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Ice cream antioxidants agents and their must be oils comparision

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Abstract: Three essential oils, namely, thyme (*Thymus vulgaris*), basil (*Ocimum basilicum*) and marjoram (*Majorana hortensis*) were characterized by means of GC-MS and their antioxidant activity by different assays. Basil essential oil was higher in1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) scavenging activity than other two oils. Reducing power determined by ferricyanide method was found to be concentration-dependent for the tested essential oils; the basil essential oil was also found to have significantly ($p \leq 0.05$) the highest reducing power. While, marjoram essential oil was found to have a higher antioxidant capacity than basil and thyme essential oils determined by phosphomolybdenum method. When applying H_2O_2 scavenging assay, the basil essential oil showed a significant ($p \leq 0.05$) increase in H_2O_2 scavenging activity compared to other tested essential oils. Non-significant differences were observed in physiochemical properties of ice cream treatments in comparison with the control one. In addition ice cream treatments received high scores for all the quality attributes in terms of sensory characteristics. It was concluded that basil, marjoram and thyme essential oils have an antioxidant effect and can be used as natural flavoring agents.

Key words: Thyme • Basil • Marjoram • Essential oils • Antioxidants status • Ice cream • Physicochemical properties • Sensory evaluation

INTRODUCTION

The use of essential oils as functional ingredients in foods, drinks, toiletries and cosmetics is gaining momentum [1]. Additionally, the use of essential oils is becoming popular to increase the shelf-life of food products, since consumers are more conscious about the health problems caused by several synthetic preservatives [2, 3]. Since then, the search for natural antioxidants occurring in plants as alternatives to synthetic antioxidants is one of great interest [4]. Natural antioxidants of plant origin are generally classified as vitamins, phenolic compounds including flavonoids and phenolic acids and volatile compounds in herbs and spices [5]. These natural antioxidants are becoming increasingly important, not only in food but also in preventive medicine. In medicine, natural antioxidants are one of the important sources in curing diseases associated with oxidative damage. Spices and herbs provide foods with flavors and food preserving power, including antiseptic and antioxidant activity [6, 7]. The *Labiatae* family is one of the most employed as a worldwide source of spices and also as a consolidated source of extracts with strong antibacterial and antioxidant properties [8]. The antioxidant activities of Thyme and Basil essential oils are as potential as those of the known antioxidants BHT and α-tocopherol [9]. Wild Amazonian Basil essential oil combines good antioxidant and antiradical effects [10]. Thyme oil could not only be used as an effective food antioxidant to lengthen the shelf-life of certain oils, but also can be used as dietary source of antioxidant to maintain healthy tissues [11]. The essential oils of basil and marjoram showed antioxidant activity higher than the capacity of α-tocopherol and comparable to that of BHT in egg yolk and rat liver assays [12]. The essential oil of thyme exhibited stronger antioxidant activity than BHT, curcumin and ascorbic acid [13]. The essential oil of Thyme exhibited the highest OH radical scavenging activity, although none of the thyme, basil and oregano

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essential oils reached 50% of neutralization (IC_{50}). All of the tested essential oils strongly inhibited lipid peroxidation, induced either by Fe^{2+}/ascorbate or by Fe^{2+}/H_2O_2 [14]. Ice cream is one of the most consumed dairy products in the world [15, 16]; it is generally poor in natural antioxidants. Thus, it is of interest to explore the possibility of improving the nutritional attributes of ice cream by using ingredients with health benefits, focusing on natural antioxidants, natural flavoring agents and freedom from synthetic additives in light of consumer expectations [17, 18].

The objective of the present study was to evaluate the chemical composition and antioxidant status of the thyme, basil and marjoram essential oils. Also, to study the possibility of manufacturing a functional ice cream with some health benefits, through using the mentioned essential oils as flavoring ingredient and to evaluate their effects on the physicochemical and sensory characteristics of ice cream.

