery and bakery products ***(Femenia et al., 1995)***. Apricot kernels can also be of interest as a food or feed ingredient because of their high crude protein content (20%–25%, dry

weight basis) ***(Tuncel et al., 1998).*** Sweet apricot kernels can be added to bakery prodcts as whole or ground kernels, as well as consumed as appetizers ***(Durmaz and Alpaslan, 2007).*** Apricot kernels and almonds are at high risk of aflatoxin contamination but they are poorly studied, especially apricot kernels. The first notification of aflatoxins in apricot kernels was published in 1999 in the European Rapid Alert System for Food and Feed (RASFF) network. Between 1999 and 2015 a total of 28 notifications were reported for imported apricot kernels, or derived products produced in Europe, that were contaminated with high levels of aflatoxins ***(RASFF, 2013).*** From 2010 the European maximum levels of aflatoxin B1 (AFB1) and total aflatoxins (AFs) in apricot kernels intended for further processing (12 g/kg for AFB1 and 15 g/kg for total AFs) and ready-to-eat (8 g/kg for AFB1 and 10 g/kg for total AFs) have been aligned to those of Codex Alimentarius after a positive opinion of the European Food Safety Authority ***(Codex, 2015).***

The present work aim to study the effect of soaking and roasting processes on physical characteristics and protein quality of apricot kernels. Additionally, raw and processed kernels were subjected to solvent extraction to obtain the respective oils. Chemical and GC-MS analysis of raw and oils were included in the study to present kernels as a new utilizable source in the domain of food industry. At the same time, the study provided sufficient data to direct its usage to minimize fruit byproducts and improve environmental conditions.

Material and Methods

Sample preparation

About one hundred kilograms of bitter apricot seeds were collected from different food industries along season of apricot harvest in the summer of 2016. Kernels were removed from seeds by **hand and classified into four equal quantities:**Raw apricot Kernels (RAK) were dried and remained without any treatment.Roasted **Kernels (RK):** Kernels were roasted at 40-45°C for 25-30 min.

Soaked Kernels (SK): Kernels were soaked in fresh tap water and rinsed daily. The process took 12 days until removing the bitter taste and then dried overnight at 45-50 °C.

Roasted Soaked Kernels (RSK): Dried soaked kernels were roasted at 40-45°C for 25-30 min.The four apricot kernels types were grounded and kept refrigerated at 4°C until analysis.

Chemicals and reagents All chemicals and reagents used were purchased from Merck (Darmstadt, Germany) and Sigma Chemical (St. Louis, MO, USA). All assays were reported and documented in different Laboratories of Regional Center for Food and Feed "RCFF", Agriculture Research Center "ARC", Egypt; which has been gained the international accreditation ISO 17025.

Extraction of oils According to ***(Sherif et al., 2011)*** and ***(Keyou et al.,2016)*** 720 grams of dried and grounded RAK, RK, SK and RSK were soaked individually in 2L petroleum ether overnight for three days with continuous shaking, filtered and extra purified with chloroform. The solvent was removed by a rotary evaporator at 40 °C. The extraction yields for the previous treatments were 90 ml pale yellow oil, 110 ml clear brown oil, 115 ml deep yellow oil and 115 ml deep brown oil, respectively. The extracted oils were stored in a sealed brown glass vials at 4 °C until further analysis. The

corresponded four defatted meals powder were completely purified from the solvent and kept until used in the biological experiment.

Chemical analysis

Moisture content, crude protein, fiber and fat were determined for the dried RAK, RK, SK and RSK meals according to ***(AOAC, 2000),*** ash was determined according to ***(AOAC, 1995).*** Minerals (phosphorus, iron, zinc and copper) were determined according to ***AOAC (2002).*** According to ***Sara et al. (2008),*** carbohydrate content was estimated by difference.

Phytochemical analysis

The four extracted oils and the corresponding defatted meals were subjected for determination of phytochemical compounds: total flavonoids as adapted by ***Arvouet-Grand et al. (1994);*** total phenolic content according to ***Singleton et al. (1999),*** total antioxidant capacity by the method of ***Prieto et al. (1999);*** ferric reducing antioxidant power (FRAP) according to the method of ***Oyaizu (1986);*** total tannins according to ***Makkar et al. (1993).*** The determination of alkaloids was performed as described by ***Harbone (1973)*** and further explained by ***Onwuka (2006).*** Saponin content of the sample was determined by double solvent extraction method ***Harbone (1973)*** & ***Obadoni and Ochuko (2001).*** Glycosides were identified by the method of ***(Harbone, 1973).***

Fatty acid composition of extracted oils

Fatty acid composition of extracted oils was trans esterified into their corresponding fatty acid methyl esters (FAMEs) using methanolic NaOH and boron triflouride (BF3) with methanol as described by ***AOAC (2012).***The FAMEs were quantified by Shematizu Gas Chromato-graph Series 662010 equipped with a 2010+autosampler (Japan,) and interfaced with a FID. The GC was equipped with a temperature programmable column.

GC-mass identification of oils and kernels meals

According to ***Patricia et al. (2013),*** the identification of components was based on a comparison of their mass spectra and retention time with those of the authentic compounds and by computer matching with NIST and WILY libraries as well as by comparison of the fragmentation pattern of the mass spectra data with those reported in the literature.

Determination of Afla and Okratoxins in kernels meals

Total Aflatoxin and ochratoxin standards were purchased from Sigma (St. Louis, MO, USA. Stock solutions of each mycotoxins were prepared by dissolving toxin in the appropriate solvent at concentration of 1 mg/mL. AFs in toluene/acetonitrile 99:1 and OTA in toluene/acetic acid 99:1. Extraction and identification of aflatoxins from the four types of kernels meals was performed by HPLC technique (Agillent 1200) series U.S.A according to ***AOAC (2006).***

Biological experiment

Biological value, true digestibility and net protein utilization were determined according to ***(Eggum, 1973)*** using male rats weighing 75 gm in an experimental period lasted for nine days consisting of four days pre-experimental period and five days for the main experiment as described by ***Eggum (1973).*** The experiment was carried using 5 groups of rats (5 rats/group). Each rat was fed on 150 mg nitrogen and about 10 gm dry matter daily. The animals were weighed at the beginning of the experiment, shift time and finally at the end of the experiment. Urine was collected in 250 ml conical flask filled with 50 ml 5% H_2SO_4, while the feces was collected in another flask. Every day, the urine funnels with glass wool were sprayed with 5% H_2SO_4, and the plastic net and the funnel were sprayed with 20% citric acid. At the end, rest of diet was weighed, urine and feaces contents of

nitrogen were determined according to the microkjeldahl method as described in ***(AOAC, 2005).***

