Journal of Food Chemistry & Nanotechnology

https://doi.org/10.17756/jfcn.2020-092

Research Article

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Efficacy of Cinnamon and Qysoom Essential Oils, Alone and in Combination, to Retard Lipid Oxidation in Olive Oil and Frozen Beef-Burger Models

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Received: January 02, 2020
Accepted: June 12, 2020
Published: June 15, 2020

Citation: Awaisheh SS, Rahahleh RJ, Omar SS, Al-Dabbas MM, Haddad MA, et al. 2020. Efficacy of Cinnamon and Qysoom Essential Oils, Alone and in Combination, to Retard Lipid Oxidation in Olive Oil and Frozen Beef-Burger Models. *J Food Chem Nanotechnol* 6(3): 117-123.

Published by United Scientific Group

Abstract

Oxidation consequences are detrimental for sensory and shelf life of meat products. Because of its safety and effectiveness, natural antioxidants are increasingly demanded by consumers and legal authorities. Therefore, this study aims to evaluate the effectiveness of essential oils (EOs) of *Cinnamomum verum* (Cinnamon, CEOs) and *Ahcillea arabica* (Qysoom, QEOs) to retard lipid oxidation in olive oil and frozen beef-burger models against BHT. First: CEOs, QEOs, and BHT antioxidant capacities were evaluated on thermally induced oxidation of olive oil (220 °C/2 hrs). Then; EOs were added alone or together to the beef-burger samples at concentrations of 0.05% and 0.1%; while BHT at 0.6% level served as a standard besides negative control group. Product was stored at -18 °C/21 days, and examined for lipid oxidation using thiobarbituric acid reactive substances (TBARS) assay, and sensory evaluation at zero and after 21 days. Results showed that the 0.8% of both EOs was the most effective concentration to retard oil oxidation, with TBARS values (mg MAE/kg) 0.14 and 0.28 for Qysoom and Cinnamon, respectively. The TBARS values for negative control and BHT beef-burger samples were 1.62 and 1.12; whereas the CEOs (0.05 and 0.1%) showed the strongest antioxidant effect with TBARS values of 0.73 and 0.87, respectively; followed by 0.05% mixture EOs, QEOs, then 0.1% mixture. At the beginning of storage, sensory evaluation results revealed higher acceptability for control, BHT and CEOs treated beef-burger over QEO beef-burger. But at the end of storage, the acceptability of QEOs beef-burger enhanced to equalize the acceptability of other treatments. It might be recommended that the CEOs and QEOs could retard the oxidative rancidity of frozen meat products and impart a desirable flavor effect at the same time.

Keywords

Antioxidants, Cinnamon, Qysoom, Essential oils, Frozen beef-burger, BHT, Olive oil, Sensory evaluation, TBA

Introduction

Lipid oxidation and microbial growth are the main causes of deterioration of the sensory and nutritional qualities of meat products during processing and storage [1-3]. Lipid oxidation is responsible for the development of primary and secondary oxidation products, such as the production of peroxides and aldehydes that is responsible for the development of unpleasant rancid flavors and color of meat, as well as reduction of nutritional value [4]. Health hazards and economic

losses in terms of inferior product quality are other serious side effects of lipid oxidation in meat. Besides, the high oxidation rate in refrigerated and frozen meat products makes its trading even more difficult [5]. Lipids oxidation in meat is a complex process that depends on several factors, including chemical composition, light and oxygen access, and storage temperatures of meat [6].

The common industrial practice to mitigate oxidation process and extend shelf life of meat products is the use of synthetic antioxidants (SA). Antioxidants are additives capable of donating hydrogen (H·) radicals for free radicals scavenging and inhibition the propagation reaction during oxidation process [7]. Various types of SA are used in meat industry, including butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), tert-butyl hydroquinone (TBHQ), and propyl gallate (PG) [8-9]. Even though SA effectively retard lipid oxidation, minimize rancidity, and consequently improve quality and extend shelf life of meat products without affecting its sensory or nutritional attributes, SA have been questioned for their toxicological and carcinogenic effects [9-12]. However, because of the safety concerns and overuse of these SA, the demands for natural antioxidants (NA) has been emerged as an alternative to SA in food processing. Hence, extensive research efforts have been carried out to explore novel NA to mitigate lipids oxidation process [12-15], control pathogens growth and ensure safety [16-20], improve quality and maintain nutritional value of meat products [21, 22]. Eventually, NA have increasing application potentials in the meat industry because of its safety, effectiveness and the consumers' and legal authority acceptability over the use of SA.