MATERIALS AND METHODS

Materials: Thyme (*Thymus vulgaris*), basil (*Ocimum basilicum*) and marjoram (*Majorana hortensis*) essential oils were purchased from Kato Aromatic, Giza, Egypt. The ingredients of ice cream mix included fresh buffalo's milk and cream were obtained from the herd of the dairy cattle at Faculty of Agriculture, Ain Shams University, Qaliubiya, Egypt. Skimmed milk powder, granulated cane sugar and vanilla were obtained from the local market of Cairo, Egypt. Sodium carboxy methyl cellulose (CMC) was produced from BDH chemicals Ltd Poole; England Hydrogen peroxide, ammonium molybdate, sodium phosphate, sulfuric acid, ethanol, potassium ferricyanide, phosphate buffer, trichloroacetic acid, ferric chloride and methanol were obtained from El-Gomhoreya Co., Cairo, Egypt. While, 1,1-diphenyl-2-picrylhydrazyl radical (DPPH)reagent was purchased from Sigma–Aldrich Inc. (St. Louis, MO, USA).2,2-diphenyl-1-picrylhydrazyl.

Methods

GC-MS Analysis: To identify the components of the three essential oils, 1µL of sample solution (1µg/ml) in hexane were analyzed by HP-5890 GC equipped with HP-5972 mass detector. The analysis was performed by using HP-innowax column 30 m x 0.25 mm id x 0.25 µm film thickness. Mobile phase is helium, flow rate 1ml/ min. Initial temperature 75°C/8min, oven temperature raised up from75 to 200°C at rate of 40°C/min, final temperature 270°C/3min. The Injector temperature 270°C and the mass detector temperature was 300°C. The fragmentation pattern of the obtained mass spectra was analyzed by Wiley7N mass library software.

Free Radical Scavenging Effect: The DPPH free radical scavenging effect was assessed by the method of Kondo *et al.* [19]. Briefly, 0.1ml of each essential oil at different concentrations (from 0.07 to 100% diluted in ethanol) was added to 2 ml DPPH (0.21 mM in 95% ethanol). The mixture was shaken, left for 60 min at room temperature in the dark and the absorbance was measured at 517nm in a spectrophotometer (Shimadzu UV-Vis 160A -spectrophotometer). The percentage of DPPH inhibition was calculated using the following equation:

$$\text{Percentage of inhibition} = [(Abs_{control} - Abs_{sample})/Abs_{control}] \times 100$$

where: $Abs_{control}$ is the absorbance of the control reaction (blank with 0.1ml ethanol and 1.9 ml DPPH) and Abs_{sample} is the absorbance of the sample reaction (0.1ml essential oil diluted in ethanol and DPPH). The sample concentration (in 1 mL reaction mixture) providing 50% inhibition (IC_{50}) was estimated by plotting the percentages of inhibition against essential oil concentrations. All determinations were performed in triplicate. As positive control, the IC_{50} was estimated for the synthetic antioxidant reagent BHT. To standardize DPPH results, the antioxidant activity index (AAI), proposed by Scherer and Godoy [20] was calculated as follows:

$$AAI = [\text{DPPH concentration in reaction mixture } (\mu g/ml) / IC_{50} (\mu g/ml)]$$

Samples were classified as showing poor antioxidant activity (AAI < 0.5), moderate (0.5 < AAI < 1.0), strong (1.0 < AAI < 2.0) and very strong (AAI > 2.0).

Reducing Power: The reducing power of essential oils of thyme, basil and marjoram was determined according to the method of Oyaizu [21]. A volume of 0.4 ml of ethanolic solutions of each sample with different concentrations (20-120 mg/l) with 20 mg/l interval of essential oils were added to 1ml potassium ferricyanide 1% and 1ml phosphate buffer 0.2 M, pH 6.6. The reaction mixtures was incubated at 50°C for 20 min. After incubation, 1 ml trichloroacetic acid 10% was added to the mixture, which was then centrifuged at 650 × g for 10 min. Two ml of the

supernatant was mixed with 2 ml distilled water and 0.4 ml ferric chloride 0.1% and the absorbance were read spectrophotometrically at 700 nm. Higher absorbance of the reaction mixture indicated greater reducing power.

Antioxidant Capacity by the Phosphomolybdenum Method: Total antioxidant capacity of thyme, basil and marjoram essential oils was determined according to the method of Prieto *et al.* [22]. 0.5 ml of ethanolic solution of each sample with different concentrations of 25, 50, 75 and 100 ppm of essential oils was added to 3.5 ml reagent solution (0.6 M sulfuric acid, 28 mM sodium phosphate and 4mM Ammonium molybdate). Blank solution consisted of 3.5 ml of reagent solution and 0.5 ml of ethanol. Tubes (screw capped) incubated in a water bath at 95°C for 90 min. and then cooled down to room temperature. The absorbance of the aqueous solution of each sample was read at 695 nm against blank. The antioxidant capacities expressed as equivalents of α-tocopherol from the molar absorbtivity of α-tocopherol (4000 M^{-1} cm^{-1}).

