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Research Article

CONTENT OF FATTY ACIDS IN CORN (*ZEA MAYS* L.) OIL FROM ECUADOR

CARRILLO W[1]*, CARPIO C[2], MORALES D[1], VILCACUNDO E[2], ÁLVAREZ M[1], SILVA M[1]

[1]Research Department, Laboratory of Functional Foods, Faculty of Foods Science and Engineering, Technical University of Ambato, Av. Los Chasquis y Rio Payamino, Campus Huachi, CP 1801334, Ambato, Ecuador. [2]Research Department, Faculty of Health and Human Sciences, Bolivar State University, Academic Campus "Alpachaca" Av. Ernesto Che Guevara s/n y Av. Gabriel Secaira, EC. 020150, Guaranda, Ecuador. Email: wi.carrillo@uta.edu.ec

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ABSTRACT

Objective: The aim of this work was to determine the fatty acids content in corn seeds oil (*Zea mays*) sample cultivated in Ecuador.

Methods: Corn oil was obtained from corn oil seeds using the cold pressing method. Methyl esters fatty acids analysis were carried out using the gas chromatography (GC) method with a mass selective detector and using the database library NIST 14.L to identify the compounds present in the corn seed oil.

Results: Methyl esters fatty acids were identified from corn (*Z. mays*) seeds using the GC mass spectrometer (GC-MS) analytical method. Fatty acids were analyzed as methyl esters on a capillary column DB-WAX 122-7062 with a good separation of palmitic acid, stearic acid, oleic acid, elaidic acid, linoleic acid, arachidic acid, and linolenic acid. The structure of methyl esters fatty acids was determined using the GS-MS method. Corn oil has a high content of linoleic acid (omega 6) with a value of 52.68% of the total content of fatty acids in corn oil and 29.70% of oleic acid (omega 9) of the total content of fatty acids in corn oil. The sample presented a value of 12.57% of palmitic acid.

Conclusions: Corn oil shows a good content of fatty acids omega 6 and 9. The higher value was of omega 6 with 52.68% content. Corn oil has a good proportion of polyunsaturated of lipids (53.80%) and 14.86% of saturated lipids.

Keywords: Corn, *Zea mays*, Fatty acids, Lipids.

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INTRODUCTION

Maize (*Zea mays* L.) has been a crop extended and an important food for the American societies since pre-hispanic times [1] the domestication of crop was originated in Mexico ca. 8700 cal. BP and later spread to North and South America [2]. The earliest evidence of maize cultivation and consumption in South America are from the Pacific coastal regions of Peru and Ecuador ca. 3000 BC [3,4]. Maize (*Z. mays* L.) is the third most important food crop in the world and a major source of energy, protein, and other nutrients for both human and livestock. Maize contains 7-13 g/100 g proteins (d.m.). However, the quality of maize proteins is poor, because they are deficient in the essential amino acids lysine and tryptophan [5,6]. Due to the economic importance of maize, genetic improvements have played a key role in the development of genotypes that could grow in a wide range of environment, rainfall, and altitudes. Corn seeds oil is mainly used for salad and cooking oil and the production of products as margarine. Its fatty acid composition comprises 40-68% of linoleic acid, 20-32% of oleic acid, and 8-14% saturated fatty acids, mainly palmitic acid [7].

METHODS

Oil extraction

Corn is cultivated in the central region of Ecuador. Corn oil sample was obtained from corn seeds using the cold pressed method. Oil was then stored at 4.0±2°C. Oil extraction was conducted using a Soxhlet apparatus for approximately 5 hrs with hexane as solvent, with a solid to solvent ratio of 1/7 m/v. After the extraction process, the flask contents were filtered, and the liquid fraction containing the lipid extract and solvent was poured into a 250 mL flask of a rotary film evaporator to remove the solvent. The obtained oil was collected, evaporated under nitrogen, weighed, and stored in sealed amber glass vials at −20°C until analysis [8].

