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Effects of selected oils as natural preservatives on chemical Quality and shelf life of beef kofta

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ABSTRACT

Preservatives of natural sources have become a seemingly better and safer than artificial preservatives. Since these preservatives come from plants, they don't have negative side effects like artificial preservatives. This study investigated the effects of *Laurus nobilis*, *Moringa oleifera* and Olive oils at different concentrations on the sensory attributes and chemical quality of beef Kofta at 4°C for 10 days cold storage period. Results revealed that samples treated with 1% Moringa, 0.5 % Moringa and 1% olive oils maintained the overall acceptability until 10th days of cold storage while those treated with 1 % laurel, 0.5 % laurel and 0.5 % olive oils got spoiled at 10th day. On the other hand, control samples got spoiled at 8th day of cold storage. Samples treated with selected oils showed marked decrease in their chemical analysis pH, Thiobarbituric Acid (TBA) and Total Volatile Basic Nitrogen (TVB-N). These results indicating that these oils have potent antioxidant effects. Best antibacterial and antioxidant results were obtained in samples treated with 1% *Moringa oleifera* oil followed by those treated with 1% olive oil then Laurel oil at 0.5% which showed the lowest results with accepted sensory properties. On the other hand, Laurel oil 1% is more effective as antibacterial and antioxidant and demonstrated more enhancements of sensory attributes. So, the results suggested that Laurel oil 1%, Moringa oil 1% and Olive oil 1% can be applied to beef kofta as natural preservatives.

Introduction

Kofta is a family of meatball which consists of minced or ground meat, usually beef, mixed with spices or onion. However it can be exposed to several ways of contamination through improper preparation, bad handling and improper storage which constitute the most direct and harmful source of microbiological contamination (Hassan *et al*., 2015).

Addition of antioxidant-rich ingredients to meat products is intensely used to increase their shelf life, maintain positive sensory characterization, and inhibit the damage caused by lipid oxidation (Homayounpour *et al*., 2021; Ribeiro *et al*., 2019).

Chemicals formed from lipid oxidation play a key role in the production of the characteristic aromas associated with meat products, which are highly valued by consumers; Lipid oxidation is a complicated process which occurs in three different manners, each of which involves a series of complex reactions: autoxidation, enzymatic-catalyzed oxidation, and photo-oxidation. Autoxidation, which is a continuous free radical chain reaction, is the predominant process-causing lipid oxidation in meat (Domínguez *et al*., 2019).

The synthetic antioxidants in meat and meat products cause toxic effects so, the idea of natural antioxidants has increased (Shah, 2014) and using of natural antioxidants in meat products preservation has attracted consumer's attention for their safety and potential health benefits (Islam *et al*., 2017).

Application of the phytochemicals from plants as a natural preservative in food products has become an important issue to replace the synthetic ingredients and produce healthier products (Singh *et al*., 2015).

Moringa oleifera (MO) is the most common species of Moringaceae family, it is frequently known as drumstick tree or horse radish tree. It possesses nutritional and medicinal importance with some valuable vitamins, minerals, and amino acids (Madane *et al*., 2019). Many studies on *Moringa oleifera* were carried out due to its multiple uses in production of foods, drugs and condiments (De Oliveira *et al*., 2018).

One of the most important sources for essential oils is *Moringa oleifera*, which is a good source of antioxidants and has many uses, including a natural food supplement and preservative because of its great antimicrobial, bioactive, antioxidant properties and has major potential use in functional food formulations that can promote health and nutritional benefits (Anwar *et al*., 2007; Ekpo *et al*., 2019; Fabiane *et al*., 2021).

Moringa oleifera can also be used to improve the nutritional value of meat products where it contains high concentrations of essential fatty acids, amino acids and fiber which found in meat in lower concentrations (Falowo *et al*., 2018). The essential unsaturated fatty acids of *Moringa oleifera* have the ability to control the blood cholesterol level and decrease the cardiovascular diseases (Robiansyah *et al*., 2014).

Laurus nobilis, commonly known as Laurel or Bay, is a plant belongs to the Lauraceae family that includes about 2500 species (Hamdan and Masoud, 2020) also used broadly to give a distinctive flavor and aroma to different foods (Fernández *et al*., 2019).