H_2O_2 Scavenging Capacity Assay: The ability of thyme, basil and marjoram essential oils to scavenge hydrogen peroxide was determined according to the method of Ruch *et al.* [23]. A 20mM solution of hydrogen peroxide was prepared in 95%ethanol.Hydrogen peroxide concentration was determined spectrophotometrically at 230 nm by using the molar absorptivity of 81M^{-1} cm^{-1}. Ethanolic solution of each sample at concentrations of 25, 50, 75, 100, 200 and 300 ppm of essential oils were added to a hydrogen peroxide solution. Absorbance of hydrogen peroxide at 230 nm was measured after 10 min against a blank solution that contained essential oils in ethanol without hydrogen peroxide.

% Scavenging of hydrogen peroxide = (As/Ac -1) ×100

where: As= absorbance of sample, Ac= absorbance of control (hydrogen peroxide solution in ethanol without sample).

Production of Flavored Ice Cream with Essential Oils: Ice cream was manufactured according to Arbuckle [24]. Base ice cream mix was standardized to contain 7% fat, 11% milk solids not fat (MSNF), 15% sugar and 0.3% stabilizer (CMC). The required amounts of sugar, stabilizer, skim milk powder (97% DM), cream (50% fat) and buffalo whole milk (6% fat) to prepare one kg of basic ice cream mix were 150, 3, 45.5, 50 and 751.5 g, respectively. The mix was heat treated at 85°C for 5 min, then cooled to 5°C and kept at same temperature (5°C) over night for aging. After aging, the mix was divided into four equal portions. 0.01% vanilla was added to the first portion (as a control), while, other portions (treatment I, II and III) were enriched with the essential oils thyme, basil and marjoram as flavoring agent. Thyme oil was added to the treatment I at a concentration of 10 ppm, while basil and marjoram oils were added to treatments II and III, respectively, at the level of 3 ppm. The addition percentage of aforementioned essential oils to ice cream mixes were in accordance with the used report given by Burdock [25]. Each mix was frozen in an experimental ice cream batch freezer (Taylor, Model, 1039, USA). This machine was automatically controlled to stop whipping when ice cream was frozen. The resultant products were packed into PVC cups (ca. 60 ml) covered and hardened at -26°C 24 hrs before analyses. Three replicates were carried out for every treatment.

Ice Cream Evaluation

Physicochemical Analysis: Ash, fat and protein of ice cream samples were determined as described by A.O.A.C [26].The pH values of ice cream samples were measured to nearest 0.01 units using Beckman pH meter type 7010, with combined glass electrode (Electric Instruments, Limited). Specific gravity of mixes and final products was determined according to Winton [27]. The overrun percentages of the resultant ice cream were determined as described by Akin *et al.* [28].

Assay for DPPH Radical Scavenging Activity: Briefly, ice cream sample (50 g) was extracted with 25ml 500 ml l^{-1} methanol solution for 12h. The mixture was filtered with Whatman No. 4 paper and then 0.3 ml of the sample was added to 1.2 ml methanol and 1.5 ml of 0.5 mmol/l DPPH (in methanol). The solution was kept at room temperature for 90 min. and the absorption at 517nm was measured [29]. The DPPH radical scavenging effect was calculated as follows:

Scavenging activity %=$[(Abs_{control} - Abs_{sample})/Abs_{control}]$ x100

Sensory Evaluation: The sensory evaluation of the ice cream samples was conducted by ten member semi trained panels of food science department staff using a score test for appearance, body and texture, flavor, resistant to

melting and general acceptability. Hardenedice cream samples were tested at a serving temperature of -10°C. The sensory characteristics were assessed on a scale from 1, for very poor to 9 for excellent [30].

Statistical Analysis: Data were analyzed using analysis of variance (ANOVA) followed by Duncan's Multiple Range Test with $P \leq 0.05$ to determine the significant differences in results using SAS software [31].