Fatty acids analysis by gas chromatography-mass selective detector (GC-MSD)

The fatty acid composition of oil extracted from corn seeds was analyzed by injecting fatty acid methyl esters [9] into an Agilent Technologies 7980A system GC (Agilent, Santa Clara, CA) equipped with a MSD 5977A GC/MSD, an auto-sampler 7693, column (60 m × 250 µm × 0.25 µm, Agilent 122-7062). The oven temperature was programmed as follows: From 80°C; ramp 1: To 100°C at 20°C/min for 1 minute; ramp 2: At 200°C at 25°C/min for 10 minutes; ramp 3: At 250°C at 2°C/min. The injector and detector temperatures were set at 250°C. Helium was used as carrier gas at a linear flow velocity of 1.4 mL/min.

RESULTS

Corn oil was analyzed using the GC/MS method. The profile of peaks analyzed show seven majoritarian peaks with different retention times. The first peak was observed at 19,283 minutes of retention, a second peak with 25,947 minutes of retention, a third peak was observed at 26,819 minutes of retention, a fourth peak was identified at 27,121 minutes of retention, a fifth peak was observed at 28,593 minutes of retention being this peak the more abundant, a sixth peak was observed at 31,038 minutes of retention, and finally a seventh peak was observed at 34,233 minutes of retention, with a residual abundance (Fig. 1a). The profile of peaks from fatty acids of *Z. mays* observed in the chromatogram is similar to the one described by Latons *et al*., 2015 (Fig. 1b) [10].

Fatty acids of corn oil from Ecuador were methyl esterified. Fatty acids from corn oil were identified using the GC/MSD. The precursor ions were compared to three database library NIST 14. L. Seven majority peaks were identified with their associated retention time. The concentration of fatty acids in corn oil obtained in the laboratory was calculated with a peak area percentage. Fatty acids methyl esters were characterized: C16:0 palmitic acid with 12.57% of fatty acids content, C18:0 stearic acid with 2.02% of fatty acids content, C18:1 oleic acid with 29.70% of fatty acids content, C18:1 trans elaidic acid with 0.81% of fatty acids content, C18:2 linoleic acid with 52.68% of fatty acids content, C18:3 linolenic acid with 1.12% of fatty acids content, and finally C20:0 arachidic acid with 0.27% of fatty acids content (Table 1). The content of linoleic acid (omega 6) was very high, whereas the content of linolenic acid was very low with a value of 1.12% of linolenic acid of corn oil. The content of oleic acid from corn oil was higher with a value of 52.68% of oleic acid. The content of polyunsaturated lipids was very high with a value of 53.80% of polyunsaturated lipids. Our results are in accordance with values reported by other authors.

The mass spectrum of methyl esters fatty acids obtained from corn oil is shown in Fig. 2. The identity and structures of these fatty acids were confirmed with the GC-MS method. Palmitic acid (C16:0) was identified using the mass spectrum with ions of mass/charge (m/z) between 55 and 270 m/z. In the previous range, the ions 74 and 87 m/z were the most abundant in the mass spectrum (Fig. 2a). Stearic acid (C18:0) (Fig. 2b), oleic acid (C18:1) (Fig. 2c), linoleic acid (C18:2) (Fig. 2d), and linolenic acid (C18:3) (Fig. 2e).

DISCUSSION

The food diet in the developing countries is changing continually and rapidly, especially the consumption of fats, edulcorates, preservatives, additives, and food of animal sources. The consumption of food of vegetal sources is increasing with vegetal proteins, antioxidants, and vegetal oil. In the Western developed countries, a diet rich in animal food is popular. The nutrition transition in the developing countries starts when the consumption of vegetal oils and seed oils start to be high together with higher consumption of meat and bovine milk [11,12]. In 1997, the world production of vegetal oils and vegetal fats was around 71 million tons whereas the production of animal fat (butter and tallow) was stable with 12 million tons in the world. Vegetal oils such as soybean, sunflower, rapeseed, palm, and groundnut oil have triplicated their consumption from 1961 to 1990 [13,14]. When the economic capacity of a country increases, intake of fats increases. In poor countries, the consumption of fats can also increase as today the cost of vegetal oils is extremely low. It has been studied that saturate fat consumption is harmful to human health and can increase the cardiovascular risks in consumers. "Oil world" indicates that in the next 10 years the production of vegetal oil can increase to 118 million tons. The production of palm oil can increase from 15 million tons to

