Short note

Fatty acid composition of the seeds of two pepper varieties dried using different methods

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Optimum drying methods should be determined for seed longevity and preservation of the germination rate. Furthermore, while obtaining vigorous and healthy seedling by drying, the risk of genetic damage is minimised. In this study, fatty acid compositions of seeds of two pepper varieties dried by different methods were investigated. The fatty acid composition of the seeds of two pepper varieties dried by different methods had different saturated and unsaturated fatty acids. For saturated fatty acids, the seeds of two pepper varieties dried by different methods contained palmitic and stearic acids as the major component and contained small amount of myristic, margaric, arachidic and lignoceric acids. The major unsaturated fatty acids were identified as oleic and linoleic acids. Total saturated fatty acids contents varied between 13.41 and 21.56% and total unsaturated fatty acid contents varied between 78.44 and 86.59%. These findings may also help to better evaluate pepper seed oil in pharmaceutical and cosmetic commodities and confirm product authenticity.

Keywords: Pepper seeds, drying method, saturated fatty acid, unsaturated fatty acid

1. INTRODUCTION

Paprika is used in soups, stews, sausages, cheeses, snacks, salad dressings, sauces, pizzas, confectionery, drinks, etc. It is widely used as a food ingredient to change colour and flavour [1]. Drying is one of the most frequently used methods of processing and preserving red pepper [2]. Many drying methods are used for this purpose. Each drying method has negative and positive effects. After drying seeds are considered as by-products. Oil obtained from pepper is suitable for use as an alternative source of oil [3]. The chemical properties of pepper seed oil have been reported to be like safflower [4]. The potential of paprika seed oil for use in salads or cooking was recognised early [5].

The main reason of the differences in fatty acids composition of the cultivars could result from the genetic structure of the plant, irrigation, temperature and fertilisation [6, 7, 8, 9]. Drying methods significantly influence the fatty acid composition of the red peppers. Biochemical characteristics of the cultivars result in differences in drying methods. Not only the plant species, but also the cultivars should be taken into consideration in drying operations [10, 21].

Although there are some studies on the effect of the different drying steps on the fatty acid composition [11], it is not known whether there are differences air convective, microwave, freeze, open-sun, shade and greenhouse drying methods on fatty acid compositions of different pepper cultivars. The aim of this study is to examine the fatty acid composition of seed oil obtained from the seeds of two pepper varieties using different drying methods.

2. MATERIALS AND METHODS

2.1. MATERIALS

In the study, two pepper varieties named Pınar and Bozok, which are widely cultivated, were used. From the peppers harvested from the field, fruits that were not damaged and close in size and diameter were selected.

2.2. METHODS

2.2.1. Drying procedure

In this study, eight different drying processes (60 and 80°C air-convective, 300 and 600 W microwave, open-sun, shade, greenhouse and lyophilising) were performed on red pepper seeds. A hybrid oven with air-convective and microwave drying processes was used for drying seeds. Initial moistures of seeds were determined in an oven at 105°C for 24 h. In convective drying, drying processes were implemented 0.5 m s^{-1} air velocity. In open-sun, greenhouse, and shade drying, seeds were laid out on 50×50 drying papers. The seeds were dried under direct sunlight from 08:00 to 18:00 at temperatures between 25.8 and 42.5ºC in Kayseri, Turkey in August. The average relative humidity was 48.75%. The greenhouse is 72 m^2 (6 × 12 m) size which of 10 mm polycarbonate covered steel construction and has 4 ventilation and 1 circulation fan for homogeneous distribution of air. During the drying, the average temperature of the greenhouse was recorded as 34.55°C and relative humidity as 34.20%. Shade drying was carried out at room temperature. A lab-scale freeze dryer (Christ ALPHA 2-4 LSCplus, Germany) was used for freeze drying process at temperature of -55°C. The drying process was continued until the pepper varieties reached the equilibrium moisture value. After drying, the seeds of the peppers were separated and ground for analysis. All tests were conducted in 3 replications of factorial experimental design.

