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THE EVALUATION OF IMPACTS OF PULSED ELECTRIC FIELD AS A PRE-TREATMENT ON THE FATTY ACIDS PROFILE OF SESAME OIL

ZAHRA TALE MASOULEH[1], SIMIN ASADOLLAHI[2*], MOHAMMAD REZA ESHAGHI[2]

[1]Graduated student, Department of Food Science, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

[2]Assisstant Professor, Department of Food Science, Varamin-Pishva Branch, Islamic Azad University, Varamin, Iran

***Corresponding author address: Naqshe Jahan sq, Pishva, Tehran; Telefax: +98 21 22255237; E Mail: siminasadollahi@iauvaramin.ac.ir**

ABSTRACT

The aim of this research is the impact assessment of Pulsed Electric Field (PEF) application before extracting by cold pressed on the fatty acids profile of the sesame oil. In our work, PEF pretreatments were carried out with different field intensities (1 and 2 Kv/cm), pulse numbers (10, 30 and 50) and at a constant frequency of 2 Hz. Then, all seeds (pretreated and untreated oil seeds) were extracted by cold pressed. Finally the effect of PEF on the profile and amount of the fatty acids were investigated by Gas chromatogram. In pretreated and untreated samples, no noteworthy changes were observed in the content of saturated fatty acids, monounsaturated and polyunsaturated fatty acids. Therefore PEF can be introduces as a non-thermal process in the production of oil from seeds with minimum modification of the nutritional ingredients.

Keywords: Sesame, Pulsed Electric Field, Fatty acids, Gas chromatography, Oil

INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to the Pedaliaceae family, is formed from 16 genera and 60 species. Sesamum genus is the major genus cultivated in the world. Generally, due to the high amount of oil (more than 50%) and protein (around 20%), this seed is

cultivated in the different parts of the world especially in the tropical and subtropical regions of Asia, Africa and South America (1), (2), (3). The lipid profile of this application of pulsed oil is mostly composed of 90-96% triacylglycerol (TAGs) and of 2-3% phospholipids (PLs), which include monounsaturated fatty acids and 44% polyunsaturated fatty acids. About 80 % of unsaturated fatty acids in sesame oil are oleic acid (35.9-47%) and linoleic acid (35.6-47.6) fatty acids and their quantity is almost equal with each other and the rest of them are palmitic (8.7- 13.8%), stearic (2.1-6.4%) and arachidic acids (0.1-0.7%) influenced by ecological and cultural factor (4), (5), (6), (7). Despite of its high degree of unsaturated fatty acids, the researcher demonstrated a significant stability of sesame oil to oxidation. This could be related to presence of antioxidant compounds such as lignans (sesamol, sesamolin and sesamin) and tocopherols (gama tocopherol) and is known as the Queen of oilseeds (8), (5), (9). Nowadays the production and consumption of sesame seed in view of its medical properties through the decreasing of LDL, cholestrol level, oxidative stress (10) and anti-cancer activities (11) has been extremely regarded. Pressing and solvent extraction are commonly used for various oilseeds extraction. Extraction by cold pressing is relatively easy, inexpensive and done at temperature below 45 ºC, no chemical and additives are used and are the best way to maintain the beneficial compounds such as essential fatty acids (omega-3) and tocopherols (12). In recent years, electric field (PEF) has been outspread as a pretreatment of extracting oil from seeds with the aim of achieving the maximum extraction yield and facilitating the process without any changes of other ingredients (13). Pulsed electric field (PEF) process is done by using the high voltage to foods placed between parallel electrodes and generating temporary or permanent pores, which is called electroporation. The main consequence of these ruptures is to enhance mass transfer process of interacellular materials (14), (15), (16), (17). PEF has been previously assessed as a pretreatment for oil extraction from olives (18), rapeseeds (19) and to preserve the orange juice-milk (20) with minimal modification in the fatty acids profile.

The objective of this article is to evaluate the effect of PEF as a pretreatment before cold pressed extraction on the fatty acids profile of sesame oil.