Plant extracts (PEs) and EOs are among the most powerful and effective NA. The majority of the NA constituents are phenolic compounds, tocopherols, flavonoids, carotenoids, and phenolic acids. They are used as antioxidants to prevent or retard lipid oxidation in a wide variety of foods. The phenolic compounds exhibit various antioxidant activities including a strong H·-donating activity or high radical scavenging capacity [23].

Several attempts have been made to inhibit lipid oxidation and improve meat quality by using NA, such as feeding the NA to animals in diet, applying the NA compounds onto the meat surfaces, or using active packaging material containing NA [24-26]. Even though, the effectiveness of wide range of PEs and EOs, such as rosemary, thyme, sage, ginger and oregano extracts to reduce lipid oxidation has been reported in different types of meat products [21-24]; the need to screen different plants and herbs for new and novel NA to mitigate lipids oxidation, improve quality, and maintain the nutritional value of foods, has become a priority in food processing field. However, antioxidant effect of Cinnamon EOs (CEOs) has been studied well in food models [21-25], this effect has not been studied for Qysoom EOs (QEOs). To our knowledge, this is the first in the literature to evaluate the antioxidant activity of QEOs in frozen beef-burger model. Therefore, the objective of this work was to study the effectiveness of EOs of Cinnamon in combination with Qysoom to retard lipid oxidation in olive oil and frozen beef-burger models.

Material and Methods

Medicinal plants and essential oils extraction

The pure EOs of Cinnamon (*Cinnamomum verum*) and Qysoom (*Ahcillea arabica*) were procured from a local extraction facility in Amman-Jordan. EOs were extracted in the facility by using steam distillation instrument. EOs were analyzed for total phenolic content, DPPH radical scavenging activity and reducing power.

Total phenolic contents of plant EOs

The total phenols content of the two EOs were determined using Folin-Ciocalteu (F-C) assay [27]. The suitable aliquot of EOs (0.5 mL) and 2 mL of sodium carbonate (75 g/L) were added to 2.5 mL of 10 % (v/v) F-C reagent (Sigma-Aldrich, Steinheim, Germany). After 30 min incubation at room temperature, the absorbance was measured at 725 nm using UV/VIS spectrophotometer (Biotek-810, MO, USA). The amount of total phenolics was calculated gallic acid equivalent (GAE) from the calibration curve using standard GA solution (0.1 mg/ml). Tests were carried out in triplicate.

DPPH radical scavenging assay

The free radical scavenging activity of CEO and QEO was determined by the DPPH assay [28, 29]. The radical form of DPPH compound strongly absorbs radiation at 517 nm wavelength, and its absorption capacity is declined as a result to reduction of DPPH radicals by an antioxidant. Briefly, 0.1 mM solution of DPPH in methanol was prepared and 2 mL of this solution was added to 1 mL of EOs solutions or BHT (80 µg of each EO or BHT in 1 ml of 0.1 M Tris–HCl buffer, pH 7.4). After 20 mins at room temperature, the absorbance was measured at 517 nm using UV/VIS spectrophotometer (Biotek-810, MO, USA). The lower absorbance of the reaction mixture the higher free radical scavenging activity. The capability to scavenge the DPPH radical was calculated using the following equation: DPPH Scavenging Activity = $(Abs_{control} - Abs_{sample}) / Abs_{control} \times 100$.

