Content is avaliable at SCOPUS

Meat Technology — Special Issue 64/2

www.meatcon.rs ▪ www.journalmeattechnology.com

UDK: 664.933:636.592

ID: 126547977

https://doi.org/10.18485/meattech.2023.64.2.65

Original scientific paper

Investigating the influence of rosehip tea marination on lipid oxidation in turkey breast meat

Meltem Serdaroğlu[a], Özlem Yüncü-Boyacı[a], Merih Karaman[a] and Hülya Serpil Kavuşan[a]*

[a] Ege University, Engineering Faculty, Food Engineering Department, 35100 Bornova, İzmir, Turkey

ARTICLE INFO

Keywords:
Turkey meat
Marination
Color
Rosehip
Antioxidant

ABSTRACT

The utilization of natural antioxidants has emerged as a potential strategy to inhibit or delay lipid oxidation in meat and meat products. Rosehip, the fruits of *Rosa canina*, has gained attention as a rich source of bioactive compounds with potent antioxidant properties. In this study, turkey breast slices were marinated in rosehip infusion prepared with varying amounts of rosehip powder (6.67% (R1), 10% (R2), and 13.33% (R3)). Total phenolic content and DPPH activity of the prepared marinades were found to be high. As a result of marinating turkey breast samples with rosehip infusion, a significant decrease in TBARS values was observed. For peroxide values, the marinating process was found to be effective starting from day 5 of storage. The pH of samples fluctuated during storage. Also, rosehip marination caused significant changes in the color parameters of the samples. While L* values of the turkey breast slices marinated with rosehip infusion decreased, a* and b* values increased. As a result, it was concluded that rosehip infusion can be used as a natural antioxidant in meat products.

1. Introduction

Turkey breast meat has gained popularity as a healthy alternative to other meats due to its high protein content (23.03–27.59%) and low fat content (0.42–3.08%). This nutritional profile makes it an attractive choice for health-conscious individuals (*Çelen et al.*, 2016; *Oblakova et al.*, 2016). Additionally, turkey breast meat is a good source of vitamins and minerals, including niacin, vitamin B6, phosphorus and selenium, which play important roles in supporting various body functions and promoting overall health. Despite the high nutritional value of turkey meat, its consumption remains limited, as the low fat content and tenderness of turkey breast meat have a negative impact on consumer preference.

Marination is a widely employed technique used to enhance the market share of meat products. Marination is a processing technique, traditionally used to improve organoleptic qualities and water retention of the meat while prolonging shelf-life (*Alvarado et al.*, 2007; *Kaewthong and Wattanachant*, 2018; *Çınar*, 2022). It offers various benefits such as improving aroma and flavour, enhancing tenderness and correcting color defects (*Barbanti and Pasquini*, 2005). Several studies have reported that marinating turkey breasts leads to improvements in textural and sensory parameters also retards oxidative changes (*Serdaroğlu et al.*, 2007; *Gök and Bor*, 2016; *Augustyńska-Prejsnar et al.*, 2021). Another description of marination in terms

***Corresponding author:** Meltem Serdaroğlu, *meltem.serdaroglu@ege.edu.tr*

Paper received Jun 9th 2023. Paper accepted Jun 21st 2023.
Published by Institute of Meat Hygiene and Technology — Belgrade, Serbia

of morphology is influencing the pH of the tissue to move away from its isoelectric point (around 5.2–5.3 for red meat), creating space between the myofilaments to retain sufficient water (*Önenç et al*., 2004). Wine, vinegar, lemon juice, fruit juices, milk, fermented milk products, oils and salt have been widely used for marinating different kinds of meat (*Goli et al.*, 2011). In addition to these main components, the utilization of fruit and vegetable juices and extracts in marinade solutions has also been investigated because of their antioxidant and antimicrobial properties *(Nile and Park*, 2014; *Afrin et al*., 2016; *Kalaycıoğlu and Erim*, 2017; *Saricaoglu et al.,* 2019; *Van de Velde et al.*, 2019; *Sengün et al.*, 2020).

