JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2017, *23* (4), 229-235

Journal of Agroalimentary Processes and Technologies

Physico-chemical properties and fatty acid compositions of some edible pumpkin seed genotypes and oils

Ö. Türkmen[1], M. M. Özcan[2*], M. Seymen[1], M. Paksoy[1], N. Uslu[2], , S. Fidan[3]

[1]*Department of Horticulture, Faculty of Agriculture, Selçuk University, 42079 Konya, Turkey*
[2]*Department of Food Engineering, Faculty of Agriculture, Selçuk University, 42079 Konya, Turkey*
[3]*Transitional Zone Agricultural Research Institute, 26001 Eskişehir, Turkey*

Received: 15 August 2017; Accepted: 10 November 2017

Abstract

Fatty acid composition, total phenol and antioxidant activities of pumpkin seeds were determined. While genotype 109 has the highest seed yield (144.2 kg/da), genotype 106 had the lowest seed yield (42.9 kg/da). In addition, genotype 109 had the highest yield of seed (43.74 g/da) and yield of seed per plant (57.70 g). Oil contents of pumpkin ranged from 31.60% to 38.60%. The fatty acid compositions of seed oils were oleic (31.65%-43.43%), linoleic (37.62% - 49.25%), palmitic (9.98% - 12.41%) and stearic acids (6.20% - 7.28%). The content of linoleic acid was found higher than that of content of oleic acid of the genotypes except genotype 106. The antioxidant activities of seeds were found between 5.44% and 17.75%. Total phenol contents of seeds were determined between 0.25 and 0.35 mg GAE/ 100ml.

Keywords: Breeding, *Cucurbita pepo*, edible pumpkin seed, oil, yield, fatty acid composition

1. Introduction

Pumpkin which is grown annual called summer squash pumpkins and unripe fruit are consumed, in addition to *Cucurbita moschata*, *Cucurbita maxima* and *Cucurbita mixta* which known as winter squash, the mature fruits are used, have different species [1]. Pumpkin fruits are used as dessert, jam, candy and meal [2]. In addition to these, seeds of pumpkin are consumed as edible pumpkin, and are used as source of vegetable oil. Production of edible pumpkin has an important place in the agriculture associated with improving industry and it is a good alternative to some products [3]. Pumpkin seeds have high oil contents (40-50%) [2, 4-8]. Pumpkin seed oils are used as salad oil due to high nutrient content in Austria, Slovenia and Hungary [9]. Pumpkin seed oils are consumed as ingredient in soups and minced meat or used as frying oil in some countries [10].

It is also used in diet and medicine [11-13]. It is informed that consumption of 70-80g pumpkin seed per day is useful for human health [14]. In addition to these applications, pumpkin is also consumed as edible pumpkin seed.

Due to monoic flower structure of edible pumpkin, emerging diversity is an undesirable property and this property causes different problems. So, one of the biggest problem is variety problem in growing of edible pumpkin seed. Some studies were done to determine yield and fatty acid characteristics of some edible pumpkin seed genotypes in these genotypes. The purpose of this study was to determine of oil yields, antioxidant activity, total phenol contents and fatty acid composition of pumpkin seed and seed oil.

Corresponding author: *e-mail:* mozcan@selcuk.edu.tr; Tlf:+90.332.2232933

2. Materials and Methods

2.1.Material

This study was carried out in the vegetable trial field in Agricultural Faculty of Selcuk University in 2012. 120 edible pumpkin seed genotypes were collected from different region of Turkey, and 6 genotypes which have thin, long seed structure and demanded by market were used as plantal material. In this study, genotypes 101, 37, 106, 100, 17 and 109 were were used.

2.2.Method

Seeds were sown on 25th of April and 10th of May 2012 by distance of 80x50 cm and 6 seeds were sown in each pit and 3 seeds/plant from each genotype according to Nerson [15] and Ghanbari et al., [16]. Fertilization and irrigation were made with drip irrigation system. The plants were fertilized with doses of 6kg N, 10kg P and 10 kg K/da. Harvest was made with hand. Seeds of ripe fruits were removed with hand, and were dried. Soil analysis were made in trial field and the field had poor, limy structure from the stand point of organic matters and nutritional elements. In this research, parameters of yield such as number, size, diameter, weight, yield of fruit, 1000 kernels weight, seed width, seed lenght, seed index; properties of plantal and quality of seed such as branching, color of ripe fruit, intensity and color of spot in ripe fruits, seed color and ease of hint were determined. In addition to these parameters, yield and fatty acid composition of pumpkin seed and seed oils, total phenol and antioxidant activity of seeds were determined.