MATERIAL AND METHODS

Plant

The afghan cultivars sesame seeds (*Sesamum indicum* L.) were obtained from Oghab halva company, Tehran, Iran at 14th September and transferred to researcher institute of food science and technology, Mashhad, Iran.

MATERIALS

Following Reagent and solutions used in this study: standard boron triflouride (BF3) (5% in methanol), is used for the catalyst of methylation and was purchased from Sigma-Aldrich**.** Methanolic NaOH, Saturated NaCI solution and hexan were purchased from Merck.

Chemical analysis

Assessment of chemical composition of this seed moisture, crude protein (micro-kejeldal), crude fibre and oil contents (Soxhlet) were done using the methods described by (21), the ash content was measured using the method of (22) and total carbohydrate was determined by differences.

PEF-treatment

In our previous article six PEF treatments were applied for sesame seeds to show the increase of the oil extraction yield up to 40.03% with electric field. The pre-treatments were carried out with different field intensities. With E=1 Kv/cm and 10, 30 and 50 pulses are shown as A1, A2 and A3, with E=2 Kv/cm and 10, 30 and 50 pulses are shown as B1, B2 and B3 and untreated sample was considered as a control sample. Fig. 1 shows the production scheme of electrical pre-treatments and untreated sample (control). For pre-treated with PEF, we used pulsed electric field apparatus, which was designed and manufactured by laboratory. It equipped with a power supply, a treatment chamber consist of two parallel stain steel plate with 4 cm distance and a discharge switch. For each sample, 1400g of seeds were immersion with 1400g of distilled water in chamber and were pretreated with different intensities (1 and 2 Kv/cm) and pulses number (10, 30 and 50). Due to the impact of moisture content of the samples on the pressing efficiency, the seeds (pre-treated seeds and control sample) were dried by oven (50˚C) during 35 min from about 45 to 5-7% (19), (23), (13).

Fig 1. Illustrated diagram of the sesame oil production for: electrical pre-treatments and untreated sample.

Pressing

After drying, all samples were pressed with cold-pressed equipment (DD85, Oekotech, Germany), which consist of a feeding hopper, a press cylinder, a press screw and a nozzle. 1400 g of each sample were weighted and inserted to the feeding hopper then the extraction occurred in the temperature rage 50-55˚C at 50 bar.

Methyl sters separation

Firstly in a 5ml spill test tube 5 mm, about 0.04 gr of pure oil were weighed and 5 ml of caustic soda solution of methanol 2% (dissolved 2 gr of sodium hydroxide in 100 methanol solution) was added to it. After that, the mixture heated for 10 minutes in a boiling water bath and cooled at ambient temperature, then 2/2 ml trifluoride boron (BF_3) was added to the contents of the tube and placed again for 3 minutes in boiling bath. After cooling, 1/5 ml Hexan solution and saturated sodium chloride solution was added to tube and mixed thoroughly and stirred. After mixing and completing the two phases, the upper phase, which contains the methyl sters was separated from bottom phase by micropipettes, then transferred to disposable vials and maintained to GC until the injection time (24).

Gas chromatography

The Gas Chromatography (GC) (Agilent 7890A, USA), equipped with flame ionization detector (FID) and capillary column (CPSill-88, Varian, USA, length of 100 m, a diameter of 22/0 mm and outer diameter of 33/0 mm) used. A temperature program is used to separate components of fatty acid was prepared as follows; injection temperature of 270 ° C, 260 ° C temperature detector and the column temperature program was as follows: 5 min at 190 ° C, increasing column temperature at 5 degrees per minute to a temperature of 235 ° C (14 min). Finally, the fatty acids concentration and composition can be identified and measured by comparing the area of the GC pick (which is related to the standard mixture of fatty acids) and under the samples pick.

Statistical analysis

A completely randomized design (CRD) with 7 treatments and 3 replications was conducted and Duncan's multiple range tests was used for means comparison (ANOVA). Statistical analysis of variance was calculated by using SAS software version 9.1 and graphs were plotted using Excel software.