Results

Chemical composition of raw and treated apricot kernels is presented in **(Table 1)**. The obtained results indicated that apricot kernels had carbohydrate contents of 9.73-21.9% for RSK and RK. Roasted kernels had the highest content with respect to other treated samples. Protein valued 26.7-37.15% for RSK and RK. RAK, RK, SK and RSK had fat content of 31.07, 17.25, 35.05 and 38.91%, respectively. Fibers ranked for 11.4, 15.6, 17.51 and 19.04%, respectively.**Table (2)** summarized the mineral content of treated kernels. RAK and RK had maximum phosphorous content of 6109 and 6963 ppm, followed by SK (2645 ppm) and RSK (2327 ppm). All samples were packed with iron (48.55-60.15 ppm), zinc (33.49-54.30 ppm) and copper (9.46-15.8 ppm). Amino acid profile **(Table 3)** ascertained that glutamic was the most abundant acid recording 6.51, 6.66, 6.08 and 5.77%, respectively.As shown in **(Table 4)**, roasted kernels had the highest total antioxidant capacity of 2301, followed by raw kernels (1127), soaked kernels (190) and finally roasted soaked kernels 311.3 mg AAE/100g. Total phenols accounted for 13.68, 26.48, 17.06 and 18.64 mg GAE/100g, respectively and flavonoid content were 6.12, 10.52, 5.67 and 8.14 mg QE/100g, respectively. Ferric reducing antioxidant power (FRAP) increased by increasing the concentration mediating a high reducing ability of all types of kernels meals **(Fig.1)**. Qualitative determination of glycosides ensured its presence in the raw and treated kernels. Soaked kernels had the low concentration of tannin (0.57%) considered as anti-nutrient factor. Iodine values of the extracted oils

varied from 105.19-106.5 mg KOH/g. Roasted kernels oil had the lowest free fatty acids of 0.12%, while soaked kernel oil registered the highest value (7.3%) as presented in **Table (5)**.Peroxide value is an indication of the amount of hydroperoxides arising from lipid oxidation. Low peroxide value of SK (1.67 Meq/Kg) indicating good quality.Fatty acids profile **(Table 6)** ensured that oleic acid was the most abundant in all tested oil samples accounted for 60.82, 60.54, 60.54 and 61.49%, respectively. Linoleic acid was the second major fatty acid valued 25.94, 26.06, 26.07 and 26.13%, respectively. Appreciable amount of palmitic and vaccinic acids was detected in the extracted oils. As shown in **Table (7)**, the extracted oils were free from glycosides, tannins, saponins and alkaloids. FRAP results **(Fig. 2)** reflected the antioxidant activities of the extracted oils due to phenols and flavonoids contents.GC-MS analysis of dried RAK, RK, SK and RSK meals and oils extracted from treated samples ensured the existence of several bioactive compounds as shown in **(Tables 8, 9)**.**Table (10)** showed the results of afla and okratoxins, all samples were free from okratoxins. Aflatoxin was found in traces in SK and RSK, while, RAK and RK were free. In vivo evaluation of meals is shown in **Table (11)**, results demonstrated that RAK had the highest BV, TD and NPU than that in case of SK, RSK and RK meals; but they were lower in comparison to casein standard as a reference. RK registered the lowest BV, TD and NPU values indicating that thermal process affected the protein quality and impacted its in vivo utilization.

Discussion

The apricot, Prunus armeniaca L., is a member of the Rosaceae, subfamily Prunoideae. The percentage of the kernel in the

pit varied from 18.8 to 38.0% ***(Kappor* et al., *1987).*** Results ascertained that apricot kernels could be considered as a source of protein, fat, fiber and carbohydrate. These data were strongly correlated with ***Beyer and Melton (1990)*** who reported that carbohydrate amounted to 17.3% and with ***Gabrial et al. (1981)*** who cited that protein content varied from 14.1 to 45.3%.Our data clearly demonstrated increased iron and zinc levels in all tested samples, which is in contradiction with ***Normakhmatov and Khudaishukurov (1973) and Ozcan (2000)*** who reported that iron and zinc valued 2.82 mg/100g and 2.33 mg/100g, respectively.L-glutamic acid, the most abundant in all tested kernel samples, is a non-essential amino acid acted as important neurotransmitter for normal and healthy brain function ***(Hardman et al., 2001).*** Antioxidant activities of tested kernels could be attributed to high phenol and flavonoid contents.

A fact supported by ***(Perez-Jimenez et al., 2008)*** who attributed the antioxidant properties of plant foods to their terpenoid, carotenoid and phenolic constituents. The high concentration of phenolic compounds in fruit peels and seeds provided an appropriate justification for the use of fruit byproducts as a source of natural antioxidants ***(Francisco and Resurreccion, 2009).***Antinutrients in plant foods are responsible for deleterious effects related to the absorption of nutrients and micronutrients. However, some antinutrients may exert beneficial health effects at low concentrations. The biologically active phytochemicals (tannins and saponnins) have curative properties. Saponins are attracting considerable interest as a result of their beneficial effects in humans. Recent evidence suggests that saponins possess hypocholesterolemic, immunosti-mulatory, and anticarcinogenic properties. In addition, they reduce the risk of heart diseases in humans consuming a diet rich in food legumes containing

