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Examination of microbial and chemical properties of chicken fillet treated with *Saturejarechingeri* essential oil, sodium dodecyl sulfate and citric acid during refrigerated storage

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ABSTRACT

The effects of *Saturejarechingeri* essential oil (*Sr*-EO), sodium dodecyl sulfate (SDS) and citric acid on increasing the shelf life of chicken fillets during refrigerated storage were investigated. The treatments included 28 chicken fillets divided into four groups, with three replicates each. Each group was immersed in a solution containing normal saline (control), 0.5% *Sr*-EO, 0.5% *Sr*-EO + 0.5%SDS,or 0.5% *Sr*-EO + 0.5%SDS + 0.1% citric acid for 15 min and refrigerated for 15 days. Bacterial quality (mesophilic and psychrophilic total counts), chemical analysis (pH, TBA, and TVN), and sensory evaluation were performed on days 0, 3, 6, 9, 12, and 15. The bacterial load of mesophilic and psychrophilic bacteria increased over time for all four groups, but the number of bacteria in *Sr*-EO + SDS + citric acid group for mesophilic microbial index and in *Sr*-EO + SDS group forpsychrophilic microbial index was less than that in other samples. At the end of storage time, the highest TVN value was observed for control group (41.06 ± 8.29 g / 100 g) and the lowest value (33 mg / 100 g) was found for *Sr*-EO+SDS +citric acid group followed by *Sr*-EO+SDS and*Sr*-EO groups. There were no significant differences in the TBA value and pH between the treatment and control samples. The control group showed undesirable and unacceptable sensory properties on day 6 whereas the sensory factors of *Sr*-EO and SDS+*Sr*-EO groups were within the optimal range of consumer acceptance until days 9 and 6, respectively. The results showed that compared to controls, theSDS+*Sr*-EOsolution was more effective in extending the shelf life of refrigerated chicken fillets to four days.This type of combined treatment could be a useful way to increase the refrigerated storage time of chicken meat.

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1- Introduction

Chicken is a highly perishable food that will deteriorates within 4-10 days even when it is refrigerated [1]. Fresh meat products are usually marketed at refrigerated temperature (2-5°C). Lipid oxidation and microbial growth can occur during refrigerated storage. Chicken meat spoilage can cause huge economic losses to producers; therefore new methods need to be developed to extend the shelf life and improve the overall quality of meat [2]. To retard or minimize the oxidative spoilage of foods, effective synthetic antioxidants are added to the products; however, owing to their potential carcinogenesis [3]. and the lack ofconsumer acceptance , natural antioxidants have recently attractedmuch attention; So, there is a growing interest in identifying new and natural antioxidants that can be used in place of synthetic compounds [4].

Saturejarechingeri belonging to the *Lamiaceae*family, is one of an exclusive savory species in southwestern Iran [5]. *S.rechingeri* is commercially important (medicinal, food, and cosmetic applications) due of its high carvacrol content in the essential oilsand free phenolic acids [6].In traditional medicine, it is used as a sedative, disinfectant, decoction, and spice. In recent years, extensive studies have been conducted on the biological and medicinal effects of this plant including its antioxidant, antimicrobial, anti-diabetic, analgesic and anti-inflammatory properties and interesting results have been obtained. Its antimicrobial effects have beenstudied in vitro and demonstrated by many researchers. Carvacrol and thymol have been reported to play key roles in the antimicrobial activity of *S. rechingeri*essential oil (*Sr*-EO). Thymol and carvacrol are also found in other plants, such as thyme, but their high proportion in *S.rechingeri* is responsible for thiercharacteristic antimicrobial effects [7,8].

Sodium dodecyl sulfate (SDS) is a potent alkaline sulfate microbicide and a highly effective anionic surfactant that kills bacteria by denaturing cell surface proteins. SDS is also a common ingredient used in cosmetics and detergents and is used in the laboratory as a protein solvent. It is a safe and healthy substance, with no adverse effects on human health [9]. In recent years, the use of SDS as a disinfectant in the food and equipment industry has attracted increasing attention. The effect of SDS, individually or in combination with other substances on reducing bacterial contamination has been studied in beef[10],chicken breast meat, and blueberry[11,12]. The use of citric acid at standard concentrations as a flavoring in food is common and harmless. The use of citric acid along with other disinfectants has a synergistic effect on reducing microbial count[13, 14].

To date the effect of *Sr-EO* individually or in combination with SDS and citric acid, on the shelf life of chicken meat has not been studied. Therefore, in the present study, we investigated the effects of *Sr-EO*, SDS, and citric acid on the shelf life of chicken meat.