RESULTS AND DISCUSSION

Chemical Composition of the Essential Oils: Chemical composition of thyme, basil and marjoram essential oils is presented in Table 1. The different constituents of the samples were identified and quantified by GC-MS. Thyme volatile oil was particularly rich in thymol (44.332%) and *p*-cymene (43.19%) which were major components, followed by linalool (4.677%) and carverol (0.448%). Basil oil contained linalool (42.41%), 2-piperitone (12.21%) and euganol (11.00%) as main constituents. While, di-(2-ethylhexyl) phthalate (17.40%), sabinene (12.59%), γ-terpinene (12.02%), β-phellandrene (11.19%) terpinen-4-ol (10.62%) and α-terpinene (10.46%) were the major components in marjoram volatile oil. From the present data it could be assumed that the pattern of terpenoid components of the essential oils under investigation was not the same either in quality or in quantity. These differences in composition will be reflected the differences in antioxidant activities. Similar observations were obtained by Lee and Shibamoto [9] and Vardar-Ünlü *et al.* [13].

Antioxidant Capacity Assays: In light of the differences among the wide number of test systems available, the results of a single-assay cangive only a reductive suggestion of the antioxidant properties of essential oils toward food matrices and must be interpreted with some caution. Moreover, the chemical complexity of essential oils, which are often a mixture of dozens of compounds with different functional groups, polarity and chemical behavior, could lead to scattered results, depending on the test employed. Therefore, an approach with multiple assays in screening work is highly advisable.

Free Radical Scavenging Effect: The essential oils basil, marjoram and thyme were able to inhibit 50% of the radical scavenging activity of DPPH (Table 2). The lowest IC_{50} values were obtained from basil (0.249 mg/ml) and marjoram (0.338 mg/ml) essential oils with no significant difference ($p \leq 0.05$), thus being classified as strong antioxidants according to Scherer and Godoy [20]. While, the antioxidant activity of thyme essential oil was statistically ($p \leq 0.05$) lower than those found for basil and marjoram oils, which were within the values obtained in other studies [32, 33].

Reducing Power: Data presented in Table 3 demonstrate the reducing power of thyme, basil and marjoram essential oils at different concentrations. The obtained results revealed that all tested essential oils exhibited a reducing power at varying degrees. A positive correlation was observed between concentration and reducing power of the tested essential oils. Significant differences were noticed among the essential oils in their concentrations and reducing power. The highest reducing power was recorded for essential oil basil followed by marjoram and then thyme. Other studies, Olson [34], Benzie and Strain [35] and Huang et *al.* [36] reported that the reducing power is an important parameter reflecting the oxidation-reduction potential of an essential oil.

Antioxidant Capacity by Phosphomolybdenium Method: The obtained results revealed that all the tested essential oils had antioxidant capacities significantly differed between them and their concentrations (Table 4). There were a positive correlation between concentration and antioxidant capacity of the essential oils under investigation. The antioxidant capacity of oils was descendingly found to arranged in the following order being for marjoram >basil>thyme in all the tested concentrations. The determination of the antioxidant capacity by phosphomolybdenium method was based on electron transfer. the assay based on the reduction of Mo (VI) to Mo (V) by the antioxidant and subsequent formation of a green phosphate/ Mo (V) complex in an acidic solution as mentioned by Prieto *et al.* [22], Huang *et al.* [36] and Jayaprakasha *et al.* [37].

H_2O_2 Scavenging Capacity Assay: The tested essential oils exerted a concentration- dependent scavenging of hydrogen peroxide (H_2O_2) as shown in Table 5. The concentration of H_2O_2 in the systems containing essential oil samples dropped very sharply during the initial 10 min period of the assay especially in basil oil. The percent of H_2O_2 scavenging activity of essential oils under investigation increased in the following order basil>thyme>marjoram at all tested concentrations. Mechanism of H_2O_2 scavenging activity is explained according to Wettasinghe and Shahidi [38]. Since phenolic compounds identified in essential oils of thyme, basil and marjoram and they are good electron donors,