RESULTS AND DISCUSSION

3.1 Characterization of sesame oil

Table 1 shows the comparison and chemical composition of the sesame seed used in this work that is similar to other study. It has an

oil content of 49%, 21.2% crude protein, 14.8% carbohydrate, 5% ash and 4.3% moisture. All results ex-pressed in dry matter basis.

3.2 Gas chromatography

Figures 2-8 show the chromatograms of the fatty acid composition of untreated and pretreated samples with pulsed electric field.

GC analysis illustrated that oleic acids (43/64%) is the most abundant fatty acid introduced in the sesame oil and following that linoleic acid (39/1065%) and palmitic acids (9/549%) can be identified.

From table can see that between untreated and treated oils were not observed considerable changes (p>0/05) in the content of saturated fatty acids (myristic C12:0, palmitic C16:0, margaric C17:0, stearic C18:0, arachidic C20:0, behenic C22:0, lignoceric C24:0). Similar article reported that orange juice-milk treated by high-intensity pulsed electric fields (35 and 40 Kv/cm), showed not statistically differences in the contents of saturated fatty acids before and after electric field (20).

Unsaturated fatty acids of untreated and treated crude sesame oil were determined by gas chromatography as, palmitoleic (C16:1), heptadecenoic (C17:1), Oleic (C18:1), linoleic (C18:2), linolenic (C18:3), eicosenoic (C20:1). According to another study using pulsed electric filed as a non-thermal pasteurization technology on the grape juice, it was determined that PEF did not affected considerable the concentration of unsaturated fatty acids, which is similar to our results.

Table 1: Chemical composition of *Sesame indicum* L. oil seed and comparison with other verities (g/100 g dry matter)

Component (%)	Verities			
	Afghan cultivars (obtained data)	Sudanese cultivars (25)	Congo cultivars (26)	Nigerian cultivars (27)
Moisture	4.3	5	5.7	7
Protein	21.2	24	20	19.1
Lipids	49	52	54	48.2
Carbohydrates	14.8	13.5	13.4	17.9
Ash	5	5	3.7	5.2
Fiber	6.2	_	3.2	3.6

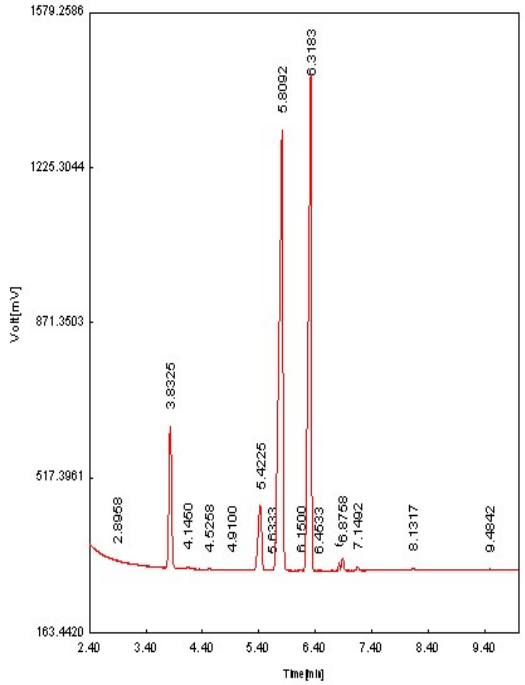

Fig 2. GC Chromatogram of untreated sesame oil (control sample)

