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A COMPARATIVE STUDY ON EXTRACTION AND CHARACTERIZATION OF MELON (*Cucumis melo*) SEED OIL AND ITS APPLICATION IN BAKING

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ABSTRACT

Melon (*Cucumis melo*) seeds are rich source of oil, protein and possess numerous medicinal properties; however, these are normally treated as waste. Present study was conducted to characterize the melon seed oil and to assess its potential to improve bread quality characteristics. For the purpose melon seed oil was extracted, analyzed regarding different parameters and utilized in bread manufacturing at various concentrations (T_0=5% Shortening (control), T_1=4 % melon seed oil, T_2=5 % melon seed oil, T_3= 6 % melon seed oil, T_4=7 % melon seed oil). The results showed that melon seeds contain 29.86% oil. Iodine and saponification values were found as 118.8±3.57 (mg Iodine g^{-1}), 188.83±5.37 (mg KOH g^{-1}) respectively. Fatty acid profile revealed that linoleic acid was found in higher concentration i.e. 62.95g/100g. The oleic acid, palmitic acid, steric acid and cis-5, 8, 11, 14, 17 eicosapentanoic acid methyl esters were present in concentrations of 20.35, 4.96, 3.01 and 1.89g/100g, respectively. It was found, the melon seed oil improved bread quality characteristics like volume, relative volume, specific volume and density when it was applied at the level of 5% (T_2). It improved sensory attributes of bread samples with the best results produced by T_2.

Keywords: Melon seed oil, Fatty acid profile, Bread quality, Volume, Sensory evaluation.

INTRODUCTION

Malnutrition is one of the major threats to the people of developing countries like Pakistan while the ever-increasing population is aggravating the situation. This scenario emphasizes the researchers to preserve available food commodities in efficient way and to explore the potential of raw/waste materials to produce value-added products to fill the gap of food shortage to feed mankind (FAO, 2009).

Melon is one of the fruits containing higher range of essential macro and micro-nutrients (Jeffrey, 1990; Menon and Ramana, 2012) and its consumption in different forms and value-added products may play a role in dealing with malnutrition. It has the useful therapeutic properties such as analgesic, anti-inflammatory, anti-oxidant, free radical scavenging capacity, anti-ulcer, anti-microbial, hepato-protective, diuretic, anti-diabetic and anthelmintic activity. Moreover, melon seeds are a rich source of heart friendly unsaturated oil which contains significant quantities of vitamin A & E (Milind and Kulwant 2011; Ahmad *et al*., 2012).

The valuable melon fruit is grown in large quantities in different regions of Pakistan, where after fruit consumption the seeds go wasted. Since last decades, efforts had been made to improve methods and ways to manipulate vegetable and fruit wastes to produce value-added products. However, many efforts still remain to be fulfilled. The search for antioxidants from natural sources has also received much attention to replace the synthetic antioxidants while melon seed oil contains higher proportions of these antioxidants which provide protection against various degenerative diseases including cancer and coronary heart diseases.

Bakery products are one of the most commonly consumed food items in which fat plays a significant role. Various essential sensory characteristics of bread are intensely reliant on the fat contents and type; as fat imparts tenderness, improves flavor and mouthfeel (Pareyt and Delcour, 2008). For bakery enterprises, developing new products with low fat contents having healthier fatty acid profile is a potential strategy to utilize the benefits of oils from unconventional sources and to enhance the business. Saturated fat content of bread and other baked food items can be reduced by using melon seed oil, which contain extensively low saturated fatty

acid contents. It would be a fascinating choice for obtaining healthier bread. Melon seed oil (MSO) has large amounts of monounsaturated fatty acids and antioxidant contents, which can scavenge free radicals and provide adequate protection against oxidation. Keeping in view the high yields of musk melon, loss of potentially valuable seeds, role of seed oil in maintaining human health and food preservation, this project was planned to extract the quality melon seed oil and to utilize it in the development of value-added food products.

MATERIALS AND METHODS

Raw Material Procurement: The muskmelon fruit, chemicals required for seed oil extraction (n-hexane, diethyl ether) and analysis (glacial acetic acid, iodine trichloride, carbon tetra chloride, sodium thiosulphate) were purchased from market.

Sample Preparation: The raw material (melon fruit) was sorted, cleaned, washed and the pulp was removed to recover seeds. The seed kernels were dried to remove moisture and processed for the extraction of kernel oil. The seeds were ground and stored in air tight containers for onward oil extraction (Tian *et al*., 2017).

Oil Extraction: The dried, ground kernels were used for the extraction of oil by Soxhlet oil extraction apparatus using n-hexane and diethyl ether (solvents) as described by AOCS (1998). After extraction, solvent from the extracts was removed by evaporation. The oil was refined before application in food products.