Oil content. Pumpkin seeds were dried at 60ºC/12h in oven and grounded with blender. The oil of ground samples was extracted with petroleum benzine about 6h in soxhlet apparatus. A rotary vacuum evaparator was used separating the solvent at 50° C and total oil content of pumpkin seeds was determined [17].

Fatty acid composition. Esterification process of samples were made according to ISO-5509 [18] method. Fatty acid methyl esters were injected gas chromatography (Shimadzu GC-2010) equipped with flame-ionization detector (FID) and capillary column.

Analysis conditions of instrument:
Injection block: 260ºC
Dedector : 260ºC
Mobile phase : Nitrogen
Total flow rate: 80 ml/min

Column: Fused silica column (Tecnocroma TR-CN100, 60m x 0.25mm, film thickness: 0.20µm).

A standard fatty acid methyl ester mixture (Sigma Chemical Co.) was used to identify sample peaks. Commercial mixtures of fatty acid methyl esters were used as reference data for the relative retention times [17]. Quantitative analyses of the fatty acids were performed using the heptadecanoic acid methyl ester as internal Standard. The results are mean values of three replicates.

*Total phenol and radical scavenging activity***.** Total phenolic compounds were prepared by using Folin-Ciocalteu Reagent [19]. The free radical scavenging activity of the extract was determined by using 1, 1-diphenyl-2-picrylhydrazyl or DPPH [20].

2.3.Statistical Analyses

Obtained datas were averaged and differences between applications were compared using JAMP statistical program [21].

3. Results and Discussions

T According to the yield results, it was found statistically significant differences among genotypes (Table 1). While genotype 109 has the highest seed yield with 144.2 kg/da, genotype 106 had the lowest seed yield with 42.9 kg/da. Obtained seed yield per decare was higher than seed yield of farmer conditions (90-100 kg/da). In previous study [2], oil seed pumpkin was obtained 36-57 kg/da seed yield. In addition, maximum seed yield of edible pumpkin was established as 170 kg/da in every other week level of irrigation and 100x40 cm plant spacing by irrigation culture [16]. Nelson [15] studied about effect on seed yield of plant spacing with edible pumpkin and obtained 110 kg/da seed yield with application of 4 plant / m^2. Our seed yields were found higher than other studies (Table 1).

When seed yield per fruit was analyzed, seed yields were found between 28.53 and 43.74 g. The maximum seed yield for per fruit had 43.74 g with genotype 109, while the minimum seed yield per fruit was 28.53 g with genotype 4. Similary, Nerson and Paris (2001) found 25-69 g seed yield per fruit. Obtained seed yields for per fruit were corresponded to other studies (Table 1). According to Table 1, seed yield for per plant had parallel results with other parameters of yield. The genotype 109 was the highest seed yield (57-70 g). The

genotype 106 had the lowest seed yield (17.15 g). Yegul et al., [2] obtained 36-57 g seed yield for per plant. Seed yield for per plant showed a changing as for that grown plant number. Our results were also corresponded to other studies [15,16]. When fruit number for per plant was analyzed, the genotype 17 had maximum number of fruit with 1.47 fruits / plant. The genotype 106 had minimum number of fruit with 1 fruit / plant. It was informed that 1-3 fruit / plant were obtained depends on variety and plant spacing [2,15,23].

Fruit length showed significant differences among genotypes, while the highest fruit length is 21.11 cm with the genotype 106. The lowest fruit length was 10.67 cm with the genotype 17 and 11.22 cm with the genotype 4. From the point of fruit diameter, the genotype 101 had the highest value (17.55 cm). The genotype 106 had the lowest value (12.22 cm) (Table 2). Nerson and Paris [22] studied on fruit of edible pumpkin and they found that fruit height was 14-22 cm, and fruit diameter was 15-20 cm.

When fruit weight was analyzed, the most heavy fruit was the genotype 37 with 1902 g; the lightest fruit was the genotype 17 with 928 g. According to study of Yegul et al., [2], the mean of fruit weight changed between 892 and 1394 g. In another study, these values were found between 2740 and 3977 g [16]. Genotypes used as edible pumpkin have different sizes. Our genotypes have also middle size fruit structure (Table 2).