2. Materials & methods

2. 1.Extraction of essential oil and analysis of its compounds

The leaves of *S.rechingeri* were collected from Dehloran region located in Ilam province, separated from the stem, dried in the shade, and then crushed in a mill. The essential oil was extracted usingthe water distillation method and a Clevenger apparatus. The essential oil yield was 3.41% (3.41 ml essential oil per 100 g of dried plants). The prepared essential oil was injected into a GC/MS instrument(Agilent 5977B, USA) to characterize its constituents.The capillary column was HP-5MS (5% phenyl methyl

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silicone and 95% dimethylpolysiloxane), (length: 30m; internal diameter: 0.25mm and 0.25µm film thickness). The column temperature program was set as follows: the oven temperature was maintend at 60 °C for 1 min, changed from 60°C to 250 °C at 5 °C/min, and maintained at 250 °C for 2 min. The Injection volume was 0.2 µL and the temperature of the injector was 250°C. The carrier gas was helium with a purity of 99.99%, constant flow rate 1.1ml per min, and split ratio of 1:100. . The procedure was operated in e electron impact mode at 70 eV. GC-MS analysis was performed in triplicate.

2. 2.Preparation and treatments of samples

Fresh chicken fillets were purchased from Ahwaz retail market on the day of slaughter. 28 portions of fillets weighing 100-120 g were separated and manually prepared for treatment. They were washed withtap water and placed on a UV-sterilized stainless steel colander to remove excess water. The colander was then placed in alaminar hood for 5 min. The fillets were divided into four groups and placed separately in UV-sterilized plastic containers, and200 mL of each treatment solution was transferred to each container (Table 1).Chicken fillets were immersed in the solution for 15 min at room temperature.

Table 1: Different treatment solutions

Treatment 1	Normal saline as control
Treatment 2	0.5% *Sr*-EO
Treatment 3	0.5% *Sr*-EO + 0.5% SDS
Treatment 4	0.5% *Sr*-EO + 0.5% SDS +0.1% citric acid

After 15 min, the fillets were placed in sterile UV-sterilized polyethylene bags. A total of 28 fillets (seven pieces per treatment) were used each time. All samples were refrigerated at 7°C for 15 d. Sampling was performed on days 0, 3, 6, 9, 12, and 15, and microbial, chemical, and sensory evaluations wereperformed. All experiments were performed in triplicates**.**

2.3.Microbiological analysis

Chicken fillets (10g) were aseptically transferred into sterile bags containing 90 ml of normal saline and homogenized in a stomacher (Lab blender 400, France) for 1 min. Serial dilutions (1:10) were prepared and each diluted sample (0.1 ml) was cultured on plate count agar. Plates were incubated for 48 h at 37°C and for 10 day at 7°C to count mesophilic and psychrophilic bacteria, respectively [15,16]. The results were expressed as log colony forming units per gram (log CFU/g) [17].

2. 4. Determination of thiobarbituric acid reactive substance (TBARS)

FollowingXiong et al. (2015) with some modifications, 5 g of the sample was homogenized in 50 ml of sterile distilled water. Five gram of Trichloroacetic acid powder wasadded and mixed rapidly to prevent lumping. The mixture was then filtered andtrichloroacetic acid solution (10%) was added until the volume reached 50 ml. Then, 3 ml of the filtered solution and 3 ml of 0.2 M thiobarbituric acid reagent were mixed in a glass tube and placed in an oven at 95 °C for 45 min. After cooling, the absorbance of the samples was measured at532 nm and the amount of malondialdehyde (mg/kg of fillet) was calculated using the following equation [18]:

TBRS (mg MDA/kg) = Absorbance rate × 7.8

2. 5. Measurement of total volatile nitrogen

Volatile nitrogen content was achived by Kjeldalapparatus. The chicken samples (5 g) and distilled water (60 mL) were mixed and transferred into a tube containing 1 g of magnesium oxide (MgO). The distillate was absorbed using 40 ml aqueous solution of 2% boric acid containing 0.5

ml of tashiro's indicator solution. The boric acid solution was titrated using sulfuric acid (0.1 N) solution, and the amount of acid consumed was recorded. The total volatile nitrogen was calculated in mg per 100 g of chicken meat using the following equation[19, 20];

TVN (mg/100 g) = (consumed acid (ml) for sample–consumed acid (ml) of control × 1/4 × 100 / (weight of sample (g)

2. 6. Measurement of pH

Chicken samples(10g)were homogenized in 90 ml of distilled water. The pH valuesof the samples were measured using a digital pH meter[21,22].

2. 7. Changes in sensory properties

Raw chicken fillets were evaluated in terms of color, odor, texture,and overall acceptance by a panel offive people (five women, 25-35 years old). Sensory evaluation was performed using a 5-point hedonic scoring system including color (5, no color changes; 1, severe color changes), odor (5, highly desirable; 1,unacceptable), texture (5, firm; 1, very soft), and total acceptance (5, highly desirable, 1, highly unacceptable). The acceptance score for human consumption of chicken fillets was 4[23, 24].

2. 8. Statistical analysis

Data were analyzed descriptively and analytically using SPSS version 16. Quantitative data analysis (TBA, TVN, PH and logarithm of mesophilic and psychrophilic bacteria) were performed by variance analysis with repeated measurements and LSD supplementary tests. Qualitative data analysis (odor, color, texture, and total acceptance) was performed using Friedman and Kruskal-Wallis tests. Statistical significance was set at $p \leq 0.05$.