saponins. Saponin-rich foods are important in human diets to control plasma cholesterol, preventing peptic ulcer, and osteoporosis and to reduce the risk of heart disease ***(Habtamu and Negussie, 2014).*** Thus all studied kernels can be considered as beneficial for health as referring to its trace content of tannins and saponnins.Iodine values of the extracted kernels oils varied from 105.19-106.5 mg KOH/g, was closely supported by the findings of ***(Gandhi* et al., *1997)*** who cited that apricot kernels oil had iodine value of 99. In contradiction to ***(Gandhi et al., 1997)*** who found that free fatty acids (FFA) scored 4.2%, the obtained data showed that free fatty acid of raw apricot kernel oil valued 2.66%. Lower values of FFA indicated the more acceptable oil to the human palate ***(Codex, 1993).***The extracted oils had peroxide values of 23.17, 5.79, 1.67 and 2.34 Meq o_2 /Kg oil, respectively. Values less than 30 meq/kg indicated the best quality of apricot kernel oils. This was strongly related to ***(Codex, 1993)*** that peroxides values between 30 and 40 meq/kg detected rancidity in fats and oils.The extracted oils contained unsaturated fatty acids in the range of 93.96, 94.25, 92.93 and 94.58% for RAK, RK, SK and RSK, respectively. Saturated fatty acids consisted 5.93, 5.66, 6.35 and 5.53% of the oils, respectively. This fact represented a key step for considering apricot kernels oils as value added products possessing health effects in decreasing bad cholesterol levels due to its high contents of UFA.Our results are in accordance with ***Gandhi* et al. *(1997)*** who reported that apricot kernel oil had 94% unsaturated fatty acids, rich in oleic and linoleic acids*. (**FAO/WHO, 2009)*** claims that replacing dietary saturated fatty acids (SF) with polyunsaturated fatty acids (PUFA) decreases the risk of cardiovascular diseases.Vaccinic acid, an isomer of oleic acid, is the principal ruminant *trans* fatty acid. Consumption of this natural *trans* fatty acid may impact favorable health effects ***(Field,***

2009).GC-MS analysis of RAK oil showed the existence of cinnamic acid which is an organic acid naturally occurring in plants, well known antioxidant and health promoter due to its strong free radical scavenging properties ***(Soya, 2012).*** Phoroglucinol is a phenol derivative with antispasmodic, anti-inflammatory, antioxi-dant and antitumor activities ***(Noel and Se-Kwon, 2011).*** Citronellyl tiglate is a flavor and fragrance agent. Chalcone exhibited wide range of biological activities such as antidiabetic, antineoplastic, cardioprotective ***(Mahapatra and Bharti, 2016),*** hypolipidemic and antihypertensive. Bisabolol is natural sesquiterpene possessing antiinflammatory and antimicrobial properties ***(Kamatou and Vilijoen, 2010).*** Vanillic acid is a major catecholamine metabolite exhibiting moderate antioxidant activity as reported by ***Alberti et al. (2009).***The most predominant compound in RK, SK and RSK oils was vitamin B6 exerting a crucial role in antioxidant mechanisms. ***Peter et al. (2016)*** studied the thermodynamic of vitamin B6 antioxidant potential and reported that it may show weaker antioxidant effect than naturally occurring phenolic compounds. All meal samples were free from okratoxins. Aflatoxin was found in traces in SK and RSK, while, RAK and RK were free. Our results were in contradiction to the European maximum levels of aflatoxin B1 (AFB1) and total aflatoxins (AFs) in apricot kernels intended for further processing (12 g/kg for AFB1 and 15 g/kg for total AFs) and ready-to-eat (8 g/kg for AFB1 and 10 g/kg for total AFs) have been aligned to those of Codex Alimentarius after a positive opinion of the European Food Safety Authority ***(Codex, 2015).*** The obtained data indicated that roasting as a thermal processing led to in vivo diminution of biological value (BV) of raw apricot kernels meal (RAK) from 79.34 to 49.14% for roasted kernels meal (RK). Consequently, the BV of soaked kernels meal (SK) declined from 72.94% to 64.66%

for roasted soaked kernels meal (RSK) as showed in **(Table 11)**. In the same manner, true digestibility (TD) and net protein utilization (NPU) were reduced with thermal processing and these changes in protein quality parameters (BV, TD and NPU) were due to Maillard reaction which may play an important role in enhancing the allergenic properties of and the protein modifications, these results are in convenient with ***Henryk*** **et al. (** ***2009)*** and disagree with ***Abdus*** **et al. (*1989)*** who reported that roasting caused a slight increasing trend in the protein quality. *In vivo* protein quality of RAK, SK. RK or RSK meals were lower than standard casein as shown in **Table (11)**.

As a result, dried apricot kernels meals and the corresponding extracted oils possessed antioxidant capacity due to their phenolic, flavonoids and vitamins contents. Moreover, the kernels were relatively high in minerals, fibers, fat, carbohydrates and protein contents.

Table (1): Proximate analysis of raw and treated apricot kernels meals

Samples	Protein (%)	Fat (%)	Fiber (%)	Ash (%)	Moisture (%)	Carbohydrate (%)
RAK	31.45	31.07	11.40	3.08	5.7	17.30
RK	37.15	17.25	15.60	3.60	4.5	21.90
SK	27.10	35.05	17.51	1.40	5.0	13.94
RSK	26.70	38.91	19.04	1.32	4.3	09.73

Results were expressed as average of duplicate determinations.

Table (2): Mineral content of raw and treated apricot kernels meals

Samples	P (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)
RAK	6109	56.51	44.45	13.97
RK	6963	48.55	54.30	15.51
SK	2645	60.15	39.50	10.99
RSK	2327	55.44	33.49	09.46

Results were expressed as average of duplicate determinations

Table (3): Amino Acids profile of treated apricot kernels meals

A (%)	RAK	RK	SK	RSK
Asparagine	3.37	3.39	2.44	1.91
Therionine	0.71	0.83	0.76	0.63
Serine	0.89	1.07	1.06	0.88
Glutamic	6.51	6.66	6.08	5.77
Glycine	1.51	1.79	1.52	1.36
Alanine	1.40	1.68	1.22	1.12
Valine	1.39	1.49	1.19	1.33
Isoleucine	1.02	1.18	1.06	0.93
Leucine	1.88	2.20	1.70	1.45
Tyrosine	1.06	1.12	1.02	0.79
Phenylalanine	1.61	1.77	1.45	0.24
Histidine	0.74	0.81	0.88	0.73
Lysine	0.90	0.63	1.10	0.82
Arginine	2.80	2.76	2.49	2.15
Proline	1.07	1.22	1.18	0.95
Cystine	0.96	0.70	0.72	0.53
Methionine	0.44	0.38	0.44	0.33

Table (4): Phytochemical analysis of treated apricot kernels meals

Test	RAK	RK	SK	RSK
Total antioxidant capacity (mg AAE/100g)	1127	2301	190	311.3
Total phenols (mg GAE/100g)	13.68	26.48	17.06	18.64
Total flavonoid (mg QE/100g)	6.12	10.52	5.67	8.14
Tannins (%)	0.86	1.38	0.57	0.66
Saponins (%)	0.46	0.68	2.61	2.02
Alkaloids (%)	8.03	4.13	3.61	4.71
Glycosides	Positive	Positive	Positive	Positive