Screening of reducing power

Reducing power of the plant extracts were determined according to Al-Dabbas et al. [30]. Briefly, 80 µg of each EO was mixed with 2.5 ml phosphate buffer (0.2 M, pH 6.6) and 2.5 ml (10 g/l) potassium ferricyanide, and incubated at 50 °C for 30 min, followed by addition of 2.5 ml trichloroacetic acid (100g/l) with centrifugation at 1650 g for 10 min. A 2.5 ml quantity was taken from the upper layer of the solution and mixed with 2.5 ml ferric chloride (1 g/l). Ascorbic acid (300 µg) was used as a standard, solution containing all reagents without EOs as a control. Absorbance of samples, standard and control was measured at 700 nm using UV/VIS spectrophotometer (Biotek-810, MO, USA).

Evaluation of antioxidant capacity of EOs in thermally accelerated oxidation of olive oil model

In order to determine the EOs concentration with the maximum antioxidant capacity, thermally accelerated

oxidation of olive oil model was used [31]. EOs and BHT different concentrations were prepared and used in this study. Briefly, a tube containing 5 ml of olive oil was supplemented with one of each of the following concentrations: 0.05%, 0.1%, 0.2%, 0.3%, 0.4%, 0.5%, 0.6%, 0.8%, and 1%, of each EO or BHT; olive oil sample without addition of any antioxidant served as a negative control. The samples were heated at 220 °C/2 hrs to induce accelerated oil oxidation. The TBARS assay was used to determine the oxidation rates of different treatments and control samples [32]. Ten ml of TBARS solution was mixed with 2 grams of the oxidized oil and heated at 100 °C/10 mins using boiling water bath, then the samples were cooled down immediately in ice to 5 °C. All samples were then centrifuged at 2500 rpm for 25 mins. The aqueous layer of the two resulted phases was taken and the absorbance was measured at 532 nm by using UV/VIS spectrophotometer (Biotek-810, MO, USA). The calibration curve was constructed in the concentration range of 0.1 to 1.0 mM using 10 mM malonaldehyde tetrabutylammonium salt. Standard stock solution of MDA (1 mM) was prepared in glacial acetic acid, where 31.35 mg of MDA was weighed and dissolved in 100 mL solvent. From the stock solution, different concentrations of 0.1, 0.2, 0.4, 0.6, and 0.8 mM were prepared. Different concentrations of standard MDA were analyzed with the above mentioned method. TBARS value was expressed as the mg of malonaldehyde equivalents (MAE) per kg of oil. Analysis was performed in duplicate using triplicate samples.

Evaluation of antioxidant effect of EOs and BHT in frozen beef-burger model

Refrigerated beef cuts were purchased from a local commercial source and kept at 2 °C. The meat cuts were ground together with subcutaneous fat through a 0.4-cm grinder plate (Super grinder-MK-G3; Matsushita Electric Industrial, Japan). All other ingredients were added in equal amounts (g/kg) to the various formulations of hamburger meat: 20 g table salt (sodium chloride), 3.5 g white pepper and 6.2 g burger seasoning (1.5 g nutmeg, 0.7 g sage and 0.5 g other spices). Based on previous preliminary studies (data are not shown), the beef burger was formulated to contain 0.05% or 0.1% of each EO, alone or in combination; and 0.6% of BHT. Beef-burger samples without any antioxidants served as a negative control. Burger samples were stored under freezing conditions (-18 °C) for 21 days. The TBARS assay was carried to evaluate oxidation rate of different treatments and control samples at the intervals of 0, 7, 14, and 21 days. Where, 10 grams of the burger samples was mixed with 25 ml of 20% trichloroacetic acid solution, and homogenized in stomacher (Stomacher-400-circulator, Seward, UK) at 300 rpm for 3 min. After filtration, 2 ml of the filtrate were added to 2 ml TBARS solution (3 g/l) and heated at 100 °C/10 mins, then the samples were cooled down immediately in ice to 5 °C. All samples were centrifuged at 2500 rpm for 25 mins. The aqueous layer of the two resulted phases was taken and the absorbance was measured at 532 nm by using UV/VIS spectrophotometer (Biotek-810, MO, USA) [32]. Analysis was performed in duplicate using triplicate samples.

