Fatty Acid Composition and Mineral Contents of Pea Genotype Seeds

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ABSTRACT: *Metal, non-metal and* and heavy metal contents of *different pea genotype seeds were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). For all genotypes, significant differences were observed in the mineral contents. Potassium was the most abundant element, ranged from 10146.13 mg/kg (PS3048) to 13171.97 mg/kg (PS3053) (Table 1). In addition, the phosphor content of pea seeds was found between 4004.31 mg/kg (PS 30100) and 5651.27 mg/kg (PS 3057). These pea genotypes contained 1562.32 mg/kg to 2034.28 mg/kg magnesium. Zinc contetns of pea samples changed between 29.66 mg/kg (PS 3055) and 67.81 mg/kg (PS 4053 B). The oil contents of pea samples ranged from 0.84% (PS4053 B) to 3.59% (PS 3055). Oleic acid is predominant fatty acid 12.95% to 45.02% followed by palmitic 13.68% to 77.28%, stearic (1.66% to 15.99%) acids. The highest oleic acid was found in PS3048 genotype (45.02%). The highest palmitic acid was found in PS4021 pea sample (77.28%). The current study contributes to the available information concerning the composition of several pea genotypes grown in Turkey*.

KEYWORDS: *Pea; Genotypes; Oil; Protein; Mineral; Fatty acid composition; GC; ICP-AES.*

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the important legumes grown in the world. It supplies adequate amounts of protein and minerals in the diet [1-6]. Progress in pea breeding results not only in higher yields but also in changes in the chemical composition of seeds [7,8]. Legume seeds are rich in mineral elements [9]. Nutrition to the seed crop may improve seed quality [10]. The oil content of pea seeds ranged from 0.8 to 6.1% [11]. In addition, Coxon and Davies [12] reported that wrinkled and round seeded peas contained 4.5-5.2% and 2.8-3.1% crude lipid, respectively. Although low oil, it may be of importance in the flavour of peas [13]. Pea is an annual self-pollinated species, and highly valued food legume grown extensively in the world. In Turkey,

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1021-9986/2019/2/153-158 *6/$/5.06*

the pea is considered to be a health vegetarian food and it sone of the most important human nutrition [14]. The aim of the current study was to investigate the fatty acid composition and mineral contents of some pea genotypes grown in Konya in Turkey.

EXPERIMENTAL SECTION

Material

In this study, PS30100, PS3029, PS3053, PS4021, PS4053 B, PS3048, PS3055, PS3057, and PS4028 pea genotypes that shown differences for morphological and high yield were used.

Methods

After about 50 g pea sample was dried at 65 ºC for 24 h, they were ground with a hummer mill. Protein contents were determined by the Kjeldahl apparatus. 6.25 was used as a nitrogen coefficient. The crude protein content of the grains was calculated by the coefficient of nitrogen quantity (6.25) [15].

Oil extraction

About 2 g of the seeds were ground in a ball mill and extracted with petroleum ether in a Soxhlet apparatus for 6 h [16]. The solvent was removed by a rotary evaporator at 40 °C and 25 mmHg. The oil was dried by a stream of nitrogen and stored at – 20 °C until used.

Determination of fatty acids

Fatty acid compositions for pea seed oil were determined using a fatty acid methyl ester method as described by *Hışıl* [17]. The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. The oil samples (50-100 mg) was converted to its Fatty Acid Methyl Esters (FAME). The methyl esters of the fatty acids (1 µL) were analysed in gas chromatography (GC-MS (Gas Chromatography-Mass Spectrometry) Agilent Technologies HP 6890) and MS; Agilent Technologies 5975C VL MSD equipped with a Flame Ionising Detector (FID), a fused silica capillary column (60 m x 0.25 mm i.d.; film thickness 0.250 micrometer). It was operated under the following conditions: oven temperature program. 175 °C for 7 min. Raised to 250 °C at a rate of 5 °C/min and than kept at 250 °C for 15 min); injector and detector temperatures, 250 and 250 °C; respectively, carrier gas. Nitrogen at flow rate of 1.51 mL/min; split ratio. 1/50 µL/min.

Determination of mineral contents

Pea genotype samples were dried at 70 ºC in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground samples were digested by using 5mL of 65% HNO_3 and 2 ml of 35% H_2O_2 in a closed microwave system (Cem-MARS Xpress). The volumes of the digested samples were completed to 20 mL with ultra-deionized water, and mineral contents were determined by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP AES) (Varian-Vista, Australia). Measurements of mineral concentrations were checked using the certified values of related minerals in the reference samples received from the National Institute of Standards and Technology (NIST; Gaithersburg, MD, USA) [18].