Table (5): Characteristics of extracted oils from treated kernels

Samples	Peroxide value (meq O_2/Kg)	Free fatty acids (%)	Iodine value (mg KOH/g)
RAK	23.17	2.66	106.13
RK	05.79	0.12	106.50
SK	01.67	7.30	106.43
RSK	02.34	6.58	105.19

Table (6): Fatty acids profile of extracted oils from treated apricot kernels

Fatty acids (%)	Classification		RAK	RK	SK	RSK
Capric acid	C10:0	SFA	0.17	-----	----	----
Palmitic acid	C16:0	SFA	4.85	4.75	05.17	4.54
Palmitioleic acid	C16:1 ω7	MUFA	0.73	0.69	00.17	0.67
Stearic acid	C18:0	SFA	0.91	0.91	01.18	0.99
Oleic acid	C18:1ω9	MUFA	60.82	60.54	60.54	61.49
Vaccinic acid	C18:1ω7	UFA	6.27	6.82	06.00	6.15
Linoleic acid	C18:2 ω6	PUFA	25.94	26.06	26.07	26.13
Linolenic acid	C18:3 ω3	PUFA	0.20	0.14	00.15	0.14
Non identified fatty acids			0.11	0.09	00.18	----

MUFA = monounsaturated fatty acids

UFA = unsaturated fatty acids

PUFA = polyunsaturated fatty acids

SFA = saturated fatty acids

Table (7): Chemical analysis of the extracted oil

Tested parameters	RAK	RK	SK	RSK
Total antioxidant capacity (mg AAE/100g)	809.95	816.37	554.27	1613.3
Total phenols (mg GAE/100g)	592.75	608.95	668.7	601.8
Total Flavonoids (mg QE/100g)	58.75	16.15	53.2	24.05
Tannins (%)	ND	ND	ND	ND
Saponins (%)	ND	ND	ND	ND
Alkaloids (%)	ND	ND	ND	ND
Glycosides	ND	ND	ND	ND

Table (8): GC-MS analysis of kernels meals

RT (min)	Compounds	Area sum%			
		RAK	RK	SK	RSK
3.511	Kyselina glyoxylova	--	--	--	0.63
3.608	L-Galactose, 6-deoxy-	--	--	--	0.55
4.569	Galactitol	1.2	0.35	0.73	0.83
4.665	Benzoic acid, 3,5-dimethyl-, methyl ester	--	--	--	2.71
4.883	Benzaldehyde, 4-ethyl-	0.61	0.35	0.84	--
4.9	Benzaldehyde, 4-methoxy-2,3-dimethyl-	0.67	--	--	--
6.225	Benzoic acid, p-tert-butyl-	--	0.35	--	--
6.233	1,2-Benzenediol, 3,5-di(1,1-dimethylethyl)-	--	--	0.77	0.62
7.161	Benzeneacetaldehyde, α-(phenylmethylene)-	--	0.39	--	--
7.166	2-(4-Methyl-3-cyclohexenyl)-2-propanol	--	--	--	0.76
7.169	Benzaldehyde, (phenylmethylene)hydrazone	0.87	--	--	--
7.525	2-Hexanol	--	0.41	--	--
7.885	o-Cymene	0.78	0.41	--	--
7.994	D-Limonene	--	0.42	8.09	7.3
8	Eucalyptol	0.63	--	--	--
8.307	Linalol	--	--	--	0.56
8.746	1,4-Cineol	--	--	--	0.62
9.273	L-(-)-Menthol	--	--	--	0.67
9.5	L-α-Terpineol	--	--	--	0.65
9.55	CYCLOHEXANOL, 5-METHYL-2-(1-METHYLETHYL)-, (1α,2β,5β)-	--	--	0.72	--
9.58	Levomenthol	--	0.45	--	--
10.147	Anethole	--	--	--	0.99

10.58	Thymol	0.56	0.46	0.71	1.01
10.657	2-Isopropylbenzoic acid	--	--	--	1.71
10.678	Carvacrol	--	0.48	1.65	1.45
10.732	4-Ethylbenzoic acid	1.58	--	--	--
10.937	Anethole	--	--	0.82	--
11.159	d-Glycero-l-gluco-heptose	--	--	--	1.65
11.24	Eugenol	0.58	0.59	0.89	--
11.63	Cinnamaldehyde, (E	--	0.7	--	--
11.66	O-EUGENOL				0.8
11.92	Benzoic acid, 2,3-dimethyl-, methyl ester	--	0.71	0.71	0.73
12.44	Butylated Hydroxytoluene	--	0.78	0.64	1.59
12.5	D-Amygdalin	2.47	0.83	--	--
13.245	d-Glycero-d-galacto-heptose	--	0.86	--	--
13.28	Undecanoic acid	3.2	--	--	--
15.214	Arachidic acid	1.29	--	--	--
15.252	Palmitic acid, methyl ester	--	--	0.8	1.44
15.315	Oleic acid, 3-(octadecyloxy)propyl ester	--	0.9	--	--
15.4	Margarinic acid	1.15	--	--	--
15.461	Lucenin 2	--	0.98	--	--
15.5	Oleic Acid	0.63	1	0.79	0.71
15.55	Oleine 7503	--	--	0.66	1.38
15.662	Palmitic acid	--	--	8	--
15.679	n-Hexadecanoic acid	6.83	--	--	8.26
15.821	Isopropyl palmitate	--	--	--	2.2
15.825	Ethyl palmitate	--	--	0.88	--
15.883	9-Octadecenoic acid (Z)-, ethyl ester	--	1.21	--	--
16.205	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	1.51	--	--	--
16.280	Ethyl Oleate	5.03	--	--	3.06
16.519	Linoleic acid ethyl ester	3.08	1.38	2.89	1.17