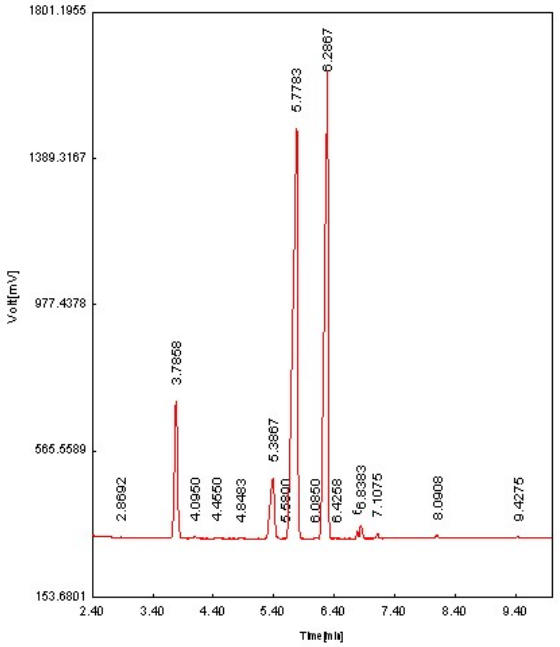

Fig 3. GC Chromatogram of the A1 sesame oil pretreated with electric field (Electric field:1kv/cm, Pulse number:10, Frequency:2).

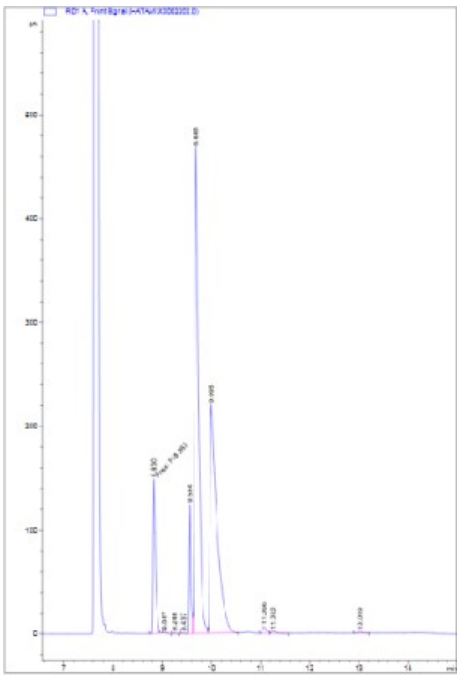

Fig 4. GC Chromatogram of the A2 sesame oil pretreated with electric field (Electric field:1kv/cm, Pulse number:30, Frequency:2).

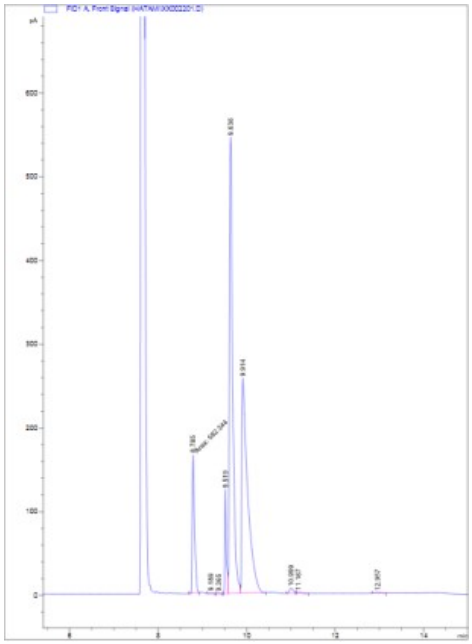

Fig 5. GC Chromatogram of the A3 sesame oil pretreated with electric field (Electric field:1kv/cm, Pulse number:50, Frequency:2).

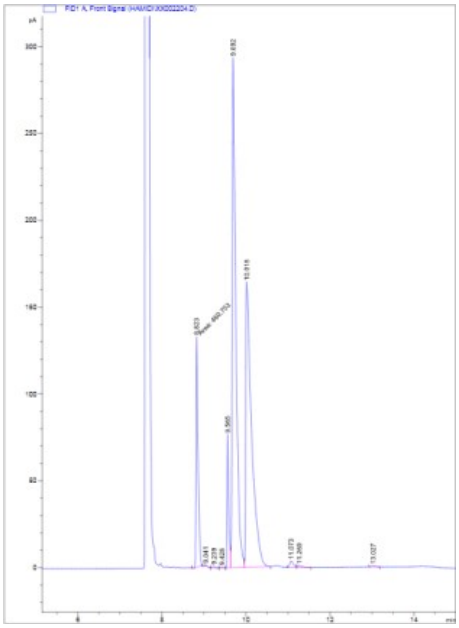

Fig 6. GC Chromatogram of the B1 sesame oil pretreated with electric field (Electric field:2kv/cm, Pulse number:10, Frequency:2).