Sensory evaluation of beef-burger

Representative samples of the different beef-burger formulations were cooked in hot oil for 10 min. The intensity of flavor, tenderness, taste and overall acceptability scores of the beef-burger were determined by 20 panelists at 0 and 21 days of storage. A five-point descriptive scale was used to evaluate the samples (1 dislike extremely, 2 dislike slightly, 3 neither like nor dislike, 4 like slightly, and 5 like extremely). The panelists included staff members and students in the Department of Nutrition and Food Processing, Al-Balqa Applied University. Samples were cut into uniform size (about 3 cm in length). Analysis was performed in triplicate using duplicate samples [12].

Statistical analysis

All data were analyzed using one-way analysis of variance of a Statistical Analysis System (SAS) software version 9.3 (SAS, 2011). A tukey-kramer test was performed to compare any significant differences ($p < 0.01$, unless otherwise indicated) in variables between groups. The normality of data distribution was analyzed using the PROC UNIVERIATE of SAS.

Results and Discussion

Total phenols, DPPH scavenging activity and reducing power of Cinnamon and Qysoom EOs

The results of total phenols, DPPH scavenging activity, and reducing power of CEOs and QEOs are shown in table 1. The total phenols of Qysoom was slightly higher than Cinnamon (27.91 vs 24.19 mg/g). Compared to BHT, the strong SA, the scavenging activity of both EOs were significantly higher, with Cinnamon being the highest (72.07, 92.17, and 59.61%, respectively). Finally, the results of reducing power of EOs compared to ascorbic acid revealed that Cinnamon had the highest reducing power, followed by ascorbic acid, Qysoom and the negative control (1.53, 0.66, 0.44, and 0.03). In the shadow of these findings, EOs of Cinnamon and Qysoom can be considered as promising NA candidates. Accordingly, these EOs were further evaluated in this study. However, several studies reported the significant effectiveness of Cinnamon and Qysoom extracts and EOs antioxidant activity including DPPH scavenging and reducing power activity. These strong

Table 1: The phenolic contents (GAE), DPPH scavenging%, and reducing power of plants EOs.

Tested EOs	Total phenolic compounds (mg GAE/g)	DPPH scavenging[2]%	Reducing power[3] (absorption at 700 nm)
Qysoom	27.89[1] ± 0.05	72.07 ± 2.02	0.44 ± 0.01
Cinnamon	24.18 ± 0.07	92.17 ± 2.03	1.53 ± 0.11
BHT	-	59.61 ± 1.48	-
Ascorbic acid	-	-	0.66 ± 0.034
Control	-	-	0.03 ± 0.00

[1]Results are means ± SEM of three determinations.
[2]DPPH scavenging activity of 80 µg/ml of EOs and BHT.
[3]Reducing power activity of 5 mg/ml of EOs and ascorbic acid.

activities were higher than those of SA, and were attributed to the presence of cinnamaldehyde and eugenol, and cineole and terpinen-4-ol constituents in Cinnamon and Qysoom, respectively [33-36]. A study in Saudi Arabia and Egypt have reported a comparable total phenols content (22.7 and 42.7 mg GAE/g), and lower DPPH scavenging activity of 1 mg/ml of EO (46.6 and 34%) of EO extracted from Qysoom herbs [37]. Another study revealed the good free radical scavenging, reducing power activity and high total phenols content of Cinnamon extracts [33].

Antioxidant capacity of EOs in thermally accelerated oxidation of olive oil model

The antioxidant effects of different concentrations of CEOs, QEOs and BHT on thermally induced oxidation of olive oil model are reported in table 2. Current results showed a dose-dependent correlation with the antioxidant capacity of both EOs and BHT. For EOs treated oils, the TBARS values declined (P <0.05) as the concentration of NA and SA increased from 0.0% up to 0.80%, from 3.49 to 0.28 and 0.14 mg MAE /kg oil for CEOs and QEOs, respectively. At 1.0% EOs level, a prooxidant effect was observed as the TBARS values increased (1.02 and 1.03 mg MAE/kg oil). Whereas, the best concentration of BHT was 1.0% with TBARS value of 0.29 mg MAE /kg oil. The high total phenol contents, and good DPPH scavenging and reducing power activity could partly explain the strong antioxidant capacity exhibited by both EOs in retarding olive oil accelerated oxidation.