16.565	Oleic acid, 2-hydroxyethyl ester	6.29	1.48	6.86	--
16.6	Undecanoic acid	3.76	--	--	--
16.728	Malonodinitrile, 2-[3-(2-hydroxyphenyl)-2-iminomethyl-1-methyl-2-propenylideno]-	--	--	--	0.98
16.799	Linoleic acid	--	1.66	--	--
16.854	Palmityl oleate	--	2.26	--	--
16.962	9-Octadecenoic acid, (E)-	56.95	--	--	--
17.013	β-Monolinolein	--	3.8	--	--
17.071	Cetiol	--	4.78	--	--
17.084	L-Ascorbic acid, 6-octadecanoate	--	--	--	52.1
17.159	Vitamin C monostearate	--	--	0.66	--
17.222	2-Hexadecanol	--	--	--	1.06
17.289	Oleic acid, eicosyl ester	--	6.35	--	--
20.007	Prednisone	--	10.94	--	--
21.282	Diisooctyl phthalate	--	14.81	--	--
21.817	Benzyl (6Z,9Z,12Z)-6,9,12-octadecatrienoate	--	31.59	--	--
23.787	Benzyl oleate	--	7.42	1.26	0.59

Table (9): GC-MS analysis of extracted oils

RT (min)	Compounds	Area sum%			
		RAK	RK	SK	RSK
3.169	2,5-Dihydroxyacetophenone	0.86	--	0.31	0.3
3.286	α-Pinene epoxide	--	1.88	--	--
3.444	5-Hydroxy-7-methoxy-2-methyl-3-phenyl-4-chromenone	0.63	--	--	0.23
3.582	carveol 1	--	--	--	0.24
3.783	Phytol	0.77	--	0.71	0.22
4.055	Codeine	1.03	3.91	--	--
4.481	3',6-Dimethoxyaurone	0.69	--	--	--
4.67	2-[4-(Dimethylamino)phenyl]-3-hydroxy-4H-chromen-4-one	0.79	1.89	--	--
4.841	Hydroquinone	0.54	--	--	--
4.912	Geranyl isovalerate	0.44	--	--	0.29
5.159	4-(Anisylideneamino)-cinnamic acid	1.8	1.78	0.37	0.56
6.71	1-Deoxy-1-(methylamino)-D-galactitol	--	1.76	--	--
7.684	Papaveroline	0.72	1.76	0.3	0.48
7.697	Benzoic acid, 2,6-dihydroxy	0.63	--	--	--
7.8	β-Resorcylic acid	0.63	--	--	--
7.876	.Gentisic acid	0.92	--	--	--
7.973	3,4-Dihydroxymandelic acid, ethyl ester	0.92	--	--	--
8.056	Salicylic acid	0.75	--	--	--
8.14	p-Hydroxybenzoic acid	0.74	2.55	--	--
9.147	Hexa-hydro-farnesol	1.55	--	--	--
9.452	4',7-Dimethoxyisoflavone	--	--	0.39	0.27
10.034	Ferulic acid	1.96	--	--	0.42
10.352	2-Hydroxypyridine	2.17	1.86	--	0.26
10.912	3-Hydroxy-4-methoxycinnamic acid	12.76	0.68	--	--
10.954	Phloroglucinol	7.54	--	--	--
11.442	Citronellyl tiglate	2.24	--	--	0.44

11.74	Flavone, 3,3',4',5,5',7-hexamethoxy-	1.84	1.21	--	--
11.97	Syringic acid	2.53	--	--	--
12.362	Farnesol	0.94	--	--	0.35
12.543	Propyl gallate	10.3	--	--	--
12.785	Gallic acid	0.55	1.02	--	--
12.936	α-Bisabolol	6.33	--	--	--
13.75	Isolongifolol	--	--	--	0.33
13.864	Homovanillic acid	7.12	1.93	--	0.24
14.394	24,25-Dihydroxyvitamin D3	--	1.25	--	0.24
14.659	Cubedol	1.77	--	--	0.45
14.993	4-Methylthio-4'-(4-nitrocinnamoyl)chalcone	4.64	--	0.35	0.58
15.13	Camphor	--	5.92	--	--
15.247	Palmitoleic acid	--	--	0.33	0.46
15.397	Resveratrol	--	--	0.81	2.01
15.526	9-Octadecenoic acid	--	6.78	1.14	2.95
15.694	Cyanidin cation	1.74	--	--	--
16.022	Vitamin B6	3.73	6.71	19.69	16.85
16.514	Shyobunone	--	--	1.58	6.61
16.555	5β,7βH,10α-Eudesm-11-en-1α-ol	7.59	7.59	2.87	11.54
16.752	Daidzin	--	--	--	0.71
16.858	1,8-Diazabicyclo [5.4.0]undec-7-ene	9.16	4.13	8.64	22.24
17.055	Dihydrouracil	1.37	3.65	--	--
17.155	Thebaine	2.18	--	0.38	7.78
17.287	5β,7βH,10α-Eudesm-11-en-1α-ol	0.93	--	21.39	--
17.604	7,8-Dihydro-α-ionone	0.69	--	27	13.83
17.757	Zearalenone	0.81	--	--	1.05
18.422	Ascorbic acid 6-palmitate	0.15	--	7.08	--
18.593	Thymolphthalein	0.76	2.62	0.93	--
18.809	Ledol	0.16	2.37	1.19	0.48
18.885	9-Octadecenoic acid (Z)-,				18.88

	methyl ester				
19.299	Sinapic acid	--	2.54	--	--
19.626	Elaidic acid	0.16	--	1.06	0.75
19.738	4-Hydroxy-3-methoxybenzyl alcohol	--	1.84	--	--
20.135	Phenol, 3-(3-ethylhexahydro-1-methyl-1H-azepin-3-yl)-	--	3.14	--	--
20.538	Chromone, 5-hydroxy-6,7,8-trimethoxy-2,3-dimethyl-	0.15	--	--	0.29
21.073	dl-Phenylephrine	0.42	--	--	--
21.289	2-Hexadecanol	0.53	--	0.52	0.23
21.31	Dimethyl caffeic acid	--	4.33	--	--
21.752	β Carotene	--	3.43	0.33	0.38
22.468	Phenol, 4-tert-butyl	--	2.93	--	--
22.606	Linoleic acid ethyl ester	--	--	0.48	0.32
22.673	Benzene, (3-methyl-2-butenyl)-	--	--	--	0.59
22.815	Methyl arachidonate	--	--	--	0.54
22.87	Apigenin 8-C-glucoside	--	--	--	0.69
23.501	β-Sitosterol	--	--	--	0.51
23.717	Probucol	--	--	0.28	0.66
22.798	Thymol	--	3.62	--	--
23.041	Ginsenol	--	3.82	--	--
23.501	β-Sitosterol	--	4.09	--	--
23.802	Carotol	--	2.9	1.35	1.82
24.261	3,5-di-t-Butylcatechol	--	1.29	0.5	--