3. Results

3.1. Chemical compositions of the *Sr*-EO

The constituents of *Sr*-EO were analyzed by GC/MS are presented in Table 2. The main compounds were carvacrol (86.91%), gamma-terpinene(2.84%), *p*-cymene (2.08%) and carvacryl acetate (1.29%).

Table.2. Chemical compositions of the *Sr*-EO

No	Compound	%	RI	RT
1	Alpha-tujene	0.36	924	5.011
2	Alpha-pinene	0.2	932	5.165
3	Beta-myrcene	0.7	988	6.365
4	Phellandrene	0.12	1002	6.711
5	Alpha-terpinene	0.73	1014	7.006
6	P-cymene	2.08	1020	7.199
7	Gamma.terpinen	2.84	1054	8.059
8	Cis-sabinenehydrat	0.19	1065	8.283
9	Alpha-terpinolene	0.1	1086	8.828
10	Linalol	0.55	1095	9.098
11	Borneol	0.15	1165	10.913
12	Terpinene-4-ol	0.81	1174	11.221
13	Alpha terpineol	0.19	1186	11.593
14	Carvacrol methyl ether	0.12	1241	13.095
15	Thymol	0.31	1289	14.602
16	Carvacrol	86.91	1298	15.064
17	Carvacryl acetate	1.29	1370	17.2
18	Trans-caryophyllene	0.45	1417	18.676
19	Beta-bisabolene	1.05	1505	21.165
20	Cis-alpha-bisabolene	0.22	1506	22.057
	Sum	**99.37**		

RI: Retention index / RT: Retention Time

3. 2. Microbial changes

In general, the total counts of mesophilic and psychrophilic bacteria in all four treatments increased over time(Fig 1 and Fig2). The growth rate of mesophilic bacteria in samples treated with*Sr*-EO+SDS+citric acid and in samples treated by SDS+*Sr*-EO was lower than that in the other treatments. The International Commission on Microbiological Specifications for Foods (ICMSF, 1998) statedthat the acceptable level of total bacteria for fresh meat is<7log CFU/g and above this level, meatbegins to spoil and does not recommend.

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The average mesophilic bacterial load increased in all control groups (Fig 1). It reached 7.24 ± 0.16 log (CFU/g) exceeding the acceptable level on day 6 of storage.However, for the other three treatments, the amount was less than seven until day 6 of storage. Given the obtained results and the determined minimum allowable microbial load for meat to be 7 logCFU/g, it was concluded that the population of mesophilic bacteria on day 6 of storage for the control group exceeded the allowable range; however, for other treatments, it exceeded the limit on day 9. In fact, the use of *Sr-EO*, SDS, and citric acid at the concentrations used could keep the population of mesophilic bacteria within the permitted range until day 6 of storage.

The average psychrophilic bacteria load also increased for the control group and other treatment groups (Fig 2). The logarithm of psychrophilic bacterial load on day 6 of storage for the control, *Sr-EO* and *Sr-EO*+SDS+citric acid groups exceeded the acceptable value (7logCFU/g) however; for *Sr-EO*+SDS,it was less than 7 logs until day 6.

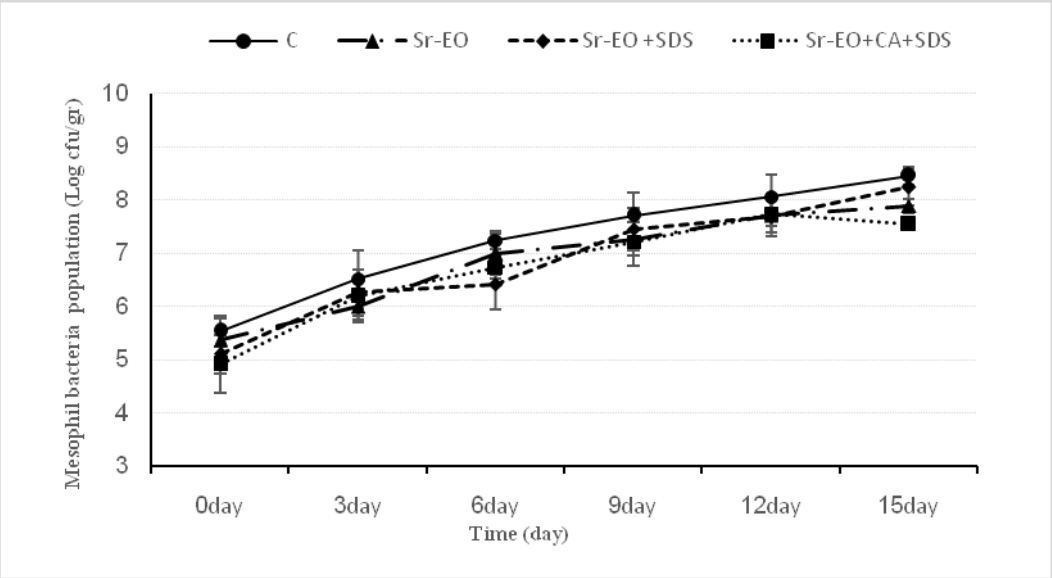

Fig. 1. Changes in total mesophilic count (log CFU/g) of chicken fillets during storage at 4 °c