Oil Quality Evaluation: The refined oil samples were analyzed for different quality attributes like free fatty acids, peroxide value, acid value, iodine value, saponification value, color, odor, specific gravity, refractive index and fatty acid profile by following their respective procedures (AOAC, 2000; AOCS 1998).

Utilization of Extracted Oil in Baked Products: The extracted oil was used in bread preparation using its different concentrations (Table 01) and the bread samples were studied for the effect of oil on the bread quality attributes like volume AACC (2000), relative volume (volume of bread samples compared with the control sample), specific volume (volume/mass) and bread density (mass/volume) according to the procedure described by Keskin *et al.,*(2004).

Sensory Evaluation: The sensory evaluation of bread samples was carried out by a trained taste panel consisting of 5 members for a period of 5 days at an interval of 24 hours according to the procedure as described by (Meilgaard *et al.,* 2006).

Table 1. Treatments of melon seed oil in bread making.

Treatment	Oil
T_0	5% Shortening
T_1	4 % melon seed oil
T_2	5 % melon seed oil
T_3	6 % melon seed oil
T_4	7 % melon seed oil

Statistical Analysis: The data obtained for each parameter in the entire study was subjected to statistical analysis to determine the level of significance as described by (Steel *et al.,* 1997).

RESULTS

The oil from melon seeds was extracted using soxhlet apparatus and the average oil contents were found 29.867±0.61% as shown in the Table 02. The melon seed oil depicted pale yellow color, oily odor and contained 0.193±0.021% free fatty acids. The oil had 0.387±0.043, 2.907±0.197, 118.8±2.997 and 188.83±1.678 acid value, peroxide value, iodine value and saponification value, respectively. While the refractive index and specific gravity of melon seed oil were 1.297±0.019 and 0.923±0.007. The results regarding oil contents are supported by the work conducted by other researchers; however, there were some differences that might be due to different agro-climatic conditions.

The results regarding fatty acid profile of melon seed oil are given in Table 03. The results revealed that linoleic acid methyl esters were found in higher content in melon seed oil 62.95g/100g. The oleic acid methyl ester, palmitic acid methyl ester, steric acid methyl ester and cis-5, 8, 11, 14, 17 eicosapentanoic acid methyl ester were present in quantity of 20.35, 4.96, 3.01 and 1.89g/100g respectively. Tridecanoic acid methyl ester, cis-8,11,14,17- eicosatrienoic acid methyl ester and myristoleic acid methyl ester were present in very low amounts.

In baked products, especially bread, the volume is one of the very important characteristics, which describes the quality and consumer acceptance. The data regarding this attribute shows that melon seed oil significantly improved this attribute (Fig. 01). The volume of bread samples in T_0 (control) was 488.67 ± 16.5^{b}, while the volume of bread samples receiving treatments T_1, T_3 and $T_4$was 507.67 ± 20.7^{ab}, 518.33 ± 20.0^{ab} and 516.33 ± 22.2^{ab} respectively. The highest increase in volume was observed in $T_2(530.33\pm19.6^{a})$. The specific volume (Fig. 02) of bread samples also exhibited significant variations under the effect of different doses of melon seed oil; specific volume of T_0 was found 3.30 ± 0.11^{b} whereas the specific volume for T_1, T_3 and T_4 samples was noted as

3.45±0.12[ab], 3.49±0.15 [ab] and 3.50±0.15 [ab] respectively. However, T_2 got maximum value (3.58±0.14[a]) for this attribute. Regarding the relative volume (Fig. 03), it was noted that this parameter revealed variations under the effect of various treatments of melon seed oil; however, only the treatment T_2 changed the results of this parameter significantly and got maximum value (1.09±0.03[a]) for this quality attribute. Results regarding the bread density (Fig. 04) explicit that bread samples having different doses of melon seed oil affected this parameter in a non-significant way and T_0 got maximum value (0.30±0.011[a]) while T_2 got minimum value (0.28±0.011[a]).

Table 02. Melon seed oil quality parameters.