Moisture contents (wet basis) were determined with the use of followed equation [22].

$$M_c = \frac{W_i - W_f}{W_i} \times 100$$

Where:

M_c, moisture content (%, w.b),

W_i, initial weight of the product (g),

W_f, final weight of the product (g).

2.2.2. Oil Extraction and Preparation of Fatty Acid Methyl Esters (FAME)

Impurities were removed from the seeds, and the clean seeds were ground into powder using a ball mill. Lipids were extracted with hexane/isopropanol (3:2) [12]. The lipid extracts were centrifuged at 1 g for 10 min and filtered; then the solvent was removed on a rotary evaporator at 50°C.

2.2.3. Capillary GLC

Fatty acids in the lipid extracts were converted into methyl esters by means of 2% sulfuric acid in methanol [13]. The fatty acid methyl esters were extracted with 2.5 ml hexane. Then the methyl esters were separated and quantified by gas chromatography and flame ionisation detection (Agilent brand 7890A model GC, 5975C model MS) coupled to a glass GC 10 software computing recorder. Chromatography was performed with a capillary column (100 m in length and 0.25 mm in diameter, BPX90: SGE 054596) using nitrogen as a carrier gas (flow rate 3 ml/min). The temperatures of the column, detector, and injector valve were 120-250°C and 230-270°C, respectively. Chromatographic conditions: starting at 50°C, then standing for 2 minutes and reaching 200°C at a rate of 20°C/min and then accelerating to 230°C at 5°C/min where it stood for 30 minutes. The total analysis time was 55.5 min. The identification of the individual method was performed by a frequent comparison with authentic standard mixtures that were analysed under the same conditions.

3. RESULTS AND DISCUSSION

Fatty acid composition of Bozok and Pinar seed varieties were dried using different methods presented in Table I and Table II, respectively. The seed oils of pepper varieties dried using different methods contain palmitic (12.62-14.46%) and stearic (4.41-8.08%) acids as the major component of fatty acids, among the saturated acids, with small amounts of myristic (0.26-0.27%), margaric (0.34-0.48%), arachidic (0.20-0.23%), and lignoceric (0.03-0.25%) acids. The major unsaturated fatty acids found in the seed oils were oleic (6.46-20.63%) and linoleic (64.65-73.91%) acids. Linolenic, palmitoleic and eicosapentaoic acids resulted to be lower than 1%. In this study, the total saturated fatty acids of pepper varieties dried using different methods were between 13.41 and 21.56%, while the amounts of total unsaturated fatty acids were between 78.44 and 86.59%.

Myristic acid was detected only in the Pinar variety seeds dried using 300 W and 600 W drying methods as 0.27% and 0.26%, respectively. Palmitoleic acid, on the other hand, was detected in seeds of the Bozok variety, dried in the shade, in addition to the applications in which myristic acid was detected. Margaric acid was detected only in the seeds of the Bozok variety dried in the greenhouse and 600 W drying applications. These results regarding myristic, palmitoleic and margaric acids do not agree with some researchers who reported that these acids were detected from different pepper seeds [14, 15, 16]. On the other hand, some scientists [17] reported that myristic and palmitoleic acids were found to be 0.17% and 0.29% in the pepper seed oil.

Palmitic acid was detected in all applications and varieties; it was found at the highest level (14.46%) in

Table I - Fatty acid composition of seeds of Bozok pepper varieties dried by different methods.