Laurus nobilis is an evergreen tree popular to mediterranean region, its essential oils are common as valuable spices and flavoring agents in food and food industry. Alpha-tocopherol is the main isomer in vegetative parts of laurel leaf, its leaves contain Flavonoids, Phenolic acids and Isoquinoline alkaloids (Hamdan and Masoud, 2020). Many studies have proved the prospective capacity of Laurel essential oil as antimicrobial agents in addition to their antioxidant properties (Rafiq *et al*., 2016). *Laurus nobilis* biological activities are attributed to a broad range of phytochemical, Vitamin E and Isoquinoline alkaloids so, it could be used as a powerful antimicrobial and antioxidant agent (Muñiz-Márquez *et al*., 2013).

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Most of fatty acids in olive are monounsaturated, with a predominance of oleic acid (65–85%) (Radzimierska-Ka´zmierczak *et al*., 2021).

Olive oil is an example of a vegetable oil extracted by olives (Olea europaea) that possesses antioxidant activities (Beriain *et al*., 2011). In Egypt, olive oil is one of the most popular products and considered as an important component of the Egyptian diet due to its high content of monounsaturated fatty acid (MUFA), more than ~ 65% oleic acid (Ciriminna *et al*., 2016). Olive oil is a main component of the Mediterranean diet, is used in medicine, and is a source of lamp fuel. It now has alot of applications in the modern cosmetic sector and in nutrition (Nunes *et al*., 2016). Polyphenols of olive oil may be associated with some properties, including anti-inflammatory, immunomodulatory, antitumor, hypoglycemic, anti-atherogenic , and antiviral properties which are partially contribute to the antioxidant effect of these products (Rigacci and Stefani, 2016).

Olive leaves attributed to a broad range of polyphenols which have biological activities making them beneficial to human health and many studies indicate that polyphenols can reduce the risk of a number of pathologies, especially those related to aging and oxidative damage (cancer, cardiovascular, or neurodegenerative diseases) (Navarro and Morales, 2017). Therefore, the current study investigated the effects of selected oils on the chemical quality and shelf Life of beef kofta.

Materials and methods

Samples collection

Fresh boneless beef meat accurately 1.5 kg at chuck area obtained from butcher shop on the day of preparation and was directly packed in sterile polyethylene bags. Primary ingredients used in this research were 94% meat, 1.8% common salt, 1.2% onion powder, 1% (garlic powder, cumin, black pepper) that were purchased from local market in Benha city, Kalyobia governorate, Egypt, while the selected oils *Laurus nobilis*, *Moringa oleifera* and Olive oils at pure state were purchased from the National Research Center, Dokki, Cairo, Egypt.

Experimental design of beef Kofta (Abustam et al., 2019)

Meat was cut into small pieces and then ground together with common salt using a food processor. Furthermore, flour, onion, garlic powder, black pepper, and cumin were added then reground to obtain meat dough. The homogeneous dough was divided into two groups, the first group (200 g) was kept untreated (control), and the second group (treated group) was divided into 6 subgroups (200 g each) which were mixed with *Laurus nobilis* oil at concentrations of LUO 0.5% and LUO 1%, *Moringa oleifera* oil at concentrations of MO 0.5% and MO 1%, and Olive oil at concentrations of OLO 0.5% and OLO 1%. Meat dough was formed into a round shape to get raw meat kofta. Kofta samples were packed in polyethylene bag, labeled, and stored at 4°C in triplicate for 10 days to be examined periodically every 2 days for sensory and chemical (pH, TBA & TVB-N) evaluation at the Animal Health Research Institute-Menofia Shebin El-Kom branch where the experiment was conducted.

Sensory evaluation (Horwitz, 2020)

The samples were evaluated by staff members in the Animal Health Research Institute (Menofia, Shebin El-Kom branch). Each member had to assess levels of odour, colour, texture (toughness or juiciness), and appearance at days 0, 2, 4, 6, 8 and 10 of cold storage. Representative samples were coded with random numbers and the judges were not informed about the experimental approach, samples of the different treatments were presented in covered small porcelain dishes to each member in a separate area where distracters, noises, and odors were minimized to give a score indicating the overall acceptance of each sample (colour, odour, texture and appearance). A nine-point descriptive scale (9 = Excellent, 8 = Very good, 7 = Very good, 6 = Good, 5 = Medium, S = spoiled) was used for the evaluation of the overall acceptability.

Chemical examination

Determination of pH value (Parvin *et al*., 2020)

Three grams of sample was homogenized for 30 sec in 27 ml of purified water. At room temperature, the slurry was set for 5 min.

Determination of Thiobarbituric acid (TBA "nmol/g") (Fan *et al*., 2019)

Lipid oxidation of raw kofta was assessed by thiobarbituric acid (TBA) assay as 5 g of sample and 15-ml TCA containing 0.1 % EDTA were mixed for 30 sec before filtering. Three ml TBA were mixed with 3-ml of the filtrate and heated in closed tubes for 40 min in a boiling water bath. The absorbance of the cooled mixture was measured by UV Spectrophotometer (Unico-UV2000, USA) set at a wavelength of 532 nm.