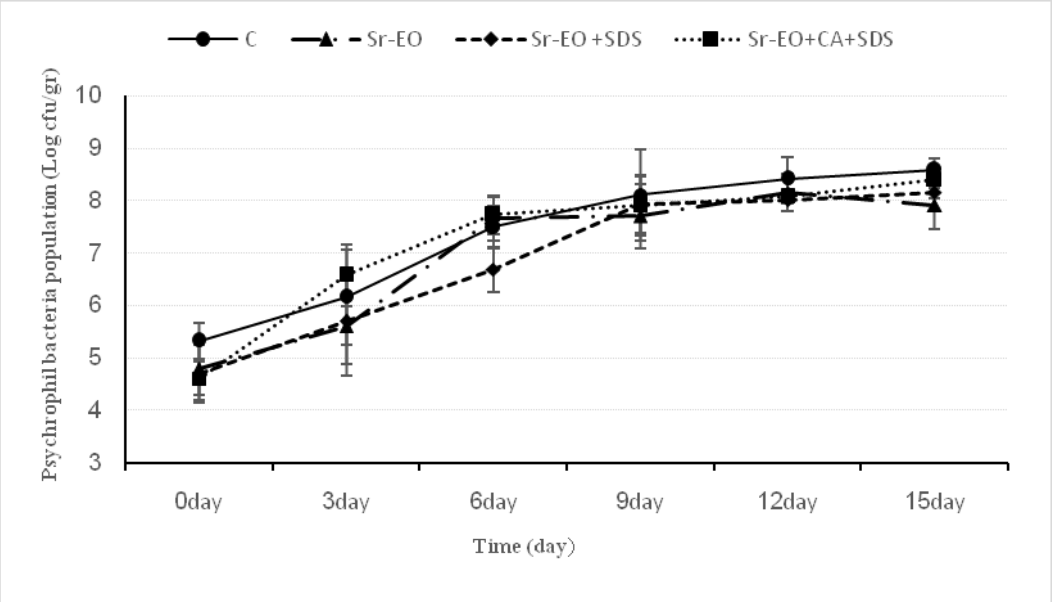

Fig. 2. Changes in total psychrophilic count (log CFU/g) of chicken fillets during storage at 4°c.

3. 3. Measurement of TBA value

According to Fig 3, the changes in the amount of thiobarbituric acid during the storage period of 15 days showed an increasing trend in all treatment groups. So that this increasing trend in the control group was similar to the *Sr*-EO+SDS+citric acid group. Also, *Sr*-EO and *Sr*-EO+SDS group showed similar changes.

At the end of the storage period, the highest amount of TBA in the *Sr*-EO +SDS+citric acid group was 0.60±0.01 mg MDA/kg and the lowest amount of TBA in the *Sr*-EO group was 0.56±0.6 mg MDA/kg and in the *Sr*-EO+SDS group was obtained as 0.56±0.03 mg MDA/kg. Statistical analysis showed that the time has a significant effect on the amount of TBA ($P<0.001$). But the group and the interaction between group and time have no significant effect ($P>0.05$).

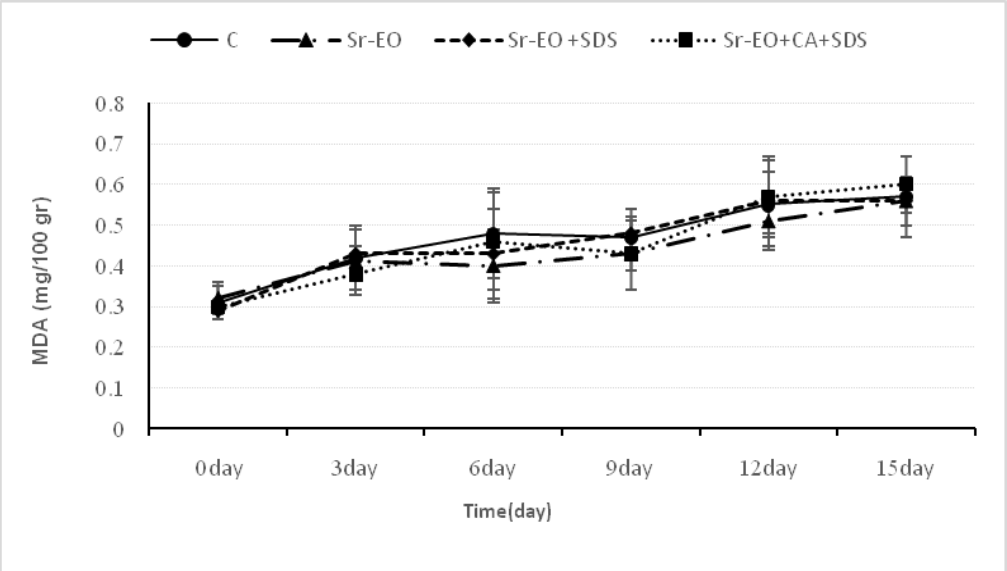

Fig. 3. Changes in TBA value (mg MDA/kg) of chicken fillets during storage at 4 °c.