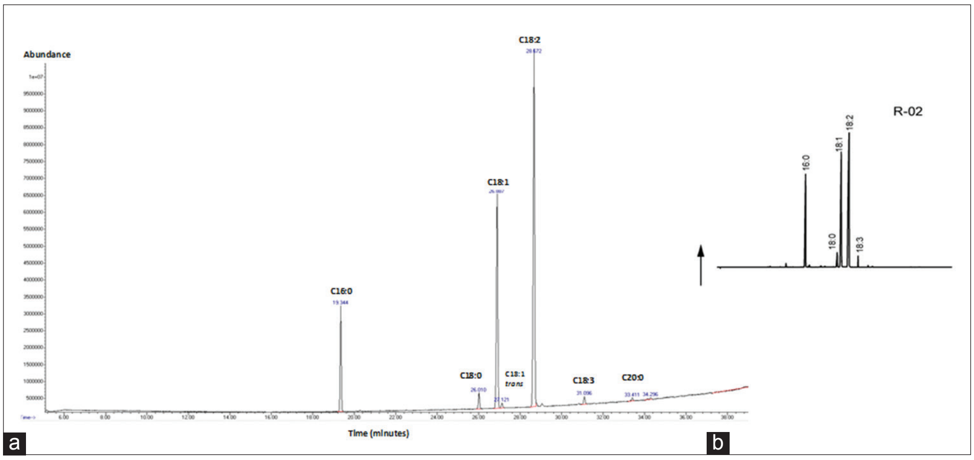
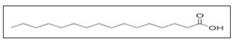
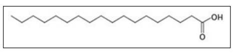
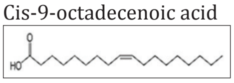
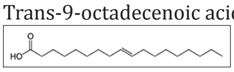
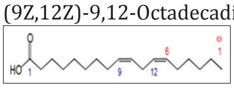
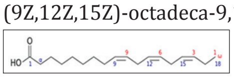
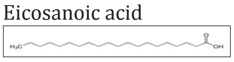


Fig. 1. (a) Gas chromatography mass spectrometer (GC/MS) analysis of methyl esters fatty acids (FAME) present in corn oil sample from Ecuador. (b) Analysis of FAME present in corn oil described for Lantos *et al.*, 2015 [10]

Table 1: Total lipid and fatty acids composition of corn oil sample from Ecuador by GC/MS analysis and their content

Retention time	FAMEs	Structural formula/chemical name	Numbers of carbons	% Peak area
19,283 min	Palmitic acid	Hexadecanoic acid 	C16:0	12.57±0.014
25,947 min	Stearic acid	Octadecanoic acid 	C18:0	2.02±0.057
26,819 min	Oleic acid	Cis-9-octadecenoic acid 	C18:1	29.70±0.113
27,121 min	Elaidic acid	Trans-9-octadecenoic acid 	C18:1 trans	0.81±0.000
28,593 min	Linoleic acid	(9Z,12Z)-9,12-Octadecadienoic acid 	C18:2	52.68±1.435
31,038 min	Linolenic acid	(9Z,12Z,15Z)-octadeca-9,12,15-trienoic acid 	C18:3	1.12±0.007
34,233 min	Arachidic acid	Eicosanoic acid 	C20:0	0.27±0.014