Estimation of total volatile basic nitrogen (TVBN)"mg" % (ES 63/10, 2006)

Accurately, 10 g of sample were minced in a stomacher for 1-2 minutes until homogenization. Then in a distillation flask 2 grams of magnesium oxide and 300 ml distilled water were added to the minced sample. Distillation was carried out and 100 ml distillate were received within 30 min. in a beaker containing 25 ml of 2% boric acid, then titration against H_2SO4 0.1M until faint pink color.

TVN mg/100g = R× 14

Where R refers to H_2SO_4 volume that exhausted in titration.

Statistical analyses

One way ANOVA using Dunnett's multiple comparisons test with individual variances ($p < 0.05$) computed for each comparison (mean value±SD).

Results

Sensory Evaluation and Overall Acceptance

Results of overall acceptance of beef kofta samples stored at 4°C revealed that the control samples were completely spoiled after the 6th day of cold storage. Addition of 1% LUO maintained the whole acceptability of sensory parameters until the 8th day, 1% MOO and 1% OLO maintained the acceptability until the 10th day of cold storage (Table 1).

Chemical Examination of beef meat samples

There are significant differences in pH mean values between various treated and untreated samples during cold storage at 4°C. The recorded results indicated decreasing pH values at two concentrations (0.5 and 1%) of treated kofta than control samples during different periods of storage. Also, by increasing oils concentrations leads to more lowering in pH values than values of lower concentrations (Table 2). The mean values of TBA of control and treated samples at the two concentrations showed decreasing in TBA values than control sample especially at the 6th, 8th and 10th days of storage period and high concentrations of Laurel, Moringa and Olive oils showed decreasing in the TBA values than lower concentrations (Table 3), while the mean values of TVB-N estimating the degree of meat deterioration during the storage period (10 days) at 4ºC as the highest rate of TVB-N values was recorded in control samples and the treatments with 1% Moringa, Olive and Laurel oils, respectively, were more effective in delaying the rate of TVB-N increase during the subsequent cold storage.

Table 1. Sensory evaluation of untreated and treated beef Kofta samples during cold storage at 4°C.

Storage days	Control	0.5% LUO	1% LUO	0.5% OLO	1%OLO	0.5%MO	1% MO
Zero day	9	9	9	9	9	9	9
2nd day	6.5	7.5	8	7.5	8	7.5	8.5
4th day	5.5	6	7	7.2	7.5	7.3	7.5
6th day	5	5.5	6	6.3	7	6.5	7
8th day	S	5	5.5	5.5	6.4	6	6.5
10th day	S	S	S	S	5	5	5.5

LUO: *Laurus nobilis* oil; OLO: Olive oil; MO: *Moringa oleifera*. Score system: 9: Excellent; 8: Very very good; 7: Very good; 6: Good; 5: Medium; S: spoiled.

Table 2. Mean pH values of untreated and treated beef Kofta samples during cold storage at 4°C (Mean±SE).

Storage days	Control	0.5% LUO	1% LUO	0.5% OL O	1% OLO	0.5% MO	1% MO
Zero day	5.63±0.02^{a}	5.62±0.02^{a}	5.59±0.01^{a}	5.56±0.02^{a}	5.55±0.04^{a}	5.53±0.02^{a}	5.52±0.03^{a}
2nd day	6.12±0.03 a	5.82±0.02^{b}	5.76±0.02^{b}	5.71±0.02^{b}	5.67±0.03 ^{c}	5.64±0.03^{c}	5.61±0.01^{d}
4th day	6.62±0.02a	6.23±0.05 ^{b}	6.12±0.03^{c}	6.16±0.02^{b}	6.06±0.02^{d}	6.03±0.01^{d}	5.92±0.02 ^{e}
6th day	6.79±0.01^{a}	6.31±0.03^{b}	6.22±0.02^{c}	6.27±0.03^{b}	6.22±0.02^{c}	6.17±0.03^{c}	6.07±0.02^{d}
8th day	S	6.55±0.07^{a}	6.37±0.03^{b}	6.42±0.03^{a}	6.32±0.03^{b}	6.32±0.03^{b}	6.21±0.01^{c}
10th day	S	S	S	S	6.41±0.01^{a}	6.43±0.02^{b}	6.31±0.01^{c}

LUO: *Laurus nobilis* oil; OLO: Olive oil; MO: *Moringa oleifera*; S: Spoiled. Different small superscripted letter is significantly different at $p < 0.05$

Table 3. TBA values of untreated and treated beef Kofta samples during cold storage period at 4°C (Mean±SE).