3. 4. Measurement of TVN value

Figure 4 shows the changes of TVN in chicken fillet samples during the storage period.The trend of changes in volatile nitrogen bases was increasing for all treatments during 15 days of storage. This increase was not significant for control group, *Sr*-EO and *Sr*-EO+SDS+citric acid group. However for SDS+*Sr*-EO group, the increasing trend on day 0 was significantly different from other days. At the end of the storage period, the highest TVN value (41.06 ± 8.29 g / 100 g) was observed for control sample and the lowest value (33 mg / 100 g) was found for *Sr*-EO+SDS+citric acid group followed by *Sr*-EO+SDS and *Sr*-EO groups. Given the allowable TVN values, it exceeded the permitted range in control group on day 12, however in other treatments, the rate of increasing trend for TVN was much slower than in control group and was in the desirable range until day 12.

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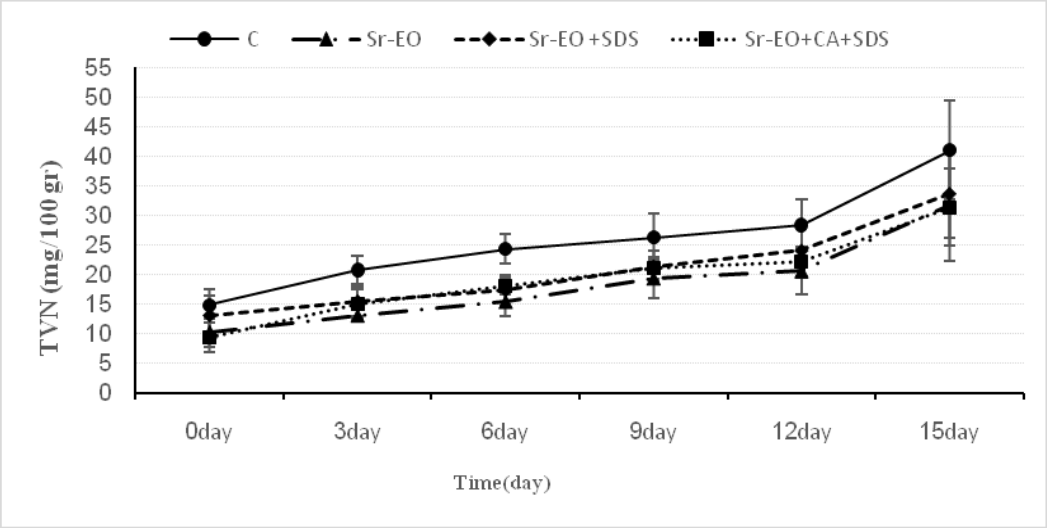

Fig. 4. Changes in TVN value (mg/100g) of chicken fillets during storage at 4 °c.

3. 5. Measurement of pH

The maximum and minimum pH values were 5.78 and 6.42 found respectively for the *Sr*-EO group and SDS+*Sr*-EO groups. In this study, the type of treatment did not have a significant effect on the pH value of the samples. The pH of the treatment groups was almost the same and only in the *Sr*-EO treatment, the lowest pH values were observed on days 7, 9 and 15.

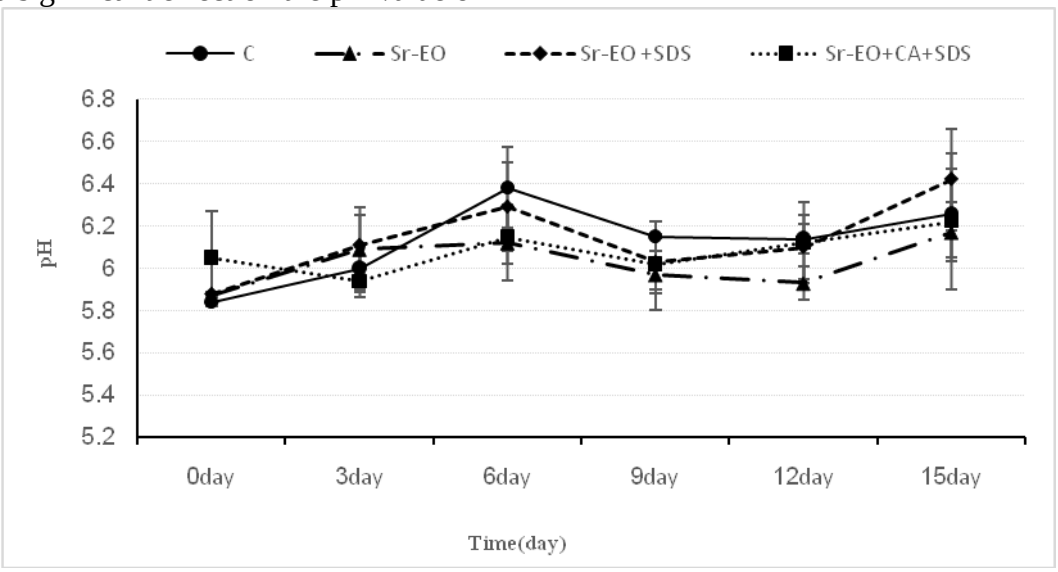

Fig. 5. Changes in pH value of chicken fillets during storage at 4 °c.

