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Effect of Long Time Electric Field Treatment on the Spatial Configuration of Fatty Acids in Crude Avocado (*Persea americana* Mill var. Hass) Oil

José Alberto Ariza-Ortega*, María Reyna Robles-López, Nelly del Socorro Cruz-Cansino, Teresita de Jesús Saucedo-Molina and Raúl René Robles-de-la-Torre

University Autonomous State of Hidalgo-Institute of Health Sciences, Nutrition Academic Area, Road Actopan-Tilcuautla, Ex-Hacienda la Concepción, San Agustin Tlaxcala, Hidalgo, 42086, Mexico

Short Commentary

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***For Correspondence**

José Alberto Ariza-Ortega, University Autonomous State of Hidalgo-Institute of Health Sciencesm, Nutrition Academic Area, Road Actopan-Tilcuautla, Ex-Hacienda la Concepción, San Agustin Tlaxiaca, Hidalgo, 42086, Mexico, Tel: +52 771 717 2000,

E-mail: jose190375@hotmail.com

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ABSTRACT

The objective of this study was to evaluate the stability of the fatty acids in crude avocado oil when the product is subjected to different conditions of electric field treatment (voltage: 5 Kilo-Volts cm^{-1}; frequency: 720 Hertz; treatment time: 5, 10, 15, 20, and 25 min). Fatty acids were analyzed by gas chromatography. Electric field is a suitable method to preserve the oil quality and composition with minimal modifications on fatty acids.

INTRODUCTION

Thermal processing is the most common method to inactivate microorganism and enzymes in avocado pulp. Unfortunately, it also reduces nutritional and flavor qualities, and produces undesirable off-flavor compounds [1]. Emerging technologies may have a solution to the mentioned problem, one of their is electric field; that is a non-thermal preservation method that uses high voltage 87 kV cm^{-1} and a short burst 60 μs or ms for inactivation of microorganisms and enzymes [2,3]. This technology leads to reversible or irreversible damage of microbial membranes and it also changes in the structural conformational of enzymes as lipoxygenase, polyphenoloxidase and others [4]. Hence, the aim of this study was to analyze the effect of electric field application 9 Kilo-Volts cm^{-1}; frequency: 720 Hertz; treatment time: 5, 10, 15, 20, and 25 min) as a method for preserving the quality of crude avocado oil.

MATERIALS AND METHODS

Samples and Oil Extraction

Avocado (*Persea americana* Mill *var.* Hass) in the stage of commercial ripeness of the State of Puebla, Mexico was used. The oil extraction was by centrifugation (Eppendorf centrifuge, model 5804 R, Eppendorf AG, Hamburg, Germany) with following conditions 15 557 gravity, 40°C and 10 min. Each one of the experiments was performed in triplicate.

Electric Field Treatment

Electric field was applied on the samples in a scale unit of electric field. The scale unit of electric field consisted of a generator (where high-voltage is produced). The generator is connected to a unit (model 9412A, Quantum Composers, Inc., Bozeman, MT) where the required waveform could be selected (a square form was selected for this work). The unit is connected to a chamber with two stainless steel connectors (acting as electrodes). Both electrodes are screwed to the final section of the

chamber. The voltage and frequency parameters were similar to those used by Castorena to inactivate the polyphenoloxidase enzyme. All treatments were performed in triplicate [5].

Gas Chromatography (GC)

Fatty acid content was calculated as the total percent of fatty acid methyl esters (FAMEs) determined by GC. GC system consisted of a GC HP-5890 (Hewlett-Packard Company, Palo Alto, CA) equipped with a Flame Ionization Detector (FID). FAMEs were extracted as follows: crude chia oil? was saponified and was derivatized to methyl esters by treatment with methanolic KOH 1 N solution, following the IUPAC method [6]. Methyl esters were extracted by adding 10 mL of hexane and 10 mL of distilled water, and the organic and aqueous phases were then separated. The residue was dissolved in hexane, and the volume injected was of 2 µL sample (split ratio 20:2) that was injected into the GC-system sample port. Oven temperature was set at 100°C (4 min hold) and increased to 250°C at a rate of 3°C min^{-1} (10 min hold). GC-system injector and detector were maintained at 230 and 250°C, respectively. Nitrogen was used as carrier gas, and flow rate was set at 1.2 mL min^{-1}. Changes in fatty acids after electric field treatment of crude oil samples were assessed by comparison with a 37-component standard (Food Industry FAMEs Mix, Restek). Column specifications were, RT®-2560 fused silica capillary column (biscyanopropyl-polysiloxane) 100 m long, 0.25 mm ID, 0.2 µm film thickness (Restek Corporation, Bellefonte, PA).