Working conditions of ICP-AES

Instrument : ICP-AES (Varian-Vista)
RF Power : 0.7-1.5 kW (1.2-1.3 kw for Axial)
Plasma gas flow rate (Ar): 10.5-15 L/min. (radial) 15 (Axial)
Auxilary gas flow rate (Ar) : 1.5
Viewing height : 5-12 mm
Copy and reading time : 1-5 s (max.60 s)
Copy time : 3 s (max. 100 s)

Statistical analysis

Experiment "randomized block" established in three replicates patterns in the experiment field of Faculty of Agriculture, Selçuk University. Varyans analysis and LSD test was made using "MSTAT-C" packet program access on the computer [19].

RESULTS AND DISCUSSION

The mineral contents of pea genotypes are given in Table 1. There were significant differences in these values among the nine genotypes of a pea. These differences in mineral and oil contents were due to a combination of genetic and environmental factors. For all genotypes, significant differences were observed in the mineral contents. Potassium was the most abundant element, ranged from 10146.13 mg/kg (PS3048) to 13171.97 mg/kg (PS3053) (Table 1). In addition, the phosphor content of pea seeds was found between 4004.31 mg/kg (PS 30100) and 5651.27 mg/kg (PS 3057). These pea genotypes contained 1562.32 mg/kg to 2034.28 mg/kg magnesium. Zinc contents of pea samples

Table 1: Protein (%) and mineral contents of pea genotype seed (mg/Kg).

Pea Genotypes	Protein	Al	Mo	Ca	B	Cd	Cu	Fe
PS30100	24.32 b	24.62 a	2.41 d	374.34 de	9.80 a	0.143	8.26 b	62.97 e
PS3029	21.52 de	23.45 ab	2.17 d	392.28 de	9.95 a	0.137	8.47 b	75.91 ab
PS3053	22.96 c	19.33 cd	3.20 c	809.03 b	10.61 a	0.167	6.55 d	70.13 cd
PS4021	24.63 b	16.42 e	2.42 d	1179.99 a	10.45 a	0.147	7.28 cd	65.52 de
PS4053 B	23.99 b	21.90 b	3.25 c	1262.82 a	10.47 a	0.123	7.89bc	78.15 a
PS3048	22.28 cd	15.70 e	1.34 e	484.13 cd	10.44 a	0.167	10.13 a	78.69 a
PS3055	20.66 e	17.55 de	6.10 a	330.48 e	7.52 b	0.137	7.76bc	64.63 e
PS3057	24.00 b	21.45bc	4.96 b	447.74cde	7.86 b	0.140	8.15bc	71.45bc
PS4028	27.35 a	17.14 de	3.57 c	517.00 c	10.51 a	0.123	8.05bc	65.77 de
Mean	23.52	19.73	3.27	644.20	9.73	0.143	8.06	70.36
Lsd	1.02	2.48	0.46	117.3	1.75		0.96	5.43
Pea Genotypes	K	Mg	Mn	Na	Ni	P	S	Zn
PS30100	11640.86b	1663.91 de	13.47 cd	169.59bc	2.02 d	4004.31 c	2389.11abc	51.74bc
PS3029	11564.75b	1772.24bcd	13.38 cd	146.53 de	2.54bc	4049.06 c	2321.23 a-d	56.95 b
PS3053	13171.97 a	1909.70 ab	16.35 b	192.16 a	2.44 cd	4294.75 c	2447.92 ab	50.57 c
PS4021	11863.94b	1994.11 a	12.00ef	158.53 cd	4.67 a	5156.98 b	2464.00 a	42.37 d
PS4053 B	12343.30ab	2034.28 a	20.67 a	182.05 ab	2.14 cd	4287.58 c	2434.49 ab	67.81 a
PS3048	10146.13c	1562.32 e	10.83 g	157.48cde	2.46 cd	4157.50 c	2350.13abc	67.63 a
PS3055	12025.55b	1718.08 cd	12.78 de	142.89 e	2.23 cd	5064.63 b	2125.79 d	29.66 e
PS3057	13137.69 a	1829.13bc	14.35 c	147.35 de	2.28 cd	5651.27 a	2181.45 cd	33.41 e
PS4028	12208.34ab	1672.24 de	11.14fg	183.72 ab	2.93 b	5374.09 ab	2230.27bcd	33.25 e
Mean	12011.39	1795.11	13.89	164.48	2.64	4671.13	2327.16	48.16
Lsd	963.50	146.70	1.10	15.34	0.45	430.60	223.00	5.225

changed between 29.66 mg/kg (PS 3055) and 67.81 mg/kg (PS 4053 B). Harmankaya et al. [20] reported that several pea genotypes contained 45.91-157.4 mg/100g Ca, 47.31-102.8 mg/100g Mg, 562.8 mg/100g-937.8 mg/100 g K, and 163.4-374.2 mg/100 g P and 2.10-5.71 mg/100g Zn. Wang and Daun [21] reported that Canadian field pies contained 59.6-106.9 mg/100g Ca, 4.1-7.9 mg/100g Fe, 687.4-1473.2 mg/100g K, 115.4-172.3 mg/100g Mg, 226.5-950.5 mg/100g P and 2.5-6.4 mg/100g Zn. The results are partly similar to the finding of *Wang* and *Daun* [21] and *Harmankaya et al*. [20].