	14:0	16:0	16:1	17:0	18:0	18:1 (9)	18:2 (9,12)	18:3 (9,12,15)	20:0	20:2	24:0	∑SFA	∑TUSFA
B1	-	14.06	-	0.08	6.62	6.95	71.44	0.50	-	0.10	0.25	21.01	78.99
B2	-	14.46	0.34	-	6.72	6.58	71.07	0.49	-	0.14	0.20	21.38	78.62
B3	-	14.34	-	-	6.65	6.92	71.23	0.50	-	0.15	0.21	21.20	78.80
B4	-	12.62	-	-	7.02	7.48	71.95	0.54	-	0.17	0.22	19.86	80.14
B5	-	13.92	-	-	5.71	7.15	72.51	0.55	-	0.16	-	19.63	80.37
B6	-	12.84	-	-	4.94	8.21	73.26	0.54	0.21	-	-	17.99	82.01
B7	-	13.05	-	0.11	6.86	6.46	72.73	0.61	-	0.18	-	20.02	79.98
B8	-	12.96	-	-	4.41	8.29	73.91	0.43	-	-	-	17.37	82.63

Pepper varieties and drying methods: B1 Greenhouse-Bozok; B2 Shade-Bozok; B3 Open-Sun-Bozok; B4 60°C-Bozok; B5 80°C-Bozok; B6 300 W-Bozok; B7 600 W-Bozok; B8 Lyophilizer-Bozok; Fatty acids: C14:0 Myristic acid; C16:0 Palmitic acid; 16:1 Palmitoleic acid, 17:0: Margaric acid, 18:0: Stearic acid, C18:1 Oleic acid; C18:2 Linoleic acid; C18:3 Linolenic acid; C20:0 Arachidic acid; C20:2 Eicosapentaoic acid, C24:0: Lignoceric acid; TSFA: Total saturated fatty acid; TUSFA: Total unsaturated fatty acid.

Table II - Fatty acid composition of seeds of Pinar pepper varieties dried by different methods.

	14:0	16:0	16:1	17:0	18:0	18:1 (9)	18:2 (9,12)	18:3 (9,12,15)	20:0	20:2	24:0	∑SFA	∑TUSFA
P1	-	13.64	-	-	5.51	14.17	64.65	0.58	-	1.45	-	19.15	80.85
P2	-	14.30	-	-	-	19.47	65.81	0.42	-	-	-	14.30	85.70
P3	-	12.77	-	-	5.19	11.90	68.85	0.70	0.21	0.21	0.17	18.34	81.66
P4	-	12.94	-	-	7.14	10.04	68.97	0.69	-	0.22	-	20.08	79.92
P5	-	13.18	-	-	-	20.63	65.45	0.51	0.23	-	-	13.41	86.59
P6	0.27	13.95	0.48	-	-	17.38	67.15	0.77	-	-	-	14.22	85.78
P7	0.26	13.98	0.38	-	7.29	10.44	67.00	0.45	-	0.17	0.03	21.56	78.44
P8	-	12.80	-	-	8.08	9.22	68.91	0.42	0.20	0.15	0.22	21.30	78.70

Pepper varieties and drying methods: P1 Greenhouse-Pinar; P2 Shade-Pinar; P3 Open-Sun-Pinar; P4 60°C-Pinar; P5 80°C-Pinar; P6 300 W-Pinar; P7 600 W-Pinar; P8 Lyophilizer-Pinar; Fatty acids: C14:0 Myristic acid; C16:0 Palmitic acid; 16:1 Palmitoleic acid, 17:0: Margaric acid, 18:0: Stearic acid, C18:1 Oleic acid; C18:2 Linoleic acid; C18:3 Linolenic acid; C20:0 Arachidic acid; C20:2 Eicosapentaoic acid, C24:0: Lignoceric acid; TSFA: Total saturated fatty acid; TUSFA: Total unsaturated fatty acid.

the Bozok variety seeds dried in the shade, while the lowest level was detected in the Bozok variety seeds dried at 60°C (12.62%). While our findings on palmitic acid were consistent with the findings of some researchers [14, 16, 18, 19], it was higher than the findings of some researchers [11, 15, 17, 20]. Stearic acid was detected in all applications and varieties except the seeds of the Pınar variety, which were dried in shade, 80°C and 300 W drying methods. While the highest stearic acid was obtained from the seeds of the Pınar variety dried by the lyophilising method, the lowest stearic acid was found in the seeds of the Bozok variety, which were also dried using the lyophilising method. The findings we obtained on stearic acid were consistent with the findings of some researchers [18, 20], but higher than the findings of some researchers [11, 15, 16, 17, 19], and lower than the value of the researcher obtaining it as 11.69% [14].