As shown in Table 2, the maximum 1000 speeds weight was obtained from genotypes 37 and 106 with 196.6g and 195.8 g respectively. The minimum 1000 speeds weight were genotype 100 with 168.9. Mean of 1000 seeds weight was found 200 g in line of edible pumpkin by Raymond [24].

Ghanbari et al.[16] reported that edible pumpkin genotypes had between 150 and 179g 1000 seeds weight. Our results were corresponded to other studies. In the current study, width, length and index had significant differences, statistically. While the genotype 37 had the best width of seed with 9.52 mm, genotypes 100 and 17 had the lowest width of seed with 7.98 mm and 7.88 mm respectively.

The highest length of seed value was 22.16 mm with the genotype 17, the lowest value was 17.94 mm with the genotype 3. Therefore, genotypes 101, 17 and 109 had the maximum seed index with 2.7, 2.78 and 2.82. Genoypes 37 and 106 had also the minimum seed index with 2.13 and 2.04. According to the study of Joshi et al. [25] about seed properties of edible pumpkin, lenght, width and thickness were 16.91mm, 8.67mm and 3mm, respectively. Aydın and Paksoy [26] obtained similar results in the study about determination of physical properties of edible pumpkin seed. It is generally prefered thin, long and having high index edible pumpkin because of easy to hint. So our chosen genotypes had these properties as high seed index. Some plant properties were also determined in the study. When colours of ripe fruits were analyzed, genotypes 101 and 109 were yellow; genotype 37 was light yellow; genotype 106 was cream; genotypes 100 and 17 were dark yellow. Generally, varieties of edible pumpkin have yellow and hues of yellow fruit colours. Spot density of fruits was in few amounts in all genotypes and colors of spot were cream (Table 3).

According to seeds colors, genotypes 37 and 106 had light yellow color. Other genotypes had also cream color. Cream colored seeds receive more attention in edible pumpkin growing. Ease of hint is an important property. In the study, while genotypes 37 and 106 were hinted easily, other genotypes had reasonable ease of hint. It is thought that ease of hint is better when it is roasted. As a result of yield study in 6 different edible pumpkin genotypes, the genotype 109 had excellent property. Besides, genotype 37 had certain quality and closed to genotype 109 from the point of yield. Therefore, genotypes 109 and 37 were determined as hopeful variety nominee.

Total crude oil content of pumpkin seeds are given in Table 4. Oil contents ranged from 31.60% to 38.60% depending on variety. Genotype 37 had the highest yield of seed oil with 38.60%, while genotype 17 had the lowest value with 31.60%. Stevenson et al. [27] studied with twelve pumpkin cultivars (*Cucurbita maxima D.*) and determined that oil contents of seeds ranged from 10.9% to 30.9% (Table 4).

Table 1. Yield properties of some edible pumpkin varieties

Genotypes	Seed Yield per hactar (kg/ha)	Seed Yield per Fruit (g/fruit)	Seed Yield per Plant (g/plant)	Fruit Number per Plant
101	1258 ab	37.3 ab	50.33 ab	1.33 ab
37	1144 ab	38.34 ab	45.74 ab	1.2 ab
106	429 c	17.15 d	17.15 c	1 b
100	986 b	28.53 c	39.45 b	1.42 ab
17	1232 ab	33.52 bc	49.28 ab	1.47 a
109	1442 a	43.74 a	57.70 a	1.32 ab
LSD %5	429	7.15	17.15	0.42

Table 2. Fruit and seed properties of some edible pumpkin varieties

Genotype	Fruit Length (cm)	Fruit Diameter (cm)	Fruit Weight (g)	1000 Seed Weight (g)	Seed Width (mm)	Seed Length (mm)	Seed Index (mm/mm)
101	13.22b	17.55 a	1377 bc	181.9 ab	8.22 bc	22.13 ab	2.7 a
37	14.22b	16.89 ab	1902 a	196.6 a	9.52 a	20.27 b	2.13 c
106	21.11 a	12.22 c	1126 cd	178.8 ab	8.77 b	17.94 c	2.04 c
100	11.22 c	17 ab	1107 cd	168.9 b	7.98 c	22.13 ab	2.78 a
17	10.67 c	15.67 b	928 d	177.7 ab	7.88 c	22.16 a	2.82 a
109	14.89b	16.78 ab	1551 b	195.8 a	8.82 b	20.82 ab	2.36 b
LSD %5	1.82	1.54	288	25.7	0.67	1.88	0.18