3. 6. Results of sensory tests

The results of the general acceptance of the samples during the storage period using the 5-point method are presented in Table 3. The statistical analysis between the groups by the type of treatment and time, with Friedman and Kruskal-Wallis test, showed that there is a significant difference between the groups in terms of color, smell, texture and overall acceptance ($P<0.05$).

The control group was unacceptable on day 6 regarding the examined four factors. The *Sr*-EO group was the best treatment, within the acceptablerange until day 9 of storage. *Sr*-EO+SDS group was also in the

acceptable range until day 6 of storage in terms of color and texture, and day 9 of storage in terms of texture. The 4th treatment containing citric acid was not acceptable and had only an acceptable odor until day 15, while its color and texture were not acceptable. The data showed that citric acid, at the concentration used had limited antimicrobial effects on the samples. In this study, treatment with citric acid resulted undesirable color and texture changes. Therefore, *Sr*-EO+SDS +citric acid treatment was not effective in extending the shelf life of the raw chicken fillets. The best treatment in terms of sensory evaluation and panelist acceptance was the*Sr*-EO group until day 9 of storage, followed by *Sr*-EO+SDS group until day 6 of storage.

4. Discussion

The results showed that, in general, the treatment of chicken fillets with solutions containing *Sr-EO* with or withoutSDS was effective in reducing the bacterial load during storage in the refrigerator.As mentioned in results, *Sr-EO*+SDS could be more effective in terms of psychrophilic bacterial count, which might be due to the effect of SDS on growth inhibition.

SDS as an anionic surfactant able to disrupt membranes and denature proteins, so by the mechanism can kill bacteria [25].25(Woo et al., 2000). The decontamination of eggshell by SDS and citric acid has been already reported. Combination of SDS with components of essential oils may have an synergistic killing effects on bacteria [26].(26) Moreira et al. (2007) reported that the effectiveness of essential oils in foods depends on the concentration of the EO used, the composition of the food and the storage temperature because of the possible interactions between the EOs and the constituents of the food as well as the presence of protein and/or fat molecules that act as physical barriers against antimicrobial agents protecting the microorganisms against antimicrobial activity [27].

Chouliara et al. (2007) reported that chicken breast treated with oregano essential oil (1%) had a more potent protective effect that treated with 0.1% oregano essential oil. The concentration of 1% EO extended the shelf life up to 19-20 days while 0.1% EO increased the shelf life by only up 1-2 days. The results obtained using *Sr-EO* and *Sr-EO*+SDS treatments in terms of increasing the shelf life of chicken fillets in the present study were consistent with the effect of the oregano EO in extending the shelf life up to 1-2 days[28]. The effect of *Saturejahortensis* essential oil on the quality and shelf life of chicken meat over refrigerated storage was also investigated [29]. In their study, pieces of meat were soaked for 2 hrs in *S. hortensis* treatment solutions at concentrations of 1, 3%, and 5%, and the results of microbial control showed that all three concentrations were effective in inhibiting the growth of microorganisms and increasing the shelf life of chicken meat by up to 2 days. A concentration of 5% had the greatest effect and reduced the total microbial load from 6.71 to 5.69 log cfu / g compared to the control. They used higher concentrations (up to 5%) and longer treatment times (2 h) in comparison to the current study, in which the treatment time of chicken fillets was 25 min and the concentration of *Sr-EO* was 0.5%.

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Table.3. Changes sensory factors scores of chicken fillets during storage at 4°c