Storage days	Control	0.5% LUO	1% LU O	0.5% OLO	1% OLO	0.5% MO	1% MO
Zero	0.22±0.01^{a}	0.21±0.01^{a}	0.21±0.02^{a}	0.2±0.02^{a}	0.2±0.04^{a}	0.21±0.02^{a}	0.20±0.03^{a}
2nd	0.72±0.03 ^{a}	0.42±0.03^{b}	0.33±0.01^{c}	0.38±0.01^{b}	0.30±0.03 ^{c}	0.31±0.03^{c}	0.28±0.01^{d}
4th	0.88±0.02^{a}	0.64±0.01 ^{b}	0.56±0.02^{c}	0.59±0.02^{b}	0.52±0.02^{c}	0.53±0.02^{c}	0.33±0.02^{d}
6th	1.01±0.03^{a}	0.83±0.02^{b}	0.76±0.01^{c}	0.79±0.01^{c}	0.68±0.02^{d}	0.70±0.02^{d}	0.45±0.02^{e}
8th	S	0.87±0.02^{a}	0.85±0.02^{b}	0.86±0.02^{b}	0.75±0.03^{c}	0.78±0.02^{c}	0.66±0.01^{d}
10th	S	S	S	S	0.86±0.01^{a}	0.87±0.01^{a}	0.82±0.01^{b}

LUO: *Laurus nobilis* oil; OLO: Olive oil; MO: *Moringa oleifera*; S: Spoiled. Different small superscripted letter is significantly different at $p < 0.05$

Table 4.TVB-N values of untreated and treated beef Kofta samples during cold storage period at 4°C (Mean±SE).

Storage days	Control	0.5%LUO	1% LU O	0.5% OLO	1% OLO	0.5% MO	1% MO
Zero day	7.6±0.5^{a}	7.3±0.4^{a}	7.2±0.2^{a}	7.3±0.6^{a}	7.1±0.5^{a}	7.2±0.5^{a}	7±0.03^{a}
2nd day	12.3±1.2 ^{a}	10.4±0.5^{b}	9.1±0.7^{c}	9.3±0.3^{c}	8.5±0.3^{d}	8.6±0.6^{d}	8.1±0.01^{d}
4th day	18±0.9^{a}	14.3±0.7 ^{b}	12.2±0.5^{c}	13.1±0.4^{c}	11.8±0.4^{d}	11.9±0.5^{d}	9.5±0.02^{e}
6th day	20±0.03^{a}	16.1±0.5^{b}	14.3±0.8^{c}	15.4±0.6^{c}	13.2±0.5^{d}	12.5±0.4^{d}	11.2±0.02^{e}
8th day	S	18.6±1.1^{a}	17.2±0.6^{b}	17.4±0.7^{b}	15.3±0.3^{c}	16.9±0.4^{c}	15.1±0.01^{c}
10th day	S	S	S	S	19.1±0.5^{a}	19.2±0.5^{a}	17.5±0.01^{b}

LUO: *Laurus nobilis* oil; OLO: Olive oil; MO: *Moringa oleifera*; S: Spoiled. Different small superscripted letter is significantly different at $p < 0.05$

Discussion

Natural preservatives have emerged as alternatives to synthetic preservatives (Marrone *et al*., 2021). Natural preservatives have potential antioxidant activity and reducing negative health effects, however meat and meat products containing synthetic additives are a major concern for human health (Yong *et al*., 2021). Hence the use of natural preservatives rather than synthetic became essential to researchers and meat manufacturers.

The sensory parameters as odor, color, appearance and texture are the first and primary factors for consumer acceptance and marketability of meat products, in this research, the sensory evaluation of different treated beef kofta samples during cold storage (4°C) was improved and extended shelf-life by using *Laurus nobilis*, *Moringa oleifera* and Olive oils compared to the untreated (control) samples at the 0, 2nd, 4th, 6th, 8th and 10th days of cold storage period.

The obtained results in Table 1, showed that the best sensory quality was achieved in beef kofta samples that were treated with 1% *Moringa oleifera* oil, followed by those treated with 1% Olive oil as compared to control samples, also it was shown from the present study that addition of 1% Laurel oil to beef kofta samples caused good improvement in the overall acceptance compared to control and the higher concentration of Laurel oil (1%) gave better sensory quality than lower concentration (0.5%) and in general the higher concentrations of used oils gave better sensory quality than the lower concentrations.