Table 3. Plant, fruit and seed observations of some edible pumpkin varieties

Genotypes	Branch prolongation	Colours of ripe fruits	Spot density of fruits	Spot color of fruits	Seeds colors	Ease of hint
101	much	yellow	few	Cream	Cream	Middle
37	middle	light yellow	few	Cream	light cream	Easy
106	non	cream	few	Cream	light cream	Easy
100	most	dark yellow	few	Cream	Cream	Middle
17	most	dark yellow	few	Cream	Cream	Middle
109	middle	yellow	few	Cream	Cream	Middle

Table 4.Antioxidant activity, total phenol values and oil contents of pumpkin seeds

Genotypes	Antioxidant Activity (%)	Total Phenol (mg GAE/100 ml)	Total Fat Content (%)
101	7.23 bc	0.344 a	33.67 b
37	8.12 bc	0.334 a	38.60 a
106	12.67 ab	0.352 a	38.37 a
100	17.75 a	0.352 a	33.93 b
17	9.44 bc	0.310 ab	31.6 b
109	5.44 c	0.249 b	37 a
LSD %5	6.45	0.07	2.61

Table 5. Fatty acid composition of pumpkin seed oils (%).

Genotypes	Myristic	Palmitic	Stearic	Oleic	Linoleic	Arachidic	Linolenic	Behenic	Arachidonic
101	0.113 b	11.04 c	7.28 a	37.04 b	42.16 b	0.513 a	0.344 a	0.140 ab	0.085 b
37	0.109 b	11.62 bc	6.2 b	31.65 c	48.27 a	0.382 b	0.277 bc	0.118 c	0.146 a
106	0.077 c	9.98 d	6.99 a	43.43 a	37.62 c	0.506 a	0.242 c	0.161 a	0.123 ab
100	0.15 a	12.41 a	6.88 ab	28.90 c	49.25 a	0.491 a	0.359 a	0.142 ab	0.078 b
17	0.14 a	12.13 ab	6.83 ab	32.16 c	46.32 a	0.489 a	0.325 ab	0.124 bc	0.116 ab
109	0.11 b	11.84 ab	6.97 ab	38.57 b	40.26 bc	0.506 a	0.272 bc	0.145 a	0.109 ab
LSD %5	0.021	0.762	0.788	3.51	3,33	0.05	0.057	0.021	0.053

Antioxidant activity and total phenol contents of pumpkin seeds are given in Table 4. While the antioxidant activity of pumpkin seeds are found between 5.44% and 17.75%, total phenol contents ranged from 0.25 to 0.35 mg GAE/ 100ml. Antioxidant activity values of sample 101, 37 and 109 numbers were found lower when compared with other studied pumpkin samples. Total phenol contents of samples were found partly similar.

Fatty acid compositions of seeds belonging to different varieties are shown in Table 5. According to obtained results, dominant fatty acids of pumpkin seed oils were linoleic, oleic, stearic and palmitic acids. Content of linoleic acid was higher than that of oleic acid content in all of genotypes (except genotype 106). Although high linoleic acid content effect oxidative stability of oils, it was a desirable situation because of being essential fatty acid. Dominant saturated fatty acids were stearic and palmitic acids. Other fatty acids (myristic acid, arachidic acid, linolenic acid, behenic acid and arachidonic acid) were determined in small quantities. According to the study of Alfawaz [28], the unsaturated fatty acid content was 18.14 ± 0.60% oleic, 52.69 ± 0.92% linoleic and 1.27 ±0.22% linolenic acids. The saturated fatty acid contents were also 16.41 ± 0.95% palmitic and 11.14 ± 1.03% stearic acids. Stevenson et al., [27] determined that the predominant fatty acids were linoleic (36.2%-62.8%), oleic (17.0%- 39.5%), stearic (5.1%-9.0%), and palmitic acids (12.6%- 18.4%). GLC analysis for the fatty acid composition of the seed oil of pumpkin showed that the prodominant unsaturates are linoleic (42%) and oleic (38%), while the major saturates were palmitic (12.7%) and stearic (6%) [5]. Ihediohanma et al., [29] reported that *Nigerian pumpkin* (*Curcurbita pepo*) seed oil contained 6.34% lauric, 6.35% myristic, 23.20% oleic and 38.36 % linoleic acids. Fruhwirth and Hermetter [30] informed that Styrian pumpkin seed oil mostly consisted of unsaturated fatty acids. The content of polyunsaturated fatty acids with 45.6 ± 5% is higher than the content of monounsaturated fatty acids with 35.9 ± 10% or saturated fatty acids with 18.5 ± 20%. Younis et al., [31] determined that pumpkin (*Cucurbita pepo*) seeds are rich in oil content (~35%), and fatty acid composition of seed oils was palmitic (13.3%), stearic (8.0%), oleic (29.0%), and linoleic acids (47.0%). Applequist et al., [32] studied on *Cucurbita pepo* and winter squash species as *C. moschata, C. maxima, C. argyrosperma*. While *C. maxima* has the maximum saturated fatty acid content, *C. pepo* had the minimum saturated fatty acid content [32]. It is also ascertained that fatty acid composition of seeds were effected by hybridization in open-pollinated and these fruits had higher yield of oil. Idouraine et al., [33] reported that oil content of seeds ranged from 34.5 ± 0.42% to 43.6 ±0.06%, and oleic acid content ranged from 46.6 ± 0.58% to 60.4 ±0.19%, and was found higher than linoleic acid content with 9.6 ±0.16% - 77.9 ± 0.15%. Also palmitic acid content was found between 12.8 ±0.17% and 15.8 ±0.56%.