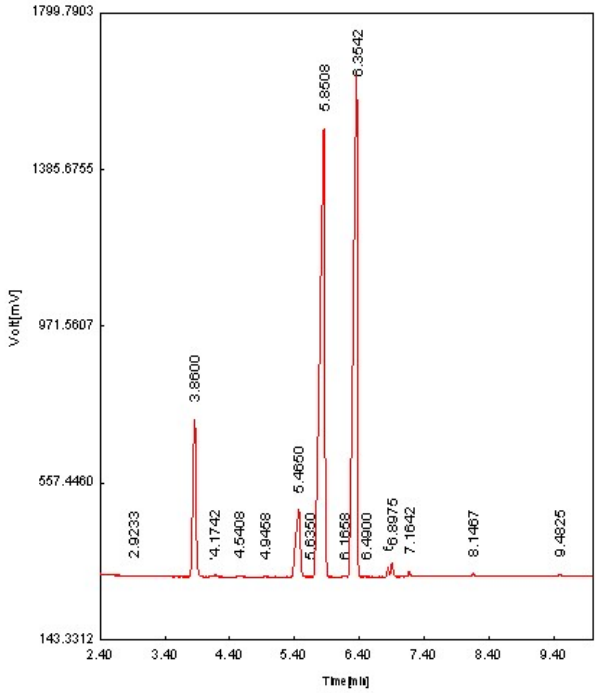

Fig 7. GC Chromatogram of the B2 sesame oil pretreated with electric field (Electric field:2kv/cm, Pulse number:30, Frequency:2).

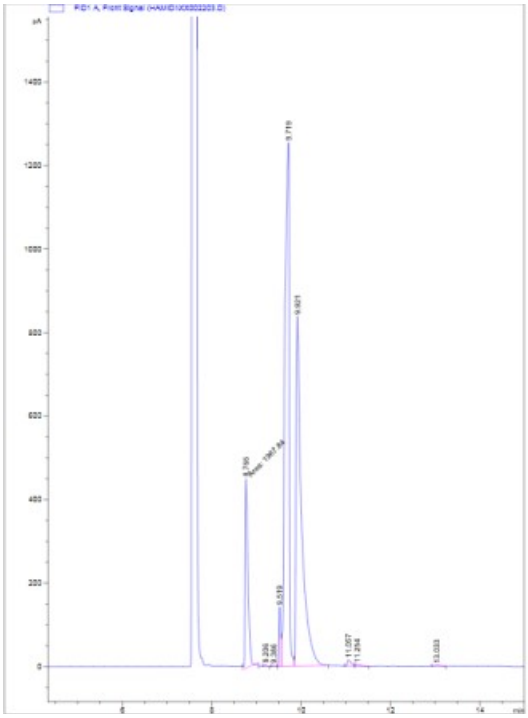

Fig 8. GC Chromatogram of the B3 sesame oil pretreated with electric field (Electric field:2kv/cm, Pulse number:50, Frequency:2)