Also, the obtained results in Table 1, showed that the addition of Laurel oil at concentration of 1 % improved sensory parameters of beef kofta and these results are similar to those obtained by Tometri *et al*. (2020), according to their results, Laurel leaf extract can be used to improve the sensory parameters of meat without causing undesirable odor. 1% MO could extend the shelf life of meat without causing any objectionable odor or changes in the sensory quality. These results are the same results obtained by Rahman *et al*. (2020). On the other hand, addition of 1% OLO to beef kofta samples caused good improvement in the overall acceptance of them compared to control one, this may be due to the delay of bacterial growth and these results came in agreement with those recorded by Aminzare *et al*. (2019).

As reported in Table 2, *Laurus nobilis*, *Moringa oleifera* and Olive oils oils usage at concentrations of 0.5 and 1% showed decreasing in pH values than control samples, also increasing the concentration of oils (1%) was more effective than low concentration (0.5%) in decreasing pH values. It was proved that the addition of 1% LUO to beef kofta samples led to a significant reduction in pH value compared to control one because

oil addition could extend sample shelf-life for its polyphenols content especially Alpha-Tocopherol, same results were recorded by Youssef *et al*. (2021) who mentioned that pH values decrease over the storage time for treated samples with Laurel leaf extract compared to control samples. As well as, the obtained results in Table 2 showed that 1% MO demonstrated the highest significant ($P<0.05$) lowering effect on pH values than those of control samples, this may be due to an activation effect of this oil as antioxidant and these results agreed with Ezzat *et al*. (2020) who reported reduction in pH values of the sausages processed by M. oleifera leaves and seeds extracts in comparison with the control. Also, marked reduction in pH value in beef kofta samples treated with 1% Olive oil indicating that it is a powerful source of polyphenols has antioxidant properties capable of increasing beef kofta shelf-life similar to results obtained by Saleh *et al*. (2020).

TBA (mg malonaldehyde equ/Kg) values is used as an indicator of lipid oxidation in meat during storage and when TBA values reach 0.9 the rancid flavor is initially detected in meat (ES, 2006). It was monitored by measuring TBA nmol/g, results are shown in Table 3, the treated Samples had lower TBA values than control sample during cold storage period also by increasing concentration of oils (1%), it was more effective than low concentration (0.5%) in decreasing TBA values. Lower TBA values were recorded in samples treated with 1% LUO indicating that this oil has antioxidant activity due to its polyphenolic content particularly Phenolics and flavonoids, these results agreed with the results of Akcan *et al*. (2017), who added that addition of 1% MO oil to beef kofta samples led to a significant reduction in TBA value compared to control one and these results were similar to that obtained by Ibrahim *et al*. (2017). On the other hand, addition of 1% OLO to beef kofta samples led to a significant reduction in TBA value compared to control one and these results were similar to that obtained by Rubel *et al*. (2021) who conveyed that Olive leaf extract can be used for meat preservation due to its antioxidant effects thanks to its phenolic content.

TVBN is an indicator of meat product quality, estimation of it showed marked decreasing in the treated samples than control sample during storage period. Also, increasing the concentration of oils (1%) was more effective than low concentration (0.5%) in decreasing TVBN values (Table 4). Addition of 1% LUO to beef kofta samples led to a significant reduction in TVBN value compared to control one and these similar to that recorded by Youssef *et al*. (2021) who mentioned that TVBN values decrease over the storage time for treated samples with Laurel leaf extract compared to control samples. As well as samples treated with 1% MO to beef kofta samples led to a significant reduction in TVBN value compared to control one and came in the same line with those recorded by Elhadi *et al*. (2017). Also, according to the results in Table 4, adding 1% Olive oil to beef kofta samples led to a significant reduction in TVBN value compared to control one and this agrees with Saleh *et al*. (2020).

Conclusion

The results of this study indicated that 1% Laurel, 1% Moringa and 1% Olive oils maintain the sensory attributes of beef kofta samples during storage at chilling temperature, contain rich sources of safe bioactive and natural antioxidants compounds such as phenols. Phenols play an important role in reducing fat oxidation, inhibiting protein degradation, significant decrease in pH, TVN and TBA, increasing fat stability, values and the shelf-life of beef kofta, which are a highly consumed product. So, it is suggested that addition of these oils (1% Laurel, 1% Moringa and 1% Olive oils) to meat and its products as natural preservatives could improve their quality and serve consumer needs as alternative to synthetic ones.

Conflict of interest

The authors declare that they have no conflict of interest.

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