Table 1: Chemical composition of thyme, basil and marjoram essential oils

Compounds %	Thyme oil	Basil oil	Marjoram oil
α-Pinene	0.026	-	-
Camphene	0.46	0.041	-
β- Pinene	0.089	0.25	-
Sabinene	-	-	12.59
Myrcene	0.79	0.82	0.15
α-phellandrene	-	-	1.98
D,L- Limonene	0.31	0.25	
α-terpinene	0.117	0.24	10.46
P-Cymene	43.19	-	-
β-phellandrene	-	-	11.19
γ- Terpinene	-	0.076	12.02
Cissabinenehydrate	-	-	1.83
Fenchone	0.031	0.024	-
α-terpinolene	-	-	1.26
Trans sabinenehydrate	-	-	3.74
Linalool	4.677	42.41	-
Pulegone	-	0.025	-
1-Borneol+ α-Terpineol	0.85	0.8	-
terpinen-4-ol	-	-	10.62
Carvone+ Citral	0.029	1.4	-
Dihydrocarveol	0.001	0.082	-
Geraniol	-	0.2	-
2-Piperitone	0.07	12.21	-
Euganol	0.029	11.00	-
Thymol	44.332	-	-
Carverol	0.448	0.043	-
trans caryophllene	-	-	0.65
di-(2-ethylhexyl)phthalate	-	-	17.40
α- Thujene	-	-	4.10

Table 2: Free radical DPPH scavenging

	DPPH	
Essential oil	IC_{50} mg /ml	AAI
Thyme	0.951 ± 0.10^{a}	1.8±0.50
Marjoram	0.338 ± 0.08^{b}	2.4±0.10
Basil	0.294 ± 0.00^{b}	2.6±0.30
BHT (control)	0.035 ± 0.04^{c}	4.0±0.06

Values are presented as mean ± standard deviation. Different letters (a–c) denote significant differences ($p < 0.05$) between essential oils/compounds.
AAI: the antioxidant activity index, IC_{50}: inhibition concentration 50%

Table 3: Reducing power of thyme, marjoram and basil essential oils.

	Concentration (mg/l)					
Essential oil	20	40	60	80	100	120
Thyme	$0.198^{Cf}\pm0.018$	$0.410^{Ce}\pm0.019$	$0.622^{Cd}\pm0.019$	$0.834^{Cc}\pm0.019$	$1.046^{Cb}\pm0.017$	$1.258^{Ca}\pm0.019$
Marjoram	$0.121^{Bf}\pm0.019$	$0.437^{Be}\pm0.019$	$0.753^{Bd}\pm0.019$	$0.977^{Bc}\pm0.019$	$1.385^{Bb}\pm0.019$	$1.701^{Ba}\pm0.019$
Basil	$0.157^{Af}\pm0.019$	$0.591^{Ae}\pm0.017$	$1.026^{Ad}\pm0.017$	$1.146^{Ac}\pm0.019$	$1.461^{Ab}\pm0.019$	$1.894^{Aa}\pm0.016$

Values are presented as mean ± standard deviation. Different letters (A,B and C) denote significant differences within columns ($p < 0.05$).Different letters (a-f) denote significant differences within rows ($p < 0.05$)

Table 4: The antioxidant capacity of thyme, basil and marjoram essential oils by phosphomolybdenium method as equivalents of α-tocopherol (nmol/g oil)

	Concentration (mg/L)			
Essential oil	25	50	75	100
Thyme	2.00±0.755^{Cd}	37.5±0.755^{Cc}	57.5±0.755^{Cb}	90.0±0.755^{Ca}
Marjoram	102.5±0.755^{Ad}	250.0±0.755^{Ac}	460.0±0.755^{Ab}	640.0±0.755^{Aa}
Basil	130±0.755^{Bd}	285±0.755^{Bc}	438±0.755^{Bb}	518±0.755^{Ba}

Values are presented as mean ± standard deviation. Different letters (A,B and C) denote significant differences within columns ($p < 0.05$).Different letters (a-d) denote significant differences within rows ($p < 0.05$).

Table 5: The percent of H_2O_2 scavenging activity of thyme, basil and marjoram essential oils

	Concentration (mg/l)					
Essential oil	25	50	75	100	200	300
Thyme	9.40±0.130^{Bf}	19.71±0.130^{Be}	34.80±0.130^{Bd}	48.87±0.130^{Bc}	87.26±0.130^{Bb}	100.0±0.130^{Ba}
Marjoram	9.45±0.130^{Cf}	14.78±0.130^{Ce}	21.03±0.130^{Cd}	29.31±0.130^{Cc}	60.36±0.130^{Cb}	90.51±0.130^{Ca}
Basil	25.73±0.130^{Ae}	44.72±0.130^{Ad}	67.28±0.130^{Ac}	89.80±0.130^{Ab}	100.00±0.130^{Aa}	100.00±0.130^{Aa}

Values are presented as mean ± standard deviation. Different letters (A, B and C) denote significant differences within columns ($p < 0.05$).Different letters (a-f) denote significant differences within rows ($p < 0.05$)