Table 2: Oxidation rates in thermal processed olive oil treated by natural and synthetic antioxidants expressed as mg malonaldehyde per kg of oil.

Concentrations	BHT	CEOs	QEOs
0.00%	3.49[1] ± 0.12 [a2(a)3]	3.49 ± 0.12 [a(a)]	3.49 ± 0.12 [a(a)]
0.10%	3.42 ± 0.10 [a(a)]	3.29 ± 0.09 [a(a)]	3.29 ± 0.09 [a(a)]
0.20%	3.27 ± 0.12 [a(a)]	0.72 ± 0.07 [b(c)]	1.04± 0.29 [a(b)]
0.30%	2.59 ± 0.09 [b(a)]	0.59 ± 0.03 [d(b)]	0.60 ± 0.05 [c(b)]
0.40%	2.36 ± 0.15 [b(a)]	0.52 ± 0.03 [d(b)]	0.37 ± 0.03 [d(a)]
0.50%	2.29 ± 0.20 [b(a)]	0.47 ± 0.07 [d(b)]	0.31± 0.06 [d(b)]
0.60%	2.24 ± 0.14 [b(a)]	0.41 ± 0.04 [d(b)]	0.24 ± 0.01 [e(c)]
0.80%	0.39 ± 0.08 [c(a)]	0.28 ± 0.07 [e(a)]	0.14 ± 0.04 [f(b)]
1.00%	0.29 ± 0.05 [c(b)]	1.03 ± 0.35 [c(a)]	1.02 ± 0.34 [b(a)]

1: All readings are means ± Standard Deviation of six determinations.
2: Values in the same column with different letters are significantly different (P < 0.05).
3: Values in the same row with different letters are significantly different (P < 0.05).

Antioxidant effect of EOs and BHT on frozen beef-burger model

Current findings revealed that the level of EOs with highest antioxidant effect (0.80%) in the thermally induced oxidation in olive oil had imparted an unacceptable flavor effect on beef-burger, as the Cinnamon and Qysoom flavor was very strong and unpleasant. Accordingly, the lower concentrations were screened for their effects on flavor to choose the best concentration to use in beef-burger formulation. The 0.05% and 0.10% levels of both EOs were found to impart a desirable flavor effect on product, therefore were used in further study.

Table 3 demonstrated the antioxidant effect of the 0.05% and 0.10% of both EOs alone or in combination in frozen beef-burger model during storage for 21 days. The negative control group (without any antioxidants addition) showed the highest (p<0.05) TBARS values after 21 days (1.62 mg MAE/kg). Compared to negative control, BHT efficiently (p<0.05) reduced oxidation rate until day 14, after which the oxidation rate increased to 1.12 mg MAE/kg in day 21. Regarding the antioxidant capacity of EOs, CEO caused the lowest (p<0.05) oxidation rates among all treatments. The TBARS values of 0.05 and 0.1% of CEO were 0.73 and 0.87 mg MAE/kg, respectively. Whereas, QEO resulted in oxidation rate similar to BHT but far lower (p < 0.05) than negative control. During the first 14 days, QEO efficiently (p < 0.05) caused low oxidation rate which increased during the last week of storage for both EO levels. MEOs resulted in oxidation rate comparable to that of BHT and QEO, but it was less efficient (p < 0.05) than CEO for both levels. Both MEOs concentrations were efficient (p < 0.05) in lowering oxidation rate during the first 14 days of storage (0.55 and 0.45 mg MAE/kg for 0.05 and 0.1%).