Rosehip is the pseudo-fruit of the rose bush. Especially *Rosa canina* L. is abundantly rich and considered to be an excellent source of polyphenols and vitamin C (*Fan et al*., 2014). Rosehip contains 2–3 times as much ascorbic acid as kiwi, 3–5 times as much as peppers, and 5–6 times as much as citrus fruits (*Karhan et al.*, 2004). The high content of polyphenols, particularly flavonoids and phenolic acids, in rosehip tea contributes to its antioxidative potential (*Fan et al.*, 2014). These compounds have been reported to scavenge free radicals, chelate metal ions and inhibit lipid peroxidation. Studies investigating the effect of r osehip on lipid oxidation in various food matrices have shown promising results (*İlyasoğlu*, 2014; *Rivera Toapanta et al.*, 2022; *Vlaicu et al.,* 2022). However, there is limited research available regarding the use of rosehip infusion for marinating meat products, specifically turkey breast meat. Therefore, the objective of this study is to investigate the impact of marinating turkey breast meat with rosehip infusion on lipid oxidation, with the aim of assessing its potential as a natural antioxidant strategy to enhance meat quality and extend shelf life.

2. Materials and methods

2.1. Materials

The fresh skinless turkey breast meat was purchased from a local producer in İzmir. The breast samples were received free of visible blood spatter or bruises and had a pH of 5.91 to 5.93. Dried rosehips were obtained from a local herbalist in Izmir. All chemicals used were of analytical grade (Sigma-Aldrich Chemie GmbH, Germany).

2.1.1. Preparation of rosehip infusion

The dried rosehip fruits were ground using a Waring 8011 EB SET2 blender (Stamford, CT) at 2nd speed for 30 sec. The ground rosehips were wrapped in filter paper to obtain the determined concentrations. Rosehip powder was added to distilled water at 100°C at concentrations of 6.67% (10 g/150 mL) (R1), 10% (15 g/150 mL) (R2), and 13.33% (20g/150 mL) (R3) and infused for 30 min. The analysis of the obtained infusion was conducted once it had cooled to room temperature.

2.1.2. Marination and cooking process

The turkey breast meat underwent slicing into slices measuring 1 cm in thickness, 13 cm in length, with an average weight ranging from 100 g to 150 g. Meat slices were randomly submerged in marinade solutions containing various concentrations of rosehip infusion (C, R1, R2, and R3) at a ratio of 1:1 (meat:marinade) in plastic bags. The slices were then left in the marinade solution for 4 hours at 1°C to allow the ingredients to permeate the meat. The control treatment consisted of distilled water only. The samples were then vacuum-packed and sous-vide cooked (WiseBath, Germany) at 80°C until the core temperature reached 73°C. The samples were rapidly cooled to room temperature and then stored at 1°C for 7 days for further evaluation including pH measurement, color evaluation, peroxide analysis and thiobarbituric acid reactive substances (TBARS) analyses.

2.1.3. Analyses

The determination of the total phenolic content (TPC) in the rosehip infusion was carried out utilizing the Folin-Ciocalteu method (*Yılmaz et al*., 2015). DPPH analysis was performed by modification of the methods applied by *Grajeda-Iglesias et al.* (2016). Triplicate measurements of pH values were conducted using a WTW pH 3110 set 2 pH meter from Germany. Color parameters of the turkey slices were determined using a digital colorimeter (Chromameter CR 400, Minolta, Japan) to obtain the color parameters including lightness (L*), redness (a*), and yellowness (b*). The assessment of lipid oxidation was performed by analysing peroxide (*AOAC*, 2012) and TBARS (*Witte et al*., 1970). The impact of rosehip infusion and storage conditions on turkey breast slices was assessed using analysis of variance (ANOVA) followed by Duncan's post-hoc tests in the SPSS software.

3. Results and discussion

3.1. Analysis of the marinade solutions

Table 1 provides a summary of the phenolic content, DPPH values, and pH of the marinade solutions. The marinades exhibited a range of pH 3.58 to pH 3.71. As the concentration of rosehip in the infusion increased, the pH decreased due to the higher acidity. The total phenolic content (TPC) ranged from 138.47 to 241.13 mg GAE/g, while the DPPH values ranged from 33.58 to 52.67 µmolTE/g. Our TPC resth the findings reported in the literature (*Koczka et al*., 2018). Furthermore, both TPC and DPPH values showed an increasing trend with the rise in rosehip concentration in the infusion. This observation aligns with the findings of a previous study (*Orhan et al*., 2012).