Acknowledgements: This study was supported by Selçuk Universty-BAP and the scinecific and tecnical resarach concil of Turkey (Tubitak project No: 110 O 088).

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Jafari M, Hossein Goli SA, Rahimmalek M., The chemical composition of the seeds of Iranian pumpkin cultivars and physicochemical characteristics of the oil extract. *Eur J Lipid Sci Technol*., **2012**, *114*, 161–167
2. Yegul M, Yıldız M, Ellialtıoğlu Ş, Abak K., Bazı kabuksuz çekirdek kabağı (*Cucurbita pepo* var. *styrica*) ıslah hatlarında tohum verimi ve kalitesi. *YYÜ Tarım Bil Derg*, **2012**, *22*(1):12-19.
3. Ferrirol M, Pico B., Pumpkin and Winter Squash, *Handbook of Plant Breeding* **2008**, *1*, 317-349.
4. Jacks TJ, Hensarling TP, Yatsu LY., Cucurbit seeds: I. Characterizations and uses of oil and proteins. *A review. Econ Bot*., **1972**, *26*, 135-141.
5. Tsaknis J, Lalals S, Lazos ES (1997) Characterization of crude and purified pumpkin seed oil. *Grasas y Aceites* **1997**, *48*, 267-272.
6. Murkovic M, Hillebrand A, Draxl S, Winkler J, Pfannhauser W., Distribution of fatty acids and Vitamin E content in pumpkin seeds (*Cucurbita Pepo* L.) In Breeding Lines. *Acta Hort.*, **1999**, *492*, 47– 55.
7. Winkler J., The Origin and breeding of the hull-less seeded styrian oil-pumpkin Varieties in Austria. *Cucurbit Gen Coop Rep*., **2000**, *23*, 101-104.
8. Gohari Ardabil A, Farhoosh R, Haddad Khodaparast MH (2011) Chemical composition and physicochemical properties of pumpkin seeds (*Cucurbita pepo* Subsp. pepo Var. Styriaka) grown in Iran. J Agric Sci Technol 13:1053-1063.
9. Murkovic M, Hillebrand A, Winkler J, Pfannhauser W., Variabilitiy of vitamin E content in pumpkin seeds (*Cucurbita pepo L.*). *Zeith Lebensm Unt Forsch.*, **1996**, *202*, 275-278.
10. Wenzil T, Prettner E, Schweiger K, Wagner F., An Improved Method to discover adulteration of styrian pumpkin seed oil. *J Biochem Biop Methods*, **2002**, *53*, 193–202.
11. Diaz Obregon D, Lloja Lozano L, Carbajal Ziniga V (2004) Preclinical studies of *Cucurbita maxima* (pumpkin seeds) a traditional intestinal antiparasitic in rural urban areas. *Rev Gastroenterol Peru*, **2004**, *24*(4), 323-327.
12. Koike K, Li W, Liu L, Hata E, Nikaido T., New phenolic glycosides from the seeds of *Cucurbita moschata*. *Chem Pharm Bull*., **2005**. *53*(2):225-228.
13. Seymen,M., Uslu, N., Türkmen, Ö., AlJuhaimi,F., Özcan,M.M., Chemical compositions and Mineral Contents of Some Hull-Less Pumpkin Seed and Oils. *J Am Oil Chem Soc* (in Pressed), **2016**.
14. Gilbert O, Fruhwirth AH (2007) Seeds and oil of the styrian oil pumpkin: Components and biological activities. *Eur J Lipid Sci Technol.*, **2007**, *109*, 1128-1140.
15. Nerson H (2005) Effects of fruit shape and plant density on seed yield and quality of squash. *Sci Hort*., **2005**, *105*, 293–304.