Table (10): Mycotoxin detection in apricot kernels meals

MYCOTOXIN	RAK	RK	SK	RSK
Aflatoxin	ND	ND	(B_1 = 4) traces	(B_1 = 4) traces
Okratoxin	ND	ND	ND	ND

ND under detection limits and considered free

Table (11): In vivo evaluation of protein quality of apricot kernels meals

Biological parameters	RAK	RK	SK	RSK	Casein standard
Biological value (%)	79.34	49.14	72.94	64.66	85.5
True digestibility (%)	94.0	77.14	93.65	85.33	96.78
Net protein utilization	74.58	37.91	68.31	55.17	82.74

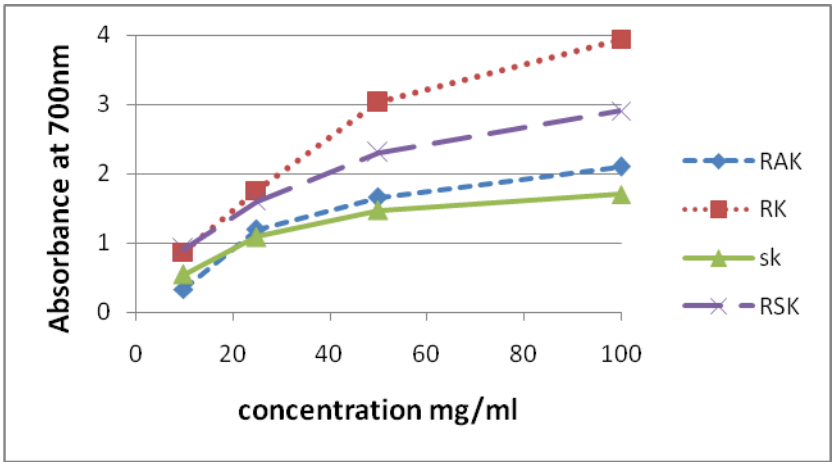

Fig. 1. FRAP of raw and treated apricot kernels meals

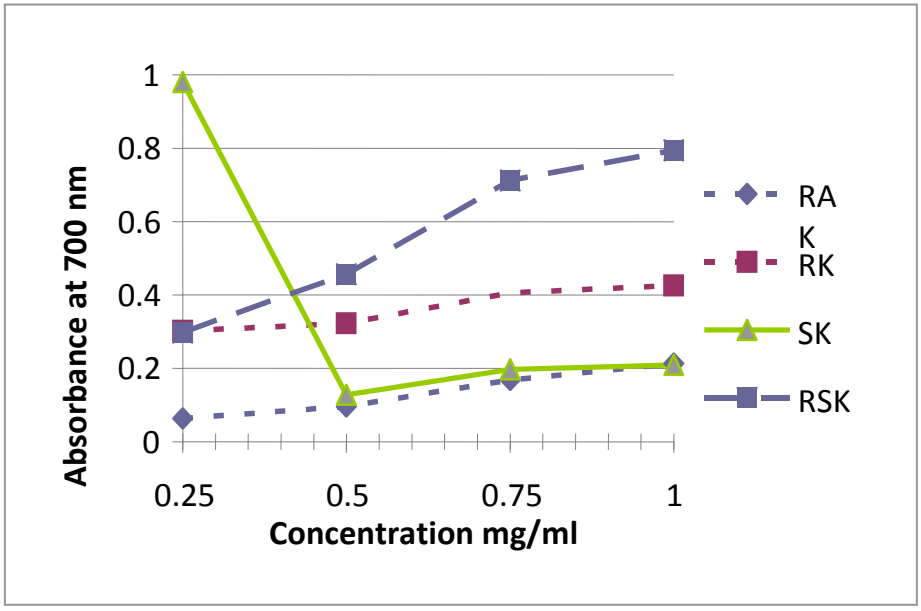

Fig. 2. FRAP of extracted apricot kernels oils

References

Abdus Sattar. S.K. Durrani..F. Mahmood. .A. Ahmad..I. Khan (1989):

Effect of soaking and germination temperatures on selected nutrients and antinutrients of mungbean. J. Food Chemistry, Volume 34, Issue 2, Pages 111-120.

Alberti, A., Amorati, R., Campredon, M., Lucarini, M. and Pedulli, G. (2009):

Acta Alimentaria, 38(4): 427-436.

A.O.A.C. (1995):

Association of Official Agriculture Chemists. Official Methods of Analysis. 16th ed., Washington D.C. USA.

A.O.A.C. (2000):

Association of Official Agriculture Chemists. Official Methods of Analysis. 17th ed., Washington D.C. USA. Chapter 4. 969.3 and 991.39 fatty acids in Oils and Fats preparation of Methyl Esters BoronTri- Flouride- AOAC-IUPAC Method Codex-Adopted- AOAC Method. Chapter 41, pp 19- 20.

A.O.A.C. (2002):

Association of Official Agriculture Chemists. Official Methods of Analysis. 17th ed., Washington D.C.
USA.Vol. 1, P 40-41.

A.O.A.C. (2005):

Official Method of Analysis, Association of official Analytical chemists, 19th Ed Arlington, Virginia,USA.

A.O.A.C. (2006):

Official method of analysis. 2006; Edition 18, volume 7, ch. 2, 21-23 (Aflatoxins), pp 59-61(Ochratoxins).

A.O.A.C. (2012):

Official Methods of Analysis. 19th Ed. Gaithersburg, MD: AOAC International.

Arvouet-Grand, A., Vennat, B., Pourrat, A. and Legret, P. (1994):

Standardisation d'un extrait de propolis et identification des principaux constituants. Journal de Pharmacie de Belgique, 49, 462–468.

Beyer, R., and L.D. Melton.(1990):

Composition of New Zealand Apricot Kernels,N.Z. Crop Hortic. Sci. 18:39–42.

Codex Alimentarius Commission. (**1993)**:

Report of the Fourteenth Session of the Codex Committee on Fats and Oils, London, 27 September - 1 October 1993, Alinorm 95/17.

Codex. (2015):

Codex Standard 193–1995. Codex general Standard for Contaminants and Toxins in Food and Feed.