3.2. Color

Color parameters of meat samples are given in Table 2. The marination process led to significant alterations in the color parameters (P<0.05). The L* values of marinated meat were lower than those of the control group (P<0.05), indicating a darker appearance of the samples. This finding is consistent with a previous study where camel meats marinated with ginger extract and citric acid also exhibited lower L* values (*Moeini et al.*, 2022). In contrast, the a* and b* values showed a significant increase (P<0.05) compared to the control group (C), indicating a shift towards more red and yellow colours. This color change can be attributed to the natural pigments present in the rosehip infusion, which imparts a red color to the marinade solution. During stor-

Table 1. The pH values, DPPH and total phenolic contents of marinades

Marinade	pH	Total phenolic content (mg GAE/g)	DPPH (µmolTE/g)
R1	3.71	138.47	33.58
R2	3.63	165.13	47.58
R3	3.58	241.13	52.67

R1: 6.67% rosehip tea, R2: 10% rosehip tea, R3: 13.33% rosehip tea

Table 2. Effect of marinade treatments on color parameters

Treatments*	Storage	C	R1	R2	R3
L*ults were consistent wi	0	$67.52\pm1.57^{a,Y}$	$60.63\pm1.25^{b,X}$	$61.21\pm1.19^{b,X}$	$52.93\pm0.69^{c,Y}$
	3	$70.98\pm1.74^{a,X}$	$51.53\pm1.15^{c,Y}$	$61.33\pm1.09^{b,X}$	$51.78\pm1.29^{c,Y}$
	5	$73.44\pm1.32^{a,X}$	$61.62\pm1.78^{b,X}$	$55.64\pm0.78^{d,Z}$	$58.10\pm0.61^{c,X}$
	7	$72.76\pm1.39^{a,X}$	$61.15\pm0.65^{b,X}$	$58.40\pm0.17^{c,Y}$	$57.47\pm0.35^{c,X}$
a*	0	$4.53\pm0.26^{c,X}$	$8.75\pm0.27^{b,Y}$	$8.63\pm0.26^{b,Y}$	$9.74\pm0.44^{a,Y}$
	3	$1.58\pm0.33^{c,Z}$	$10.86\pm0.46^{a,X}$	$7.31\pm0.21^{b,Z}$	$10.41\pm0.37^{a,X}$
	5	$0.52\pm0.23^{d,T}$	$6.47\pm0.43^{c,Z}$	$9.40\pm0.28^{a,X}$	$7.71\pm0.34^{b,Z}$
	7	$2.36\pm0.44^{b,Y}$	$6.98\pm0.57^{a,Z}$	$7.31\pm0.48^{a,Z}$	$7.56\pm0.13^{a,Z}$
b*	0	13.87 ± 0.34^{c}	$21.63\pm0.32^{a,X}$	$17.00\pm1.52^{b,Y}$	$21.06\pm0.49^{a,X}$
	3	14.06 ± 0.86^{d}	$21.79\pm0.15^{a,X}$	$16.31\pm0.40^{c,Y}$	$20.30\pm0.63^{b,X}$
	5	13.86 ± 0.55^{c}	$14.88\pm0.97^{c,Y}$	$19.10\pm0.60^{a,X}$	$17.55\pm0.09^{b,Y}$
	7	14.59 ± 0.35^{b}	$14.88\pm0.99^{b,Y}$	$15.55\pm0.48^{b,Y}$	$16.93\pm0.39^{a,Y}$

* C: distilled water. R1: 6.67% rosehip tea. R2: 10% rosehip tea. R3: 13.33% rosehip tea. $^{a-d}$ Different letters in the same row indicate a significant difference (P < 0.05). $^{X-T}$ Different letters in the same column indicate a significant difference (P < 0.05).

age, the lowest b* value was observed in the control (13.86), while the highest value was observed in the R1 (21.79) (P<0.05), this situation indicates a shift towards a more yellowish hue in groups containing rosehip infusion. Similarly, it has been reported by other researchers that b* values increase with marination (*Augustyńska-Prejsnar et al.*, 2021; *Moeini et al.*, 2022; *Unal et al.*, 2022). *Önenç et al.* (2004) reported that cattle meat samples marinated with citric acid had higher L* and a* values than control.

3.3 pH values

The pH of turkey meat plays a crucial role in determining its quality properties, such as tenderness, water-holding capacity, and microbial stability. Figure 1 presents the pH of the turkey breast slices; the initial pH of samples ranged between 5.75 (R3)–5.90 (C). The meat pH decreased with increasing rosehip concentration in the marinade. In studies using acidic marinade, it was reported that the pH value decreased (*Serdaroglu et al.*, 2007; *Gómez-Salazar et al.*, 2018; *Santos et al.*, 2020; *Cho et al.*, 2021). The R3 treatment had the lowest pH during storage (P<0.05). On day 5 of storage, the pH was increased in all treatment groups compared with at the beginning.