The oil and fatty acid composition of pea genotype seed oils are presented in Table 2. The oil contents of pea samples ranged from 0.84 (PS4053 B) to 3.59% (PS 3055). In the previous study, pea seed contained 0.24 to 4.97% oil [22-24]. Oleic acid is predominant fatty acid 12.95% to 45.02% followed by palmitic 13.68 to 77.28%, stearic (1.66 to 15.99%) acids. The highest oleic acid was found in PS3048 genotype (45.02%). The highest palmitic acid was found in PS4021 pea sample (77.28%). *Wang* and *Daun* [21] reported that Canadian field pea oils contained 0.30-0.67% myristic, 8.57-12.73% palmitic, 2.39-5.27% stearic, 17.83-30.43% oleic, 40.55-52.44% linoleic, 10.25-17.15% linolenic, 0.50-1.19% arachidic acids. *Ryan et al*. [25] reported that pea oil contained 10.65% palmitic, 3.29% stearic, 28.25% oleic, 47.59% linoleic, 9.29% linolenic and 0.22% arachidic acids. *Srivastava et al.* [26] reported that field pea oil contained 12.0-18.4% palmitic,

Table 2: Oil contents and fatty acid composition of pea seed oil (%).

Genotypes	Oil	Myristic	Palmitic	Stearic	Oleic	Linoleic	Linolenic	Arachidic	Eicosenoic
		C14:0	C16:0	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1
PS30100	1.439 d	2.257a	32.877e	15.990 a	44.800 b	0.000 g	0.000 f	0.000 g	0.000 e
PS3029	1.761 cd	0.807f	33.173 d	6.349 d	44.573 c	6.903 f	4.587 c	2.077 e	1.346 c
PS3053	1.420d	0.656 h	13.536 i	1.660 i	21.933 g	51.335 a	10.882 a	0.000 g	0.000 e
PS4021	2.082bc	0.930 e	77.275 a	4.053 f	0.436 i	13.883 d	0.000 f	0.000 g	0.000 e
PS4053 B	0.835e	1.911b	30.146 g	3.236 g	42.922 d	0.000 g	0.000 f	4.581 a	1.324 d
PS3048	2.406b	1.255d	30.479 f	6.793 c	45.024 a	9.585 e	1.055 e	2.174 d	0.000 e
PS3055	3.594a	0.778g	40.629 c	6.316 e	26.032 f	14.803 c	3.154 d	3.027 c	3.101 a
PS3057	1.583cd	0.393 i	13.678 h	1.850 h	39.634 e	36.792 b	7.017 b	0.640 f	0.000 e
PS4028	1.320de	1.781 c	54.584 b	10.652 b	12.950 h	0.000 g	0.000 f	3.546 b	1.474 b
Mean	1.827	1.196	36.264	6.322	30.922	14.811	2.966	1.783	0.805
Lsd	0.510	0.005	0.030	0.010	0.006	0.003	0.007	0.005	0.002

2.0-4.2% stearic, 16.5-24.1% oleic, 37.9-53.9% linoleic and 6.8-10.6% linolenic acids. Pea seed oil contained 18.64% palmitic, 50.72% linoleic, 11.3% linolenic, 5.27% oleic and 4.1% stearic acids [27]. This is oil content and its variation during seed growth is a function of variety [28]. Welch and Griffiths [22] reported that pea oil contained 6.4-13.4% linolenic, 43.7-60.9% linoleic, 14.2-33.3% oleic, 2.7-4.2% stearic and 12.0-16.6% palmitic acids. Murcia and Rincoın [28] reported that pea oil contained 16.7-27.3% palmitic, 10.9-21.2% stearic, 14.9-21.7% oleic, 25.2-40.3% linoleic and 7.3-14.5% linolenic acids. In the discussion of the results obtained were probably due to temperature values during pea growth and the value of cotyledon/testa ratio during seed growth [28]. Also it is known that the enzymes involved in fatty acid biosynthesis depend on agroclimatic factors [29], and lipid content varies with climatic environmental conditions [30]. *Solis et al.* [31] reported that pea seed oil contained 3.67-9.01% palmitic, 3.44-7.31% stearic, 25.52-54.90% oleic, 21.38-44.78% linoleic and 6.01-14.01% linolenic acids. *Kukavica et al.* [32] reported that linoleic and oleic acids were the main unsaturated fatty acids of field pea, where as palmitic was main saturated fatty acid of field pea. Other researchers have found variable results for mineral contents and fatty acid composition of pea seeds. There were also differences in the protein and oil contents of pea genotypes. Additionally, the seed specific parameters vary not only between kinds of seed but also for the same seed, due to different conditions in climate, soil, and harvesting [33,34]. The current study contributes to the available information concerning the composition of several pea genotypes grown in Turkey.

Acknowledgement

This work was supported by Selçuk University Scientific Research Project (S.U.-BAP, Konya, Turkey).

Received : Jul. 20, 2017 ; Accepted : Ma. 12, 2018

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