Durmaz, G. and Alpaslan, M. (2007):

Antioxidant properties of roasted apricot (Prunusarmeniaca L.) kernels. Food Chem., 63, 1177–1181.

EGGUM, BO. (1973):

A study of certain factors influencing protein utilization in rats and pigs. NIAS Copenhagen p.173.

FAOSTAT, (2013):

Food and Agriculture Organization of the United Nations Statistics Division.

FAO/WHO. (2009):

Ann Nutr Metab. 1–3. Vol. 55. Geneva, Switzerland:. Fats and fatty acids in human nutrition. Proceedings of the Joint FAO/WHO Expert Consultation. November 10–14, 2008; pp. 5–300.

Femenia, A., Rosselló, C., Mulet, A. and Cañellas, J. (1995):

Chemical composition of bitter and sweet apricot kernels. J. Agric. Food Chem., 43: 356–361.

Field CJ. (2009):

Human health benefits of vaccenic acid. Appl Physiol Nutr Metab*.,* 34(5):979-91.

Francisco, Mlld and Resurreccion, Ava. (**2009):**

Total phenolics and antioxidant capacity of heat-treated peanut skins. Journal of Food Composition and Analysis, Oxford, v. 22, n. 1, p. 16-24.

Gabrial, G.N., F.I. El-Nahry, M.Z. Awadalla, and S.M. Girgis. (1981):
Unconventional Protein Sources: Apricot Seed Kernels. Z. Ernährungswiss. 20: 208-215.

Gandhi V. M., Mulky M. J., Mikerji B., IYER V. J. and Cherian K. M. (1997):
Safety Evaluation of Wild Apricot Oil Food and Chemical Toxicology 35: 583-587.

Habtamu, Fekadu Gemede and Negussie, Ratta. (2014):
Antinutritional factors in plant foods: Potential health benefits and adverse effects health benefits and adverse effects. International Journal of Nutrition and Food Sciences; 3(4): 284-289.

Hallabo, S.A.S. El-Wakeil, F.A., Morsi, M. and Khairy S. (1975):
Chemical and physical properties of apricot kernel oil and almond kernel oil. Egypt. J. Food Sci., 3: 1–5.

Harbone J B. (1973):
Phytochemical Methods. A guide to ModernTechniques of Plant Analysis; Chapman and Hall: New York.

Hardman, JG., Limbird, LE., Gilman, AG.: (2001):
The Pharmacological Basis of Therapeutics.
10th ed. New York: MCGraw-Hill Medical Publishing Division.

Henryk Zielinski, Anna Michalska, Miryam Amigo- Benavent, Maria Dolores del Castillo and Mariusz Konrad Piskula (2009):

Changes in Protein Quality and Antioxidant

Properties of Buckwheat Seeds and Groats Induced by Roasting.J. Agric. Food Chem., , 57 (11), pp 4771–4776.

Kamatou, GPP and Vilijoen, AM. (2010):

A review of the application and pharmacological properties of bisabolol. J. Of the American oil chemists' Society. 87(1): 1-7.

Kappor, N., Bedi, K.L. and Bhatia, A.K., (1987):

Chemical Composition of Different Varieties of Apricots and Their Kernels Grown in Ladakha Region, J. Food Sci. Technol. 24:141–143.

Keyou Li , Wenhua Yang, Zhe Li , Wangwang Jia, Jiazhou Li , Pengfei Zhang , Tiancun Xiaob (2016):

Bitter apricot essential oil induces apoptosis of human HaCaT keratinocytes. International Immuno pharmacology 34, 189–198.

Mahapatra, D. and Bharti, S. (2016):

Therapeutic potential of Chalcone as cardiovascular agent. Life Sciences. 148: 154-172.

Makkar, H. P. S., Blu Smmel, M., Borowy, N. K. and Becker, K. (1993):

Gravimetric determination of tannins and their correlations with chemical and protein precipitation methods. Journal of the Science of Food and Agriculture 61: 161-165.

Noel, Vinay Thomas and Se-Kwon, Kim. (2011):

Health beneficial aspects of phoroglucinol derivative from marine brown algae. Handbook of marine macroalgae, First Edition, John Willy&Sons, Ltd, p. 378-386.

Normakhmatov, R. and Khudaishukurov, T. (1973):

Apricot as a valuable commercial byproduct. Konservn Ovoshchesush prom. 10: 32-33.

Obdoni BO and Ochuko PO (2001):

Phytochemical studies and comparative efficacy of the crude extracts of some Homostatic plants in Edo and Delta States of Nigeria. Global J. Pure Appl. Sci. 8 b: 203-208.

Onwuka, G.I. (2006):

Soaking, boiling and anti-nutritional factors in Pigeon Pea (Cajanus cajan)and Cowpea (Vignaunguiculata). Journal of Food Processing and Preservation,30: 616 – 630.

Oyaizu M. (1986):

Studies on product of browning reaction prepared from glucose amine. Journal of Nutrition. 44:307–315.

Ozcan, M. (2000):

Composition of some apricot kernels grown in Turkey. Acta Aliment., 29: 289-293.

Patricia Manzano Santanal, Migadalia Miranda, Juan Abreu Payrol, Mario Silva, Victor Hernandez and Esther Peralta. (2013):

Gas Chromatography- Mass Spectrometry Study from the leaves fractions obtained of Vernonanthura patens (Kunth) H. Rob. International Journal of Organic Chemistry, 3: 105-109.

Perez-Jimenez, J., Arranz, S., Tabernero, M., Diazrubio, M.E.; Serrano, J., Goni, I., Saura-Caiixto, F. (2008):

Updated methodology to determine antioxidant capacity in plant foods, oils and beverages: extraction, measurement and expression of results. Food Research International, Oxford, v. 41, n. 3, p. 274- 285.

Peter, S., Jan, R. and Erik, K. (2016):

Thermodynamic study of vitamin B6 antioxidant potential. Computational and Theoretical Chemistry, 1077: 32-38.

Prieto P., M. Pineda, M. Aguilar. (1999):

Spectrophotometric quantitation of Antioxidant capacity through the formation of a phosphor molybdenum complex: specific application to the determination of vitamin E. Analytical Biochemistry, 269, pp. 337–341.

RASFF (2013):

Rapid Alert System for Food and Feed. RASFF Portal.