Group	Storage time (day)	Color	Odor	Texture	General acceptance
Control	0	Aa 5±0.00	Aa 5±0.00	Aa 5±0.00	Aa 5±0.00
Sr-EO		Aa 5±0.00	Aa 5±0.00	Aa 5±0.00	Aa 5±0.00
SDS+*Sr*-EO		Aa 5±0.00	Aa 5±0.00	Aa 5±0.00	Aa 5±0.00
Acid+SDS+*Sr*-EO		Aa 5±0.00	Aa 5±0.00	Aa 5±0.00	Aa 5±0.00
Control	3	ABa 4.33±0.44	Aab 4±0.00	ABab 3.66±0.33	Aab 3.66±0.33
Sr-EO		Aa 5±0.00	Aab 4.33±0.33	Aa 4.66±0.33	Aa 4.66±0.33
SDS+*Sr*-EO		ABab 4.33±0.33	Aa 4±0.00	Aab 4.66±0.33	Aab 4± 0.00
Acid+SDS+*Sr*-EO		Bab3.83±0.16	Aa 4±0.00	ABab 3.5±0.28	Aab 3.5±0.00
Control	6	Aa 3.8±0.61	Aab 3.33±0.33	Bab 2.60±0.30	Aab 2.83±0.44
Sr-EO		Aab 4.53±0.46	Aab 4.20±0.41	Aa 4.33±0.17	Aa 4.13±0.13
SDS+*Sr*-EO		Aab 4±0.23	Aa 3.86±0.46	ABab 4.06±0.29	Aab 3.86±0.24
Acid+SDS+*Sr*-EO		Aab 3.06±0.17	Aa 3.53±0.29	ABab 3.40±0.23	Aab 3.26±0.17
Control	9	Aa 3±1.15	Bb 1.86±0.86	Bbc 2.16±0.6	Bb 2.06±0.63
Sr-EO		Aab 4.33±0.33	Aab 4.86±0.13	Aa 4.33±0.33	Aa 4.2±0.2
SDS+*Sr*-EO		Aab 3.76±0.39	Aa 3.86±0.46	Aab 4±0.00	Aab 3.83±0.16
Acid+SDS+*Sr*-EO		Ab 2.80±0.11	Aa 3.53±0.29	ABab 3.46±0.29	ABab 3.16±0.16
Control	12	Bb 1±0.00	Bb 1.33±0.33	Bc 1.33±0.00	Bb 1±0.00
Sr-EO		Aab3.83±0.44	Aa 3.56±0.29	Aa 4.16±0.16	Aa 3.83±0.44
SDS+*Sr*-EO		Aab 3.76±0.12	Aa 3.8±0.1	ABab 3.56±0.23	Aab 3.8±0.2
Acid+SDS+*Sr*-EO		ABb 2.73±0.26	Aa 3.6±0.16	ABab 2.83±0.16	Bb 1.90±0.45
Control	15	Ab 1±0.00	Bb 1±0.00	Ac 1±0.00	Ab 1±0.00
Sr-EO		Ab 2.83±0.44	ABb 2.90±0.45	Aa 2.86±0.46	Aa 2.86±0.46
SDS+*Sr*-EO		Aa 2.86±0.13	ABa 2.96±0.31	Ab 2.66±0.33	Ab 2.80±0.3
Acid+SDS+*Sr*-EO		Ab 2.43±0.43	Aa 3.66±0.16	Aab 2.20±0.2	Ab 1.50±0.28

- Different capital letters in each column indicate significant differences between treatments at each time point ($p < 0.05$).
- Different lowercase letters in each column indicate significant differences in eachtreatment at different times ($p < 0.05$).

Fat oxidation in meat generates compounds such as aldehydes, ketones, and alcohols that develop off-flavors and reduce the nutritional value of meat. The TBA value indicates fat oxidation, that is the amount of oxidation by-products, especially aldehydes, which are produced from the breakdown or oxidation of hydroperoxides. TBA is widely used to measure the degree of fat oxidation. Byun et al. (2003) reported that 2 mg of malondialdehyde per kg of meat is an indicator of the onset of fat oxidation and sensory changes in chicken [30]. Teets and Were (2008) also reported that 3 mg malondialdehyde/kg indicated the onset of oxidative spoilage [31]. In the present study, the TBA value for all treatments was much lower than this range probably due to the low fat content of chicken fillet meat since the amount of fat and fatty acid composition are crucial factors fat

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oxidation during storage. There was a significant difference among the treatments. On day 0, the TBA value for all treatments was approximately 0.3, which is in agreement with the results obtained by Hakim et al. [32]. In the current study, changes in TBA value during 15 days of refrigerated storage, except on day 9, increased for all treatments.

TVN value is an indicator of meat product freshness. It includes a wide range of volatile compounds such as ammonia, methylamine, dimethylamine, and other similar compounds that are produced when spoilage and microbial growth occur [33]. High levels of bacterial activity can increase the TVN value, because bacteria convert compounds such as tyramine oxide, peptides, and amino acids into volatile bases [34]. In a study conducted to preserve the quality of chicken breast fillets using sodium alginate incorporated with lemon verbena and clove essential oils, the lowest TVN value (36.66 mg/100 g) was obtained with 0.5% lemon verbena EO after 15 daysof refrigerated storage, which is consistent with the results of the current study [35]. In a study by Ghanbari*et al*., the effect of nanoemulsions of red grape seed essential oil at concentrations of 1%, 2%, and 5% on the shelf life of freshly packed chicken fillets at refrigerator temperature was investigated. The results showed that the nano essential oil of red grape seed at a concentration of 5% can reduce the increase in organic nitrogen bases and peroxide number during storage at 4°C by gradually releasing the substance [36].Similar to the current study, other researchers observed that chicken meatball samples treated with thyme essential oil caused a significant decrease in TVN value compared to control samples during frozen storage periods. They reported that the addition of thyme essential oil had a positive effect on storage stability and a slight change in physical properties and quality attributes [37].

Changes in pH could be a useful way to evaluate qualitative changes in meat during storage.An increase in pH indicates a loss of quality. In contrast, the decrease in pH could be due to acid, which is a common metabolite from growth of a number of bacteria including lactic acid bacteria.The pH of the sampleswas not affected by various treatments in the current study,andthe results are consistent with those obtained by Petrou et al. (2012), who investigated the natural antimicrobial effect of 1.5% chitosan, 0.25% v/w oregano, and their combination on the shelf life of chicken breast meat packed in modified atmosphere packaging during storage at 4°C[38]. These findings are consistent with the results obtained by Melo et al. (2012), who studied the effect of cellulose acetate-based active films at two concentrations of rosemary essential oil (20% and 50% v/w) on chicken breast meat during refrigerated storage. The initial average pH was 6.08 and the maximum value was 6.13 on day 6;therefore there was no significant difference in pH values among the treatments[39].