Table 2: Fatty acids composition of control oil and pretreated samples by PEF

Treatments	Fatty acids														
	E	N	C14:0	C16:0	C16:1	C17:0	C17:1	C18:0	C18:1	C18:2	C18:3	C20:0	C20:1	C22:0	C24:0
C	0	0	0/018^{b}	9/459^{d}	0/164^{a}	0/062^{ab}	0/050^{ab}	6/031^{c}	43/640^{g}	39/051^{b}	0/340^{e}	0/675^{a}	0/224^{a}	0/176^{a}	0/048^{b}
A1	1	10	0/025^{a}	9/409^{e}	0/171^{a}	0/098^{ab}	0/048^{ab}	6/092^{a}	43/821^{f}	38/836^{f}	0/321^{f}	0/697^{a}	0/233^{a}	0/159^{b}	0/089^{a}
A2	1	30	0/014^{bc}	9/358^{f}	0/053^{c}	0/053^{abc}	0/038^{b}	5/284^{d}	38/988^{c}	38/986^{d}	0/668^{a}	0/230^{b}	0/162^{bc}	0/119^{c}	0/089^{a}
A3	1	50	0/015^{bc}	9/621^{c}	0/054^{c}	0/037^{c}	0/04^{ab}	4/998^{e}	45/233^{b}	39/053^{c}	0/633^{b}	0/230^{b}	0/136^{cd}	0/12^{c}	0/089^{a}
B1	2	10	0/010^{c}	11/240^{a}	0/053^{c}	0/058^{abc}	0/042^{ab}	4/836^{f}	44/008^{d}	38/930^{e}	0/531^{c}	0/192^{c}	0/112^{d}	0/123^{c}	0/092^{a}
B2	2	30	0/029^{a}	9/573^{d}	0/138^{b}	0/071^{a}	0/055^{a}	6/061^{b}	43/897^{e}	38/700^{g}	0/319^{f}	0/686^{a}	0/243^{a}	0/166^{ab}	0/088^{a}
B3	2	50	0/016^{bc}	10/615^{b}	0/053^{c}	0/040^{bc}	0/039^{ab}	4/052^{g}	46/987^{a}	39/464^{a}	0/504^{d}	0/188^{c}	0/195^{ab}	0/116^{c}	0/089^{a}

E: Electric field intensity (Kv/cm), N: Pulse number

Common letters between control and pre-treated samples In each column, indicate that there are not significantly differences at the 5% level by Duncan's multiple range tests.

CONCLUSIONS

GC analysis demonstrated that, PEF does not affect the amount and composition of the saturated and unsaturated fatty acids. in other words the minimal changes are negligible and sesame oil pretreated by PEF is an excellence source of essential fatty acids and other nutrients for human consumption.

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REFERENCES

[1] Kobayashi T. Chromosome engineering in plants: genetics, breeding, evolution. In. Amesterdam: Elsevier Science Publilishing Company Inc; 1991. p. 581-592.

[2] Ashiri A. Sesame breeding Oxford JJ, editor: Oxford UK; 1998.

[3] Anilakumar KR, Pal A, Khanum F, Bawa AS. Nutritional, Medicinal and industrial uses of sesame (*Sesamum indicum* L.) seeds-an overview. Agri Conspec Sci. 2010; 75: p. 159-168.

[4] Yushida H, Tanaka M, Tomiyama Y, Mizushina Y. Regional distribution in the fatty acids of triagylglycerols and phospholipids of sesame seeds (*Sesamum indicum*). Journal of Food Lipids. 2007; 14: p. 189-201.

[5] Elleuch M, Besbes S, Roiseux O, Blecker C, Attia H. Quality Characteristics of sesame seeds and Byproducts. Food Chemistery. 2007; 103: p. 641-650.

[6] Uzun, B, Cagirgan MI. Path-coefficient analysis for seed yield and related characters in a population of determinate and indeterminate types of sesame (*Sesamum indicum* L.). Turk. J. of Field Crops. 2001; 2: p. 76-80.

[7] Weiss E. Sesame In: Oilseed crops. In. New York: Longman Inc; 1983. p. 282-340.

[8] Bedigian D, Harlan JR. Evidence for cultivation of sesame in the ancient world. 1986; 40: p. 137-154.

[9] Lee J, Lee Y, Choe E. Effects of sesamol, sesamin and sesamolin extracted from roasted sesame oil on the thermal oxidation of Methyl Linoleate. LWT Food Sci Technol. 2008; 41: p. 1871-1875.

[10] Khadem Haghighian M., Alipoor B., Eftekhar Sadat B., Malek Mahdavi A., Moghadam A., Vatankhah AM. Effect of Sesame seed supplementation on lipid profile and oxidative stress biomarkers in patients with knee osteoarthritis. Health Promotion Perspectives. 2014; 4(1): p. 90-97.