Table 6: Physicochemical properties of flavored ice creams by essential oils

Ice cream sample	Ash %	Fat %	Protein %	Antioxidant activity %	pH	Specific gravity	Overrun (%)
C	1.085±0.05^{bc}	6.9±0.17^{a}	4.4±0.04^{bc}	14.9±0.42^{d}	6.1±0.1^{a}	1.103±0.01^{a}	41.5±0.8^{a}
T I	1.083±0.03^{c}	7.1±0.06^{a}	4.5±0.12^{ab}	52.2±0.42^{c}	6.2±0.05^{a}	1.118±0.01^{a}	42.2±0.7^{a}
T II	1.093±0.03^{ab}	7.0±0.1^{a}	4.3±0.03^{c}	97.5±0.42^{a}	6.1±0.05^{a}	1.108±0.01^{a}	41.6±0.6^{a}
T III	1.102±0.06^{a}	7.1±0.1^{a}	4.6±0.04^{a}	74.6±0.34^{b}	6.2±0.08^{a}	1.096±0.02^{a}	42.3±1.6^{a}

Data are the mean ± SD, n = 3, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$).
C: control ice cream with vanilla; T I, T II, T III: flavored ice cream with 10 ppm thyme, 3 ppm basil and 3 ppm marjoram, respectively

Table 7: Sensory attributes of ice cream flavored by essential oils

Ice cream samples	Appearance	Body & Texture	Flavor	Resistant to melting	General acceptability
C	8.0±1.22^{a}	8.11±0.78^{a}	8.22±0.5^{a}	8.0±0.5^{a}	8.11±0.78^{a}
T I	7.89±1.17^{a}	7.67±1.0^{a}	7.67±0.87^{a}	7.44±0.73^{a}	7.67±0.87^{ab}
T II	8.0±0.71^{a}	7.89±0.6^{a}	6.56±0.88^{b}	7.78±0.44^{a}	7.11±0.78^{b}
T III	8.22±0.67^{a}	8.11±0.78^{a}	7.33±1.0^{ab}	7.67±0.5^{a}	7.89±0.93^{ab}

Data are the mean ± SD, n = 10, Mean values in the same column bearing the same superscript do not differ significantly ($P \leq 0.05$)
C: control ice cream with vanilla; T I, T II, T III: flavored ice cream with 10 ppm thyme, 3 ppm basil and 3 ppm marjoram, respectively

they may accelerate the conversion of H_2O_2 to H_2O. Hydrogen peroxide itself is rather unreactive, but it can initiate lipid peroxidation or be toxic to cell because it generates hydroxyl radicals by the Fenton reaction [39]. Under physiological conditions, H_2O_2 oxidation power is believed to be observed in combination with Fe (II) (Fenton reaction). Biologically, H_2O_2 is converted to oxygen and water by catalase [36].

Physicochemical Properties of Flavored Ice Cream by Essential Oils: The results presented in Table 6 revealed non-significant differences in ash, fat and protein contents of ice cream mixes between the control and treatments. Also, addition of essential oils as flavored agent in ice cream mix had no significant effect on pH value, specific gravity and overrun. All essential oils incorporated in ice cream showed an excellent ability in radical scavenging activity (52.2–97.5%), while it was only 14.9% in the case of the control. Thus, the addition of essential oils into ice cream increases health benefits by increasing antioxidant properties as reported by Kelvin *et al.* [40], Nadeem *et al.* [41] and Safa and Kayacier [42].

Sensory Evaluation of Flavored Ice Cream by Essential Oils: Sensory evaluation of the ice cream samples are shown in Table 7. All the samples received high scores for all the quality attributes in terms of sensory characteristics. The addition of essential oils had no significant effect ($P \leq 0.05$) on the scores of appearance, body and texture and resistant to melting characteristics. The received scores of flavor were significantly ($P \leq 0.05$)

higher for samples flavored with thyme and marjoram oils than that of basil oil. The ice cream flavored by marjoram oil was the most preferred by the panelists. These obtained results are in harmony with those obtained by Safa and Kayacier [42].

CONCLUSION

It could be concluded that, thyme, basil and marjoram essential oils were effective as antioxidant activity due, in part, to the presence of several compounds, like carverol, thymol, linalool and eugenol, in their chemical compositions. They could be used as flavoring agents and good sources of antioxidants in making ice cream with healthy benefits and good sensory acceptability.

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