Parameter	Contents
Oil contents%	29.867±0.61
FFA (Free fatty acids) %	0.193±0.021
AV (Acid value) mg KOH g^{-1}	0.387±0.043
PV (Peroxide value) meq/g	2.907±0.19
IV (Iodine value) mg Iodine g^{-1}	118.8±3.57
Sap V (Saponification value) mg KOH g^{-1}	188.83±5.37
Refractive index	1.297±0.019
Specific gravity	0.923±0.007
Color	Pale yellow
Odor	Oily

The bread samples receiving different treatments of MSO (melon seed oil) were also subjected to sensory evaluation. The data regarding external bread characteristics is depicted in Table 04. It is evident that the parameters like volume, crust color, symmetry of form, evenness of bake, character of crust and break and shred exhibited significant variations under the effect of different doses of MSO and in most of cases T_2 remained more beneficial to improve these traits. In case of internal bread characteristics (grain, color of crumb, aroma, taste, texture and chew-ability), the data (Table 05) shows that all parameters except chew-ability exhibit significant variations in response to various treatments of melon seed oil.

Table 03. Fatty acid profile of melon (*Cucumis melo*) seed oil (g/100 g fatty acids).

Fatty acids	Number of carbon atoms	g/100g total fatty acid
Tridecanoic Acid Methyl Ester	(C13:0)	0.05
Myristic Acid Methyl Ester	(C14:0)	0.00
Myristoleic Acid Methyl Ester	(C14:1)	0.02
Palmitic Acid Methyl Ester	(C16:0)	4.96
Heptadecanoic Acid Methyl Ester	(C17:0)	0.37
cis-10Heptadecenoic Acid Methyl Ester	(C17:1)	0.93
Stearic Acid Methyl Ester	(C18:0)	3.01
Oleic Acid Methyl Ester	(C18:1n9c)	20.35
Linoleic Acid Methyl Ester	(C18:2n6c)	62.95
Linolelaidic Acid Methyl Ester	(C18:2n6t)	0.09
a-Linolenic Acid Methyl Ester	(C18:3n3)	0.03
Arachidic Acid Methyl Easter	(C20:0)	0.40
cis-11, Eicosatrienoic Acid Methyl Ester	(C20:1n9)	3.08
cis-8,11,14,17- Eicosatrienoic Acid Methyl Ester	(C20:3n6)	0.04
cis-5,8,11,14,17 Eicosapentanoic acid methyl ester	C20:5n3	1.89
cis-4,7,10,13,16,19-Docosahexaenoic Acid Methyl Ester	(C22:6n3)	0.05
Tricosanoic Acid Methyl Ester	(C23:0)	0.83
Lignoceric Acid Methyl Ester	(C24:0)	0.95

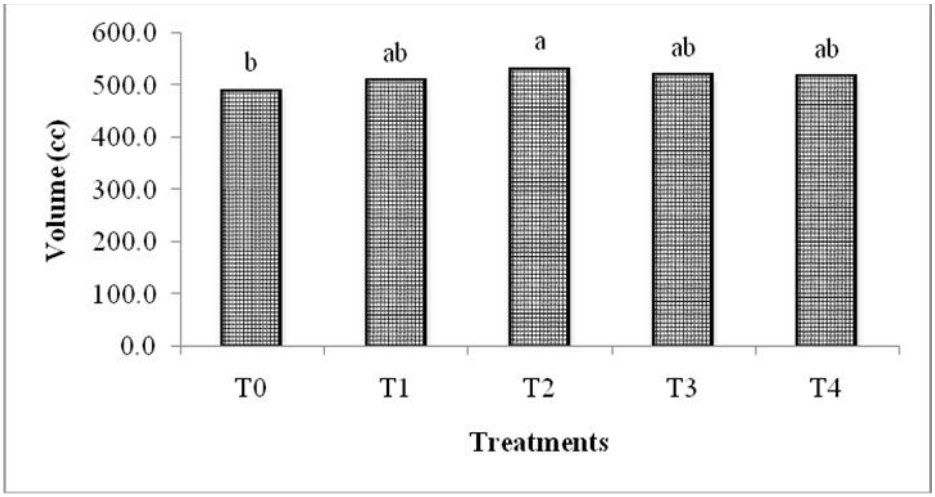

Figure 01. Bread volume under the effect of different doses of MSO.