Table 3: Oxidation rates of frozen and cooked beef-burger treated by natural and synthetic antioxidants expressed as mg malonaldehyde per kg of beef burger.

Treatments	Zero Day	7 Days	14 Days	21 Days
Control%	0.15[1] ± 0.003	0.25 ± 0.002	0.87 ± 0.12	1.62 ± 0.11
BHT 0.6%	0.09 ± 0.001	0.12 ± 0.005	0.44 ± 0.18	1.12 ± 0.13
Cinnamon 0.05%	0.04 ± 0.001	0.17 ± 0.002	0.57 ± 0.16	0.73 ± 0.09
Cinnamon 0.1%	0.04 ± 0.001	0.16 ± 0.002	0.65 ± 0.14	0.87 ± 0.07
Qysoom 0.05%	0.05 ± 0.00	0.12 ± 0.013	0.53 ± 0.11	1.09 ± 0.07
Qysoom 0.1%	0.10± 0.006	0.14 ± 0.006	0.95 ± 0.18	1.14 ± 0.08
MIX[2] 0.05%	0.02± 0.00	0.09 ± 0.016	0.55 ± 0.18	1.05 ± 0.09
MIX[3] 0.1%	0.13 ± 0.001	0.25 ± 0.008	0.45 ± 0.15	1.02 ± 0.10

1: All readings are means ± Standard Deviation of six determinations.
2: Mix: Mixture of both EOs (0.025% CEOs + 0.025% QEOs).
3: Mix: Mixture of both EOs (0.05% CEOs + 0.05% QEOs).

The oxidation of lipids in food and specially meat products is a key problem that reduces shelf life of frozen meats, fermented processed meat such as dry sausages, and cured raw meat. Cold storage of precooked meats increases lipid oxidation in these products, leading to detrimental changes in products flavor (warmed-over flavor) [38, 39]. It has long been known that the medicinal plants has strong antioxidant capacities. Accordingly, extracts of several medicinal herbs have been isolated, evaluated, and applied in food industry to avoid fat oxidation [21-23].

Results showed that both concentrations of QEO and CEOs showed superior antioxidant capacity, QEOs had the

highest antioxidant capacity in the olive oil model, whereas CEOs had the highest antioxidant capacity in the beef-burger model. The antioxidant capacity of CEOs and QEOs could be explained by the phenolic contents which seems to inhibit fat oxidation by donating electrons and/or reacting with free radicals to convert them to more stable products and terminate free radical chain reactions [32, 38]. Results also indicate that the marked antioxidant capacity of both OEs is believed to be the result of their radical scavenging activity and reducing power. Plants NA are believed to break free radical chains of oxidation by donation of a hydrogen from the phenolic groups, thereby forming a stable end product [25, 28].

Our results showed that QEOs and CEOs can be used as a strong alternative to the SA in oil and meat products, respectively. Up to our best knowledge, it is the first time in the literature to report strong antioxidant capacity of QEOs in food models and to exhibit the potentiality of using a natural Qysoom extract instead of synthetic antioxidant. In the literature, it is more abundant that Rosemary and Cinnamon extracts have stronger antioxidant capacity and wider usage and applications in food industry. But, according to our results Qysoom can be considered as a promising candidate. The antioxidant capacity of herb extracts is resulted from the activity of the polyphenolic content of the extracts [19-21]. It is very usual that each herb has its own unique groups of the polyphenols and unique concentrations of each polyphenol [4, 26]. This may partly explain the difference and variability in antioxidant capacity among different herbs used,

Table 4 showed the sensory evaluations of cooked beef-burger of different treatments, including control. At zero day, general acceptability, flavor, tenderness and taste of control , BHT, and 0.05% CEOs treated beef-burger gave the highest ($p < 0.05$) scores, whereas, and to a lesser extent 0.1% CEOs, followed by 0.05% MEOs treatments. The 0.05% QEOs treatment gave good score for general acceptability and tenderness but lower scores for flavor and taste. The lowest acceptability was for 0.1% QEOs treatment for all the sensory parameters (2.25 – 3.45 out of 5). After 21 days, and compared to zero day, the acceptability of control, BHT, 0.05 and 0.1% of CEOs, and 0.05% MEOs declined ($p < 0.05$). Whereas and surprisingly, the general acceptability of 0.1% of QEOs enhanced ($p < 0.05$) with acceptability scores similar to the other treatments acceptability.