Changes in sensory properties are one of the main reasons for the reduced shelf life of meat.Microbial growth and fat oxidation resultin the production of undesirable metabolites, thereby reducing sensory properties[22].The results of the sensory evaluation are consistent with those obtained by Hartanti et al. (2019), who investigated the effects of lemongrass and lemon basil essential oils individually or in combination at different concentrations on microbial quality and physical properties, including color, odor, texture, glaze, and slime of chicken fillet meat during refrigerated storage for 9 days. The results showed that the combined treatment had a better performance and was acceptable in terms of color and glaze until day 9 of storage. In addition, the rate of change in texture and odor in the combined treatment was slower than that in the EO and control groups[40]. Heydarian et al. (2015) also

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studied the antioxidant and antimicrobial effects of aqueous rosemary extract at concentrations of 1, 3% and 5% on the quality and shelf life of chicken meat for 5 d at 4 °C. Sensory evaluation results revealed that the sensory scores decreased significantly over time. The 3% treatment resulted in the highest sensory scores compared to the control and the 1 and 5% treatments. The 1 and 5% treatments were acceptable until day 3 and the 3% treatment until day 5[41].

5. Conclusion

Given the sensory results and total acceptance of chemical and bacterial properties, the shelf life of chicken fillets for the control group was 2- 3 days, for *Sr*-EO group 3- 4 days, for *Sr*-EO+SDS group 6-7 days, and for *Sr*-EO+SDS+citric acid group 3-4 days. The results showed that SDS+*Sr*-EO treatment was more effective in extending the shelf life of chicken fillets; therefore, it can be used to increase the refrigerated storage time of chicken meat by up to 4 days or to manufacture new products with a special aroma to meet consumer expectations. Further research is required to determine the best combination to achieve better results.

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بررسی خواص میکروبی و شیمیایی فیله مرغ تیمار شده با اسانس مرزه رشینگری، سدیم دودسیل سولفات و اسید سیتریک در طی نگهداری در یخچال

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چکیده

در این پژوهش، تاثیر اسانس گیاه مرزه رشینگری(*Saturejarechingeri*)، سدیم دودیسیل سولفات (SDS) و اسیدسیتریک بر روی افزایش ماندگاری فیله مرغ در یخچال بررسی گردید. طی ۳ تکرار و هر بار ۲۸ قطعه فیله مرغ تهیه و به ۴ گروه تقسیم شدند. هر گروه به مدت ۱۵ دقیقه در محلول‌های حاوی سرم فیزیولوژی (کنترل)، ۰/۵ درصد اسانس مرزه رشینگری، ۰/۵ درصد اسانس+SDS، ۰/۵ درصد اسانس+SDS+اسیدسیتریک(۰/۱) قرار گرفته و سپس به مدت ۱۵ روز در یخچال نگهداری شدند. آزمون‌های شمارش باکتریایی (مزوفیل و سایکروفیل)، آزمون‌های شیمیایی(pH، TBA، TVN) و حسی طی روزهای، ۰، ۳، ۶، ۹، ۱۲ و ۱۵ بر روی نمونه‌ها انجام گرفت. نتایج نشان داد بار باکتریایی مزوفیل و سایکروفیل با گذر زمان در هر چهار گروه روند افزایشی دارد، اما تعداد باکتری‌ها درگروه اسانس+SDS+اسیدسیتریک، برای شاخص میکروبی مزوفیل و در گروه اسانس+SDS، برای شاخص میکروبی ساکروفیل کمتر از گروه‌های دیگر بود. در پایان مدت زمان نگهداری، بیشترین میزان TVN مربوط به گروه کنترل (۸/۲۹ ±۴۱/۰۶ گرم در ۱۰۰ گرم) و کمترین میزان در محدده ۳۳ میلی گرم در ۱۰۰ گرم، به ترتیب مربوط به گروه اسانس+SDS+ اسیدسیتریک و گروه اسانس+SDS و گروه اسانس بود. در خصوص فاکتور TBA و pH اختلاف قابل توجهی بین گروه‌های تیماری مشاهده نشد. ازنظر فاکتورهای حسی نیز، گروه کنترل در روز ششم نگهداری در محدوده نامطلوب و غیرقابل پذیرش قرار گرفت. درحالی که گروه اسانس و گروه اسانس+SDS به ترتیب تا روز نهم و ششم نگهداری در محدوده مطلوب پذیرش انسانی قرارداشتند.نتایج نشان داد که استفاده از تیمار اسانس+SDS در افزایش مدت زمان نگهداری فیله مرغ موثرتر عمل نموده و قادر است که زمان نگهداری گوشت مرغ را دریخچال تا ۴ روز افزایش دهد. این روش می‌تواند به عنوان روشی سودمند جهت افزایش زمان نگهداری گوشت مرغ در شرایط یخچالی به‌کار رود.