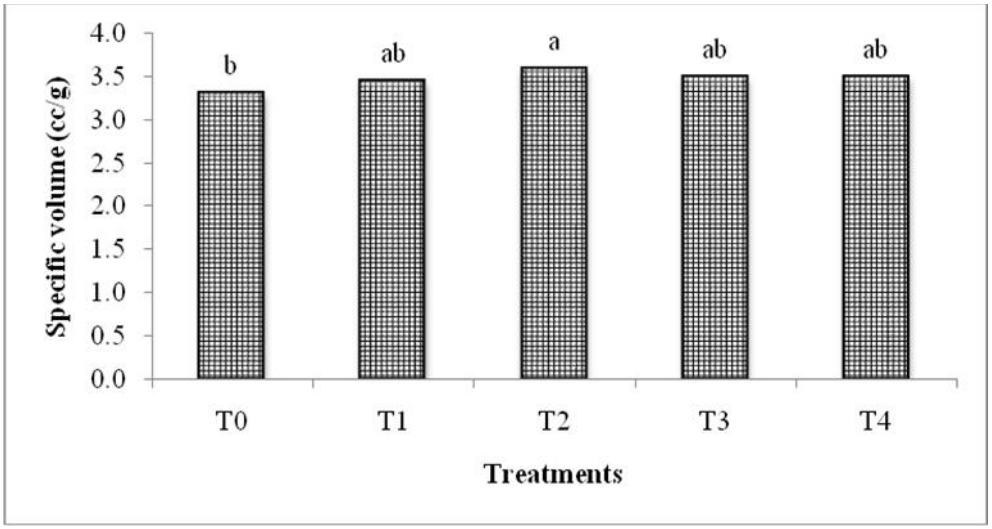

Figure 02. Specific volume of bread under the effect of different doses of MSO

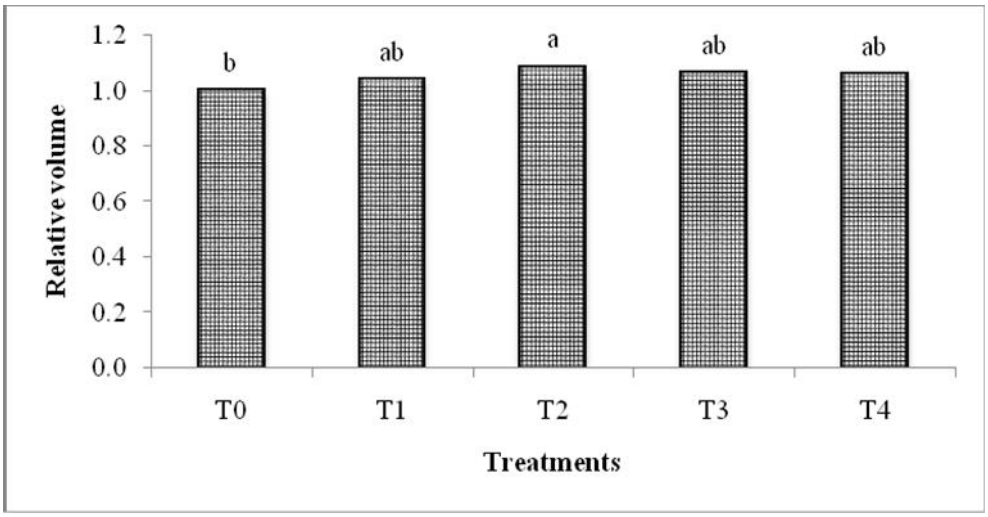

Figure 03. Relative volume of bread under the effect of different doses of MSO

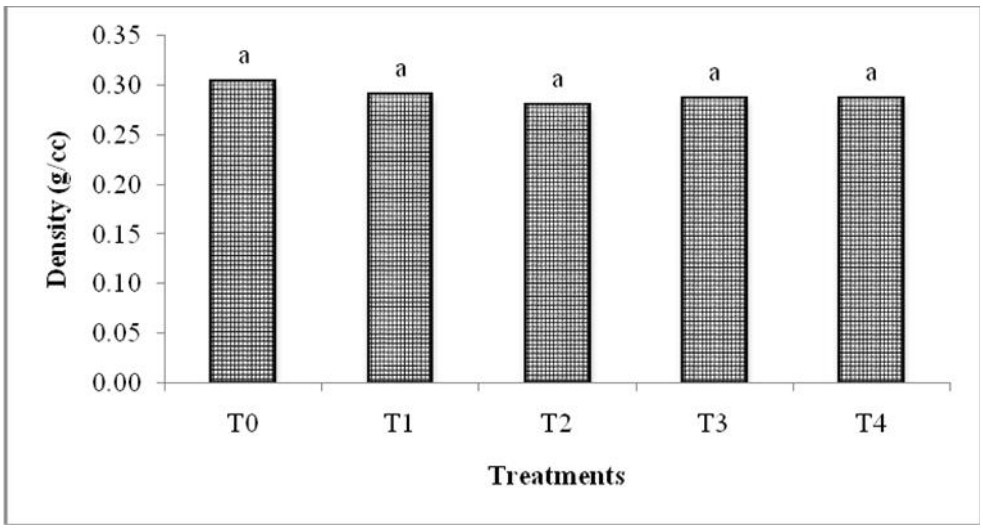

Figure 04. Density of bread under the effect of different doses of MSO

Table 4. Effect of melon seed oil on external bread characteristics.