The effect of flavor and smell intensity of Cinnamon, Qysoom or the MEOs on the overall acceptability of beef-burger was very clear. Cinnamon and Qysoom are known to have a strong and tangent smell and flavor. This strong flavor and smell necessitate to use low and marginal concentrations to avoid any negative impact on products sensory characteristics.

Conclusions

The search to find new novel NA to be used in meat industry is a very critical issue. Our results showed that both Cinnamon and Qysoom EOs are very promising candidates, as they have higher and/ or equal antioxidant capacities as the synthetic antioxidant in both olive oil and beef-burger models. The use of NA in food industry means the overcome and avoidance of many safety issues and side effects accompanied the use of SA. Furthermore, Cinnamon has higher acceptability than Qysoom in the beginning of storage period, but with time, Qysoom acceptability increased to equalize that of Cinnamon, BHT, and control beef-burgers. The combination of Cinnamon, Qysoom EOs resulted in antioxidant capacity comparable to each EOs and BHT, and at the same time modulate the sensory acceptability of beef-burger at 0.05% concentration. Eventually, Cinnamon and Qysoom EOs and their combination were able to retard meat oxidative rancidity during frozen storage and at low concentrations can used as flavoring compounds in various meat products.

Acknowledgment

The authors acknowledge Al-Balqa Applied University, Jordan, for providing fund support to carry out this research work.

Table 4: Sensory evaluation of frozen beef-burger stored at -18C at zero and 21 days treated with natural and synthetic antioxidants.

Treatments	General Acceptance		Flavor		Tenderness		Taste	
	Zero-Day	21-Days	Zero-Day	21-Days	Zero-Day	21-Days	Zero-Day	21-Days
Control%	4.28±0.79	3.78±0.98	4.28 ± 0.31	3.68 ± 0.29	3.98±1.15	3.68 ± 0.30	4.22±0.35	3.48 ±0.21
BHT 0.6%	4.33±0.86	3.90±0.59	4.03 ± 0.33	3.80 ± 1.24	4.00±1.17	3.95 ± 0.23	4.42±0.22	3.73±0.29
Cinnamon 0.05%	4.30±0.80	3.65 ± 1.04	4.10 ± 0.42	3.50 ± 0.49	3.70±0.98	3.55 ± 0.39	4.15±0.33	3.60±0.19
Cinnamon 0.1%	3.90±0.32	3.45 ± 1.23	3.70 ± 0.38	3.70 ± 1.17	3.55±1.09	3.70 ± 0.33	3.90±0.28	3.30±0.34
Qysoom 0.05%	3.93±0.38	3.60 ± 1.27	2.76 ± 0.24	3.55 ± 1.36	3.05±0.94	3.30 ± 0.34	2.45±0.23	3.35±0.34
Qysoom 0.1%	3.45±0.23	3.72 ± 0.91	2.75 ± 0.37	3.68 ± 1.26	2.78±1.32	3.93 ± 0.35	2.25±0.25	3.78±0.15
MIX[2] 0.05%	3.70±0.34	3.38 ± 1.39	3.70 ± 0.33	3.53 ± 0.39	3.35±1.04	3.78± 0.32	3.35±0.36	3.48±0.44
MIX[3] 0.1%	NA	3.25 ± 0.41	NA	3.05 ± 0.22	NA	2.80 ± 0.38	NA	3.20±0.12

NA: Not Acceptable

1: All readings are means ± Standard Deviation of six determinations.

2: Mix: Mixture of both EOs (0.025% CEOs + 0.025% QEOs).

3: Mix: Mixture of both EOs (0.05% CEOs + 0.05% QEOs).

Conflicts of Interest

The authors report no conflicts of interest.

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