Fatty acids composition of oil from OS corn hybrids

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Abstract

The fatty acid composition is a characteristic of plant species and has nutritional, biochemical and technological importance. Grains of fifteen commercial OS corn hybrids were analyzed for oil content and fatty acids composition. The oil for fatty acid analysis was extracted with diethylether contained buthyhidroxytoluene. The fatty acid compositions of oils were determined by gas chromatography with flame ionization detection. Fatty acids were separated according to carbon atoms and number of double bonds and were identified by comparing their retention time to standards. Fatty acids were quantified based on peak area by method of area normalization.

The oil content in investigated corn hybrids varied between 4,04 and 5,78% on dry matter basis. The amount of determined saturated fatty acids, palmitic (16:0) and stearic (18:0) were 8,76–11,78 and 2,00-2,57%, respectively. Oleic acids were in the range 26,68–37,96%. Polyunsaturated fatty acids were between 45,79 and 57,88% for linoleic, and 0,96 and 1,37% for linolenic acid. There were significant differences between saturated, monounsaturated and polyunsaturated fatty acid of oil from corn hybrids. In selection, choosing hybrids with good quality traits can improve the nutritional and functional quality of the corn oil.

Key words: corn, oil content, corn oil, gas chromatography, fatty acids

Sastav masnih kiselina ulja OS hibrida kukuruza

Sažetak


Udio ulja u istraživanim hibridima kukuruza je varirao između 4,04 i 5,78%. Količine zasićenih masnih kiselina, palmitinske i stearinske su bile između 8,76-11,78 odnosno 1,99-2,57%. Oleinske kiseline je bilo u rasponu od 26,68-37,96%. Polinezasićenih masnih kiselina je bilo 45,79-57,88% linolne i 0,96-1,37% linolenske kiseline. Pronađene su značajne razlike između zasićenih, mononezasićenih i polinezasićenih masnih kiselina u uljima hibrida kukuruza. Odabir hibrida sa dobrim značajkama kvalitete prilikom selekcije, može poboljšati prehrambenu i funkcionalnu kvalitetu ulja kukuruza.

Ključne riječi: kukuruz, sastav ulja, kukuruzno ulje, plinska kromatografija, masne kiseline

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Introduction

Most plant seeds contain some oil but the commercial importance of a seed as an oilseed is based on the quantity and composition of the fatty acid oil present. Vegetable oils are intended for food and non-food application, and breeding is aimed to improved oil quality. From the point of view of seed oil quality improvement, the three main parameters that are usually considered are the fatty acids composition, the triacylglycerol composition and the quantity and composition of antioxidants present in oil (Velasco and Fernandez-Martinez, 2002).

Commercial corn hybrids contain 4-5% oil in the grain, and theirs quality and quantity have been much investigated. Palmitic, stearic, oleic and linoleic acids are dominant acids in crude corn oil that can form different triacylglycerols (TAG) (Harrabi et al., 2010). The glyceride structure of plant oils is quite specific; saturated fatty acid are concentrated almost entirely in the primary positions (sn-1 and sn-3), while the sn-2 position of TAG of seed oils is greatly enriched in polyunsaturated fatty acid, and monoenoic acids are relatively evenly distributed. Distribution of fatty acids in triacylglycerols is interesting for the development of cultivars with improved oil characteristics. The fatty acids composition can be used to evaluate the stability and nutritional quality of fat and oil, while the type and the amounts of the various TAG species determine physical and functional properties of these oils and also the oxidative stability in the part dependent on TAG composition and structure (Buchgraber et al., 2004). In recent years, the analysis of fatty acids has gained on importance because of their nutritional and health implications.

The objective of this study was to investigate the oil content in grain and fatty acid composition of oil from commercial OS corn hybrids.

Material and methods

The experimental material comprised fifteen commercial corn hybrids which were created at the Agricultural institute Osijek. Grain of corn hybrids were analyzed for oil content and fatty acids composition. Oil content was determined by standard Soxhlet method. The oil for fatty acid analysis was extracted with diethylether contained buthyhidroxytoluene by Soxhlet apparatus. Before the fatty acid composition of oil can be analyzed by gas chromatography, the oil must be converted to low molecular weight, volatile, nonpolar derivatives (e.g., fatty acid methyl esters). Preparation of methyl esters of fatty acids was carried out according to International Standard ISO 5509:2000 – boron trifluoride method. The fatty acid methyl esters were analyzed by using a Shimadzu GC-2010 Plus gas chromatography system, equipped with autosampler, oven, flame ionization detector and Lab solution software (ver.2.32.00). Separation was performed on column Forte GC 30 m length, 0,25 mm inner diameter and film thickness 0,25 μm. Injected sample volume was 1 μl. Operating conditions were: split ratio of 30:1, the inlet temperature set at 225°C, the detector temperature set at 280°C, and carrier gas was He was at a flow rate 0,8 ml/min. The initial oven temperature was 150°C (held for 7 min), and then increased to 240°C at a rate of 8°C/min, held for 1 min, and finally increased to 250°C at 250°C/min and held at that temperature. Total analysis time was 25 minutes. Fatty acids were separated according to carbon atoms and number of double bonds and were identified by comparing their retention time to standards. Fatty acids were quantified based on peak area by method of area normalization.