Treatments	Volume	Crust color	Symmetry of form	Evenness of bake	Character of crust	Break and shred
T_0	6.92±0.02^{bc}	5.53±0.16^{d}	1.78±0.04^{b}	1.91±0.02^{c}	1.60±0.14^{c}	1.88±0.02^{c}
T_1	7.04±0.05^{b}	6.48±0.12^{c}	1.85±0.05^{b}	2.15±0.01^{ab}	1.85±0.07^{ab}	2.09±0.03^{a}
T_2	7.35±0.05^{a}	6.92±0.09^{a}	1.99±0.02^{a}	2.21±0.01^{a}	1.94±0.08^{a}	2.04±0.06^{ab}
T_3	6.92±0.07^{bc}	6.68±0.12^{b}	1.88±0.02^{b}	2.21±0.07^{a}	1.78±0.11^{b}	2.15±0.03^{a}
T_4	6.69±0.09^{c}	6.49±0.11^{c}	1.79±0.03^{b}	2.09±0.02^{b}	1.79±0.09^{b}	1.94±0.04^{bc}

*n 05 panelists, superscript 'a' shows the highest and 'd' shows the minimum score attainted by respective treatments

Table 05. Effect of melon seed oil on internal bread characteristics.

Treatments	Grain	Color of crumb	Aroma	Taste	Texture	Chew ability
T_0	6.88±0.06^{d}	7.11±0.10^{b}	6.59±0.33^{bc}	11.03±0.37^{c}	11.28±0.21^{b}	6.90±0.29^{a}
T_1	7.14±0.09^{bc}	7.32±0.20^{a}	7.18±0.24^{a}	11.35±0.27^{a}b	11.43±0.34^{a}b	6.98±0.33^{a}
T_2	7.30±0.09^{ab}	7.39±0.09^{a}	7.23±0.23^{a}	11.63±0.26^{a}	11.62±0.32^{a}	6.94±0.28^{a}
T_3	7.36±0.10^{a}	7.32±0.13^{a}	6.77±0.28^{b}	11.21±0.32^{bc}	11.51±0.36^{a}b	7.09±0.27^{a}
T_0	6.98±0.18^{cd}	6.74±0.06^{c}	6.39±0.22 ^{c}	11.21±0.35^{bc}	11.27±0.42^{b}	6.97±0.28^{a}

*n 05 panelists, superscript 'a' shows the highest and 'd' shows the minimum score attainted by respective treatments

DISCUSSION

The results of present study regarding specific gravity and iodine value of melon seed oil are inline with the findings of Milovanović and Pićurić-Jovanović (2005). They found the specific gravity and iodine value for melon seed oil as 0.914 and 118.8, respectively. The present results concerning iodine value, peroxide value, saponification value, color, specific gravity and refractive index are in corroboration with results reported by Oluba *et al*. (2008) who found these values as 110.0, 8.3, 192.00, yellow, 0.93 and 1.45. The minor difference of our results with the previous findings might be due to the change in environmental factors of the cultivation of this fruit.

The results of present study regarding the fatty acid profile of melon seed oil are in harmony with the results reported by Yanty *et al* (2008) and Mulengi *et al*. (2016) who found tridecanoic acid (C13:0), myristic/tetradecanoic acid (C14:0), myristoleic acid (C14:1), palmitic acid (C16:0), heptadecanoic acid (C17:0), stearic acid (C18:0), oleic acid (C18:1), linoleic acid (C18:2), linolenic acid (C18:3), arachidic acid (C20:0), eicosatrienoic acid (C20:3) almost in similar amounts as found in the present study. However, slight deviations may be due to differences in geographical conditions and environmental factors. Polar lipids with hydrophobic side chains are also used as anti-staling agents. The polar components interact with the surface of amylopectin molecules, in doing so, the non-polar fatty acid chains provide a degree of 'waterproofing'. They act by binding to gluten proteins. Modern whole meal bread depends crucially on anti-staling agents for its palatability which are found in excess in MSO (Buehler, 2006).

The findings of present work revealed that the use of melon seed oil in bread production instead of shortening helps better air incorporation during dough mixing and increases the volume by entrapping air in gluten network that results in the greater bread volume and fine bread grains.

The improved sensory attributes of bread samples may be associated with better fatty acid profile and higher levels of antioxidants in MSO which results in improved bread characteristics, better palatability and grater acceptability.

Conclusion: The kernels of melon fruit provide appreciable quantities of melon seed oil. The extracted oil is good regarding different attributes and present healthier fatty acid profile. Moreover, better performance of this oil in improving bread quality characteristics suggests that it has the potential to be used at large scale in baking industry.

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