Sara Y. H., Nafisa M. E. H., Amro B. H., Mohamed M. E. and Elfadil E. B.(2008):
Nutritional Evaluation and Physiochemical Properties of Processed Pumpkin (*Telfairia occidentalis* Hook) Seed Flour. Pakistan Journal of Nutrition 7 (2): 330-334.

Sherif E.A. Badr, Mohamed Shaaban, Yehya M. Elkholy, Maher H. Helal, Akila S. Hamza, Mohamed S. Masoud and Mounir M. El Safty. (2011):
Chemical composition and biological activity of ripe pumpkin fruits (Cucurbita pepo L.) cultivated in Egyptian habitats. Natural Product Research. 25(16): 1524-1539.

Singleton, Orthofer, and Lamuela-Raventos, (1999):
Analysis of Total Phenols and Other Oxidation Substrates and Antioxidants by Means of Folin-Ciocalteu Reagent *in* METHODS IN ENZYMOLOGY 299C(1):152-178 ·

Soya, M. (2012):
Antioxidant and antimicrobial activities of cinnamic acid derivatives. Mini. Rev. Med. Chem., 12(8): 749-67.

Tuncel, G.; Nout, M.J.R.; Brimec, L. (1998):
Degradation of cyanogenic glycosides of Bitter apricot seeds (Prunus armeniaca) by endogenous and added enzymes as affected by heat treatments and particle size. Food Chem., 63: 65–69.

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تقييم جودة البروتين بيولوجيا وتقييم الخصائص الكيمائية النباتية ودراسة تأثيرات عمليات النقع والتحميص على جنين بذرة المشمش الخام

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المركز الاقليمى للاغذية و الاعلاف - مركز البحوث الزراعية - جيزة – مصر

الهدف من هذه الدراسة هو تقييم جودة البروتين لأجنة بذور ثمار المشمش الخام ***(prunus armeniaca)*** ورصد تأثير عمليات النقع والتحميص وذلك من خلال إجراء تجربة بيولوجية باستخدام ذكور الجرذان البيضاء. كانت القيمة الحيوية لأجنة بذور المشمش الخام (RAK)والأجنة المحمصة (RK) والأجنة المنقوعة (SK) والأجنة المنقوعة المحمصة (RSK) كالتالى: 79.34، 49.14 ، 72.94 و 64.66% على التوالى. وكان نتائج الهضم الحقيقى 94.0 ،77.14 ، 93.65 و 85.33% على التوالى. تراوحت نسبة صافى الاستفادة من البروتين 74.58، 37.91 ، 68.31 و 55.17 على التوالى. و كذلك تم إجراء تقدير للمواد النباتية الفعالة والتركيب الكيميائي ومحتوى العناصر والأحماض الأمينية. وأشارت النتائج إلى أن نسبة البروتين الخام كانت 31,45 و 37,15 و 27,1 و 26,7٪ على التوالي وإرتفاع نسبة الدهون وكانت قيمها 31,07 و17,25 و 35,05 و 38,91٪ على التوالي. وتدرجت نسبة الألياف فكانت 11,4 و 15,6 و 17,51 و 19,04٪ على التوالي. والسكريات 17,3 و21,9 و13,94 و9,73٪ على التوالي . وأظهرت أجنة بذور المشمش الخام والمحمصة أعلى قيمة للفسفور 6109 و6963 جزء في المليون على التوالى ويليها الأجنة المنقوعة (2645) والأجنة المنقوعة المحمصة (2327). وسجلت العينات السابق ذكرها إرتفاع محتوى الحديد (48,55-60,15) والزنك (54,30-33,49) والنحاس (15,8-9,46) جزء في المليون. وأوضحت النتائج أن الجلوتاميك هو أكثر الأحماض الأمينية وفرة بنسبة 6,51 و 6,66 و 6,08 و5,77٪ على التوالي. بلغ إجمالي القدرة المضادة للأكسدة الأجنة المحمصة 2301، يليها الأجنة الخام (1127) والأجنة المنقوعة (190)، وأخيرا الأجنة المنقوعة المحمصة 311,3 ملج مكافئ حمض أسكوربيك/100جم. كما أن القوة المضادة للأكسدة المختزِلة للحديديك (FRAP) زادت بعمليات النقع والتحميص مما يدل على القدرة الإختزالية العالية للأنواع المختلفة من الأجنة.

إجمالي الفينولات كان على التوالى 13,68 و 26,48 و 17,06 و18,64 ملج مكافئ حمض الجاليك/100جم، ومحتوى الفلافونويد 6,12، 10,52، 5,67 و 8,14 ملج مكافئ الكوارستين/100جم على التوالي .التقدير النوعي للجليكوسيدات أوضح وجودها في الأجنة الخام والمعالجة. وبالنسبة للتانين وهو أحد مضادات التغذية فكان أقل نسبة في الأجنة المنقوعة (0,57٪). اظهر تحليل كروماتوجرافيا الغاز لعينات RAK وRK وجود مركب الاميجدالين بنسبة 2.47 و 0.83% على التوالى. بينما خلت عينات SK وRSK من وجود هذا المركب.

كما تم إستخلاص الزيت بالمذيبات العضوية من أنواع الأجنة السابقة وأوضحت نتائج تحاليله أن قيمة البيروكسيد كانت على التوالي 23,17 و 5,79 و1,67 و2,34 ملى مكافئ الأكسجين/كجم، وقيمة الأحماض الدهنية الحرة 2,66 و0,12 و7,3 و6,58% على التوالى، وقيمة الأيودين 106,13 و 106,5 و106,43 و 105,19 ملجم هيدروكسيد البوتاسوم /جم على التوالي، وكان حمض الأوليك هو الأكثر وفرة ونسبته على التوالي 60,82 و60,54 و60,54 و61,49% ويليه في الوفرة حمض اللينوليك ونسبته 25,94 و26,06 و26,07 و13,26% على التوالي. كما اكد تحليل الكتلة الكروماتوجرافى GC-MS للزيوت المستخلصة المختلفة على وجود العديد من المركبات ذات النشاط الحيوى المرتبط بتركيبها.

من النتائج السابقة يتضح إن أجنة بذور المشمش الخام والمعامل يمثل مصدر للبروتين والدهون والألياف. كما يمثل مصدر طبيعى لمضادات اللأكسدة الغني بالحديد والزنك والفسفور والنحاس. ولذلك يمكن إستخدام أجنة بذور المشمش كمصدر غنى فى تصنيع الكثير من المواد الغذائية.