16. Ghanbari A, Nadjafi F, Shabahang J., Effects of irrigation regimes and row arrangement on yield, yield compenents and seeds quality of pumpkin (*Cucurbita pepo L.*). Asian J Plant Sci., **2007**, *6*(7): 1072-1079.
17. AOAC- Official Methods of Analysis, 15 th edn. Association of Official Analytical Chemists, Washington, **1990**, DC.
18. ISO-International Organization For Standardization, Animal and vegetable fats and oils preperation of methyl esters of fatty acids, ISO. Geneve, Method ISO 5509, **1978**, 1-6.
19. Yoo KM, Lee KW, Park JB, Lee HJ, Hwang IK., Variation in major antioxidants and total antioxidant activity of Yuzu (*Citrus junos* Sieb ex Tanaka) during maturation and between cultivar. *J Agric Food Chem*., **2004**, *52*, 5907-5913.
20. Lee SK, Mbwambo ZH, Chung H S, Luyengi L, Games EJC, Mehta RG., Evaluation of the antioxidant potential of natural products. Comb Chem High Throughput Screen. **1998**, *1*, 35-46.
21. Püskülcü H, İkiz F., Introduction to Statistic. Bilgehan Press. p333. Bornova. İzmir,Turkey. **1989**, (in Turkish)
22. Nerson H, Paris HS (2001) Relationship between fruit shape and seed yield in *Cucurbita pepo*. *Cucurbit Gen Coop Rep*., **2001**, *24*, 82-86.
23. Cui H., Effects of nitrogen fertility and plant density on vegetative and reproductive development in seed pumpkin (*Cucurbita pepo* L.). M.S. Thesis, University of New Hampshire, **2005**, USA.
24. Raymond G., Vegetable seed production, **1999**, 181-187.
25. Joshi DC, Das SK, Mukherjee RK (1993) Physical properties of pumpkin seed. *J Agric Eng Res*., **1993**, *54*, 219-229.
26. Aydın C, Paksoy M., Physical properties and nutrient contents of three edible summer squash (*Cucurbita pepo L.*) varieties seeds. *J Agric Fac Selcuk Univ*., **2006**, *20*(40): 32-36.
27. Stevenson DG, Eller FJ, Wang L, Jane J, Wang T, Inglett G E ., Oil and tocopherol content and composition of pumpkin seed oil in 12 cultivars. *J Agric Food Chem.*, **2007**, *55*, 4005-4013.

28. Alfawaz M A., Chemical composition and oil characteristics of pumpkin (*Cucurbita maxima*) seed kernels. Food Sci. & Agric. Res. Center, King Saud Univ., **2004**, 5-18.
29. Ihediohanma NC, Ubbaonu CN, Akobundu ENT, Banigo EOI., Phsico-chemical properties of Nigerian pumpkin (*Curcurbita pepo*) seed oil. *Nigerian Food J*., **2006**, *24*, 123-126.
30. Fruhwirth GO, Hermetter A ., Seeds oil of the styrian oil Pumpkin: components and biological activities. Eur J Lipid Sci Technol., **2007**, *109*, 1128-1140.
31. Younis YM H, Ghirmay S, Al-Shihry S S., African *Cucurbita pepo* L.: Properties of seed and variability in fatty acid composition of seed oil. *Phytochem*, **2000**, *54*(1), 71-75.
32. Applequist WL, Avula B, Schaneberg BT, Wang Y, Khan IA., Comparative fatty acid content of seeds of four *Cucurbita* Species Grown in a Common (Shared) Garden. *J Food Comp Analysis*, **2006**, *19*(6-7), 606-611.
33. Idouraine A, Kohlhepp EA, Weber CW (1996) Nutrient constituents from eight lines of naked seed squash (*Cucurbita pepo* L.). *J Agric Food Chem.*, **1996**, *44*, 721-724.