[11] Nagendra Prasad MN, Sanjay KR, Parasad DS, Kothari R, Najunda

Swamy S. A review on Nutritional and Nutraceutical properties of sesame. J. Nutr. Food Sci. 2012; 2: p. 127.

[12] Willems P, Kuipers NJM, De Haan AB. Hydraulic pressing of oilseeds: Experimental determination and modeling of yield and pressing rates. Journal of Food Engineering. 2008; 89: p. 8-16.

[13] Tale Masouleh Z, Asadollahi S, Eshtiaghi MR. Effects of Pulsed Electric Fields as a Pre-Treatment on Yield Extraction and some Quality Properties of Sesame Oil. Int. J. Rev. Life. Sci. 2015; 5(10): p. 1100-1104.

[14] Zimmerman U. Electric breakdown, Elec-tropermeabilization and electrofusion. Reviews of Physiology, Biochemistry and Pharmacology. 1986; 105: p. 175-256.

[15] Angersbach A, Heinz V, Knorr D. Electrophysiological model of intact and processed plant tissues:cell disintegration criteria. Biotechnol-ogy Progress. 1999; 15: p. 753-762.

[16] Barbosa-Canovas GV NMGUPWB. Preservation of Food with pulsed electric fields London: Academic Press Ltd; 1999.

[17] A. W. Impact ofPulsed Electric Field (PEF) on postpermabiization process in plant cells TU Berlin: Universitätsbibliothek der Technischen Universität Berlin; 2011.

[18] Abenoza M., Beito M., Saldana G., Alvarez I., Raso J., Sanchez-Gimeno A.C. Effect of pulsed electric field on yield extraction and quality of olive oil. J Food Bioprocess Tech. 2012; 6: p. 1367-1373.

[19] Guderjan M, Elez-Martinez P, Knorr D. Application of pulsed electric field at oil yield and content of functional food ingredients at the production of rapeseed oil. Innov. Food Science and Emerging Technologies. 2007; 8: p. 55-62.

[20] Zulueta A, Esteve M, Frasquent I, Frigola A. Fatty acid profile changes during orange juice- milk beverage processing by high-

pulsed electric field. European Journal of Lipid Science and Technology. 2007; 109: p. 25-31.

[21] Pomeranz Y MC. Food Analysis: Theory and Practice. 3rd Ed. New York: Chapman & Hal; 1994.

[22] Pearson D. The Chemical Analysis of Foods. 7th ed. Edinburgh, U.K: Churchill Livingstone; 1976.

[23] Sarkis JR Bntimlve. Application of pulsed electric fields and high voltage electrical discharges for oil extraction from sesame seeds. Journal of Food Engineering. 2015; 153: p. 20-27.

[24] Metcalf LD, Schmitz AA, Pelka JR. Rapid preparation of fatty acid esters from lipids for gas chromatographic analysis. Analytical chemistry. 1966; 38(3): p. 514-515.

[25] Borchani C, Besbes S, Blecker CH, Attia H. Chemical characteristics and oxidative stability of sesame seed, sesame paste and olive oils. Journal of Agriculture, Science and Technology. 2010; 12: p. 585-596.

[26] Nzikou JM, Mvoula-Tsieri M, Matos L, Matouba E, Ngakegni AC, Linder M, Desobry S. *Solanum Nigrum* L. seeds as an alternative source of edible lipids and nutriment in Congo Brazzaville. J. Appl. Sci. 2007; 7: p. 1107-1115.

[27] Egbekun MK, Ehieze MU. Proximate composition and functional properties of fullfat and defatted beniseed (*Sesamum indicum* L.) flour. Plant Foods Human Nutr. 1997; 51: p. 35-41.

[28] Ariza-Ortega JA, Ramirez-Moreno E, Ramos-Cassellis ME, Diaz-Reyes J. Preservation of Avacado oil with electric field treatment. International Journal of research in agriculture and food sciences. 2014; 13: p. 105-117.

[29] Ghandi A. Simplified process for the production of sesame seed (*Sesame indicum* L.), Butter and its nutritional profile. Asian Journal of Food and Agro-Industry. 2009; 2(1): p. 24-27.