GC/MS: Gas chromatography/mass spectrometer

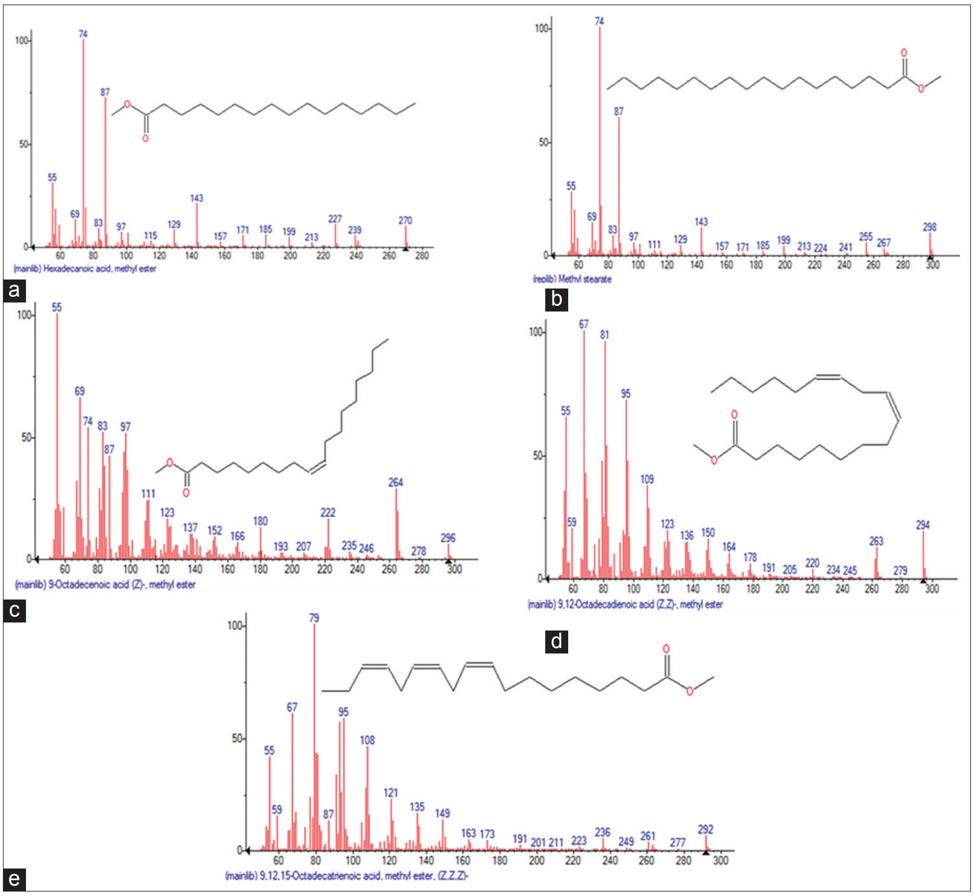


Fig. 2: (a-e) Mass spectrum of methyl esters fatty acids from corn oil

17 million tons worldwide. Around 13.5% of the world population is obese (OECD 2011), Denmark has one of the least obese populations in Europe [15]. Despite this and some generally positive trends in diet composition, many Danes have intakes of sugar and saturated fat that are too high: 65% of children and 35% of adults consume higher than recommended sugar intakes and 80% of both adults and children have intake of saturated fat that exceed dietary recommendations [16]. For this reason, in October 2012, Danish government decided to introduce a tax fat to saturate fat in Danish foods. The fat tax is a tax paid per kilogram of saturated fat in the following foods if the content of saturated fat exceeds 2.3 g/100 g. Corn oil has tax for the content of saturated fat with a value between 8% and 15%. Gofman and Böhme, 2001 reported content of fatty acids from 30 corn hybrids, the major fatty acids were palmitic, oleic, and linoleic acids, whose contents were in the ranges 9.2-12.1%, 19.5-30.5%, and 53.0-65.3%, respectively [17]. Living style is very important to human health and a good diet.

The content of oleic acid in olive oil is reported to have a value between 62% and 80% of oleic acid [18]. The oleic acid is recommended to reduce cardiovascular risk [19-21]. Vegetal oils with a good proportion of omega 3, 6, and 9 are recommended for their benefits for human health.

CONCLUSION

Corn oil (*Z. mays* L.) is vegetal oil very used in the food industry for their good composition of fatty acids. In development, countries are a good alternative for cooking food for their low cost. Corn oil has high content of omega 6 with a value of 52.68% but has a 12.57% of palmitic acid.

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