Statistical analyses were performed using statistical-graphic system "Statistica" version 7.0 (Stat Soft software Inc., Tulsa, OK, USA).

Results and discussion

Mean values for grain oil content ranged from 4,04 to 5,78% (Fig.1). Tvrtko had maximum grain oil percentage followed by Os-430 (5,04%) and lowest content was determined in Ossk 490. Tvrtko was significantly different in grain oil content compared with all the hybrids under study.
Most of corn grain oil is located in the embryo. Grain oil content is thus primarily determined by the oil concentration of the embryo and embryo size. Corn with higher oil content shows a greater feed efficiency in animal feed trials because the caloric content of oil is 2.25 times greater than that of starch on a weight basis (Val et al., 2005).

The main fatty acids obtained by gas chromatographic analysis in investigated oil: saturated palmitic (C16:0) and stearic acids (C18:0), and unsaturated oleic (C18:1) and linoleic acid (C18:2).
The results indicate that the most dominant saturated fatty acid was palmitic acid. Among hybrids high level of this acid was found in Os 713 (11.78%) and Os 499 (11.76%), the least in Os 298P (8.76%). Stearic acid amount was highest in Os 499 (2.57%) and lowest in Os 494 (2.00%) and Ossk 444 (2.02%) (Fig. 2). Oleic acid, belonging to monounsaturated fatty acids (MUFA), was the second most abundant unsaturated fatty acid in corn oil, with amounts ranging from 26.68% (Ossk 602) to 37.96% (Ossk 659). Most present fatty acid in corn oil was linoleic acid with highest amount in Os 602 (57.88%) and lowest in Os 659 (45.79) (Fig. 3). Oleic acid concentration was strongly negatively correlated (-0.96) with that of linoleic acid, suggesting that selection of genotype may be improved functional and nutritional qualities of this.

All of the hybrids contained linolenic acid, with values ranging from 0.96 to 1.36%. Very small amounts of myristic (C16:1), arachidic (C20:0), behenic (C22:0), erucic (C22:1) and lignoceric (C24:0) have been determined (<1%). In this study, the results of fatty acid composition in corn oil were in agreement with some published data (Bilgin et al., 2010; Orhun and Korkut., 2011). Saoussem et al. (2009) reported that for all the three corn varieties, linoleic acid (49.7–62.7%) was the predominant fatty acid component, followed by oleic (23.5–34.9%) and palmitic (9.5–11.5%) acids. Goffman and Böhme (2001) reported that the major fatty acids were palmitic, oleic and linoleic, whose contents were in range 9.2 to 12.1%, 19.5 to 30.5% and 53.0 to 65.3% respectively. Other authors found a wide range of fatty acids profiles in corn oil from different breeding materials (Dunlap et al., 1995a; 1995b; Saleem et al., 2008; Jimenez et al., 2009; Pollak and Scott., 2010).

Fatty acid composition is a major determinant of oil quality. The good quality of oils mainly refers to high percentages of unsaturated fatty acids, usually oleic and linoleic. Corn oil is an exent source of linoleic acid an essential polyunsaturated fatty acid (PUFA). Among traditional commercial vegetable oils, only safflower oil (77.7% linoleic acid) and sunflower oil (72.6% linoleic acid) have higher percentages of PUFA then corn oil. Althought it is highly polyunsaturated, corn oil is considered fairly stable to oxidation. A reason for this is position in TAG molecule and minor level of linolenic acid. Polyunsaturated fatty acid occupy sn-2 position of TAG, thus providing protection from oxidation (Warner and Knowlton, 1997).

Corn oil, which is high in PUFA and also contains an appreciable amount of MUFA, is well positioned for creating beneficial effect for heart disease risk reduction. These effects may be due to the unique combinations of PUFA and MUFA found in the corn oil, but may also be the result of phytosterols from corn oil (Ostlund et al., 2002).

Conclusion

The main fatty acids obtained by gas chromatographic analysis of oil in investigated OS corn hybrids: saturated palmitic and stearic acids, monounsaturated oleic and polyunsaturated linoleic acid. Most present fatty acid was linoleic acid. The significant differences between saturated, monounsaturated and polyunsaturated fatty acid of oil from corn hybrids were found. In selection, choosing hybrids with good quality traits can improve the nutritional and functional quality of the corn oil.

Reference


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