Statistical Analysis

Results were expressed as mean value ± SD. Significant differences were evaluated by analysis of variance (ANOVA). A value of α=0.05 was regarded as significant. The software used for these analyses was the Statistical Analysis System, version 6.1 (SAS Institute Inc., Cary, NC, USA).

RESULTS AND DISCUSSION

Analysis by Gas Chromatography

Table 1. shows the fatty acid methyl esters (FAMEs) found in avocado crude oil before and after electric field treatment.

FAMEs	0	5 min	10 min	15 min	20 min	25 min
C16:0	15.2 ± 2.1^a	15.2 ± 2.1^a	15.2 ± 2.2^a	15.2 ± 2.1^a	15.2 ± 2.2^a	15.2 ± 2.2^a
C18:0	0.7± 0.01^a	0.7 ± 0.01^a	0.7 ± 0.02^a	0.7 ± 0.01^a	0.7 ± 0.02^a	0.7 ± 0.02^a
C20:0	0.1 ± 0.02^a	0.1 ± 0.01^a	0.1 ± 0.02^a	0.1 ± 0.01^a	0.1 ± 0.02^a	0.1 ± 0.02^a
C18:1t	0.01 ± 0.002^a	0.01 ± 0.002^a	0.01 ± 0.002^a	0.01 ± 0.002^a	0.01 ± 0.002^a	0.01 ± 0.002^a
C16:1	7.3 ± 1.8^a	7.3 ± 1.8^a	7.3 ± 1.8^a	7.3 ± 1.8^a	7.3 ± 1.8^a	7.3 ± 1.8^a
C18:1	60.6 ± 2.4^a	60.6 ± 2.4^a	60.6 ± 2.4^a	60.6 ± 2.4^a	60.6 ± 2.4^a	60.6 ± 2.4^a
C18:2	13.3 ± 1.1^a	13.3 ± 1.1^a	13.3 ± 1.1^a	13.3 ± 1.1^a	13.3 ± 1.1^a	13.3 ± 1.1^a
C18:3	2.1 ± 0.2^a	2.1 ± 0.2^a	2.1 ± 0.2^a	2.1 ± 0.2^a	2.1 ± 0.2^a	2.1 ± 0.2^a

Average of 3 replicates. Different letters in superscripts in the same row indicate significant differences between treatments ($p<0.05$).

Table 1 shown the results of the fatty acids in crude avocado oils that were identified and quantified, in where the saturated fatty acids were: palmitic (C16:0), stearic (C18:0) and arachidic (C20:0), the unsaturated fatty acids were: palmitoleic (C16:1), oleic (C18:1), linoleic (C18:2) and linolenic (18:3). The concentration of the fatty acids in all the oils samples were similar ($p>0.05$), these results were according to the obtained for Zulueta et al. for a drink of orange juice-milk (treatment with pulsed electric field of high intensity) and for Garde-Cerdan et al. in grape juice (using bipolar pulsed electric field) [7,8]. With respect to the determination of trans fatty acids, in this work only negligible amounts of Elaidic fatty acid (C18:1t) were found in samples, generated for the peroxide oxidation Castro et al. that with the long time application of an electric field. However, the trans fatty acid concentration in crude avocado oil is within the Food and Drug Administration requirement of 0.5 g 100 g^{-1} (%) as the maximum allowed value [9].

CONCLUSIONS

Electric field treatment did not affect the concentration and quality of fatty acids in avocado crude oil. Being a non-thermal preservation method, electric field processing has good prospects to be used in the oil industry, due to that the observed changes were negligible from a nutritional point of view.

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