The major unsaturated acids in the seed oils of all applications and varieties were oleic, linoleic, and linolenic acids. The oleic acid content was higher in the Pınar variety seeds dried at 80°C (20.63%), and lower in the Bozok variety seeds dried at 600 W (6.46%). The seed oils of all the applications and varieties were richer in linoleic than linolenic acid. The greatest proportion of Linoleic acid was found in the seed oil. The linoleic acid content was higher in the Bozok variety seeds dried using the lyophilising method (73.91%), and in the Bozok variety seeds dried at 300 W (73.26%) but lower in the Bozok variety seeds dried in the greenhouse (64.65%). Linolenic acid was detected in low levels in the Pınar variety seeds dried both using the lyophilising method and in the shade (0.42%) The linolenic acid content was higher in the Pinar variety seeds dried both at 300 W (0.77%) and at 60°C (0.69%). While the values we obtained for oleic and linoleic acids agreed with the values of many scientists [11, 15, 16, 17, 18, 19], the values we obtained for the linolenic acid was low compared to some investigators [16, 17] and high compared to other investigators [18, 19].

Arachidic acid was detected only in the Bozok variety seeds dried at 300 W, and in the Pinar variety seeds dried at Sun, 80°C and lyophilising drying methods as 0.21%, 0.21%, 0.23% and 0.20%, respectively. While the values we obtained for arachidic acid agreed with the values of many scientists [15, 17, 18], some investigators found low values [16], and some investigators found high values [14, 19]. Eicosapentaoic acid was detected in all applications except for 5 different applications. The highest eicosapentaoic acid was detected in the Pınar variety seeds dried in the greenhouse with 1.45%, while the lowest eicosapentaoic acid was detected in the seeds of the Bozok variety dried in the greenhouse with 0.10%. These results regarding eicosapentaoic acid was like some researchers who reported that eicosapentaoic acid were detected from Urfa pepper seeds as 0.18% [17]. On the other hand, some scientists [16] reported that eicosapentaoic acid ranged from 0.03% to 0.05% in the red pepper seed oils extracted using different methods. The lignoceric acid content of pepper seeds dried using different methods varied between 0.03% and 0.25%. The highest lignoceric acid was detected in the Bozok variety seeds dried in the greenhouse, while the lowest lignoceric acid was detected in the Pınar variety seeds dried at 600 W. While these results on lignoceric acid were consistent with the findings of some researchers [15, 16], it was lower than the lignoceric acid values that some scientists had found as 0.37% in the seeds of the world's hottest Naga king chili pepper [19].

The total saturated fatty acids (TSFA) of pepper seeds dried by different methods were between 13.41% and 21.56%. The Pınar variety seeds dried at 80°C had the lowest level of saturated acid, and the Pınar variety seeds dried at 600 W had the highest saturated fatty acid (SFA) concentration. The total unsaturated fatty acids (TUSFA) of the pepper seeds dried using different methods were between 78.44% and 86.59%. The Pınar variety seeds dried at 80°C had the highest level of unsaturated fatty acid (86.59%), along with the seeds of the Pınar variety dried at 300 W (85.78%), and the seeds of the Pınar variety dried at shade (85.70%) (Table II).

4. CONCLUSION

In this study, seeds of two different red pepper varieties were dried with the use of 8 different drying methods. Fatty acids of the varieties were presented in such differences in drying methods. Palmitic and stearic acids were determined as the major component fatty acids, among the saturated acids. Besides, oleic and linoleic acids were found as the major unsaturated fatty acids. The greatest results were obtained for both Bozok and Pinar cultivars in freeze, 300 W microwave and shade dried samples. In further studies, researchers can focus on different drying methods and conditions, considering the current findings.

Conflict of interest

The authors declare that they have no conflict of interest.

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