3.4. Lipid oxidation

Marinating with rosehip infusion was highly effective against lipid oxidation of samples. Peroxide values ranged between 1.03–4.10 meqO_2/kg (Table 3). On day 0 and 3, there were no significant differences in peroxide values among the groups (P>0.05). However, on day 5, the R3 group exhibited the highest peroxide value, and on the day 7, the R2 group had the highest value. The fact that the control group had lower peroxide value and higher TBARS value indicates that oxidation progressed faster in this group than in the marinated meat. TBARS values of samples ranged between 0.14–1.91 mg MA/kg. The marination process resulted in a significant reduction in TBARS compared to the control group (P<0.05). The highest value was observed in the control group during storage (P<0.05). The TBARS value, including the control group, was below the accepted limit value (<2 mg MA/kg, *Witte et al.*, 1970) in all samples. This finding indicates that rosehip infusion has antioxidant effects. Consistent with our results, several studies conducted on various meat products and acidic marinades have reported significant reductions in peroxide and/or TBARS values (*Blackhurst et al.*, 2011; *Arcanjo et al.,* 2019; *Rasuli et al.*, 2021). Lipid oxidation is a complex

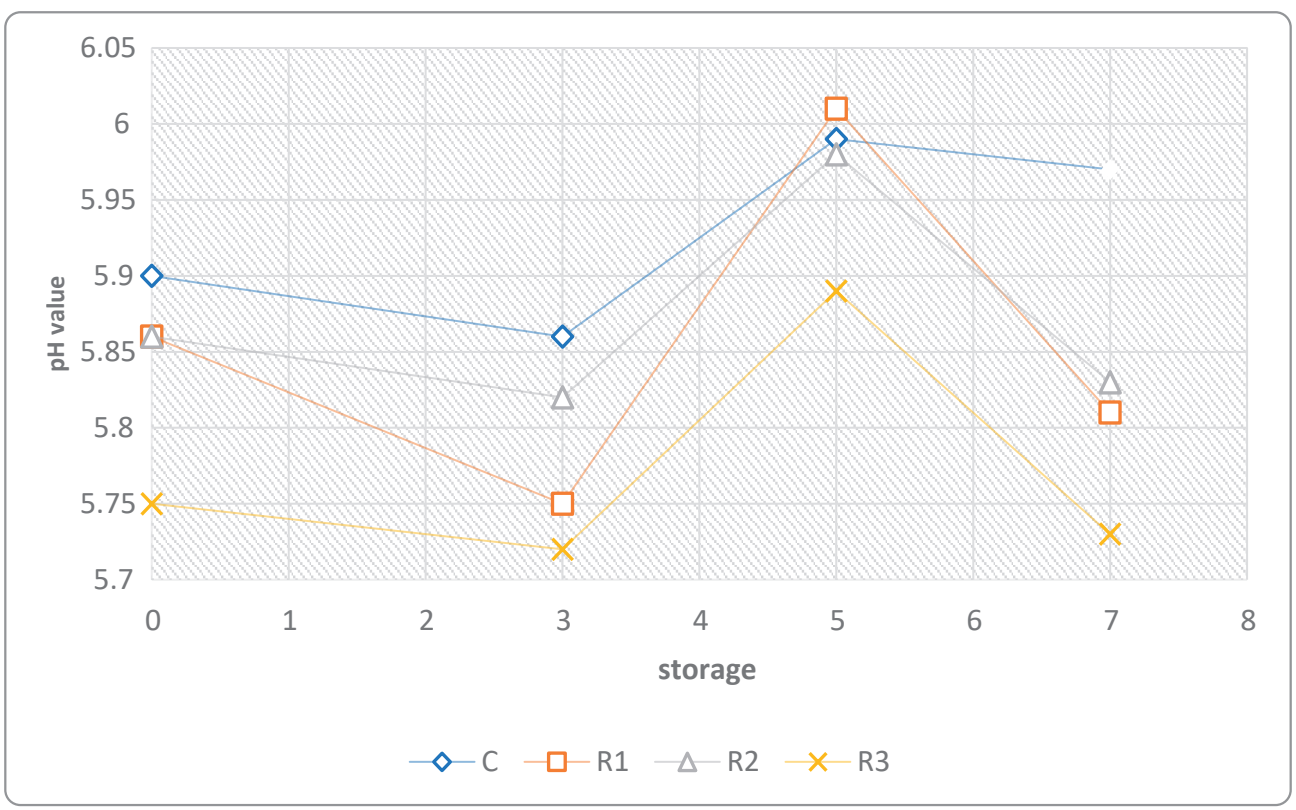

Figure 1. Effect of marinade treatments on meat pH during storage

Table 3. Effect of marinade treatments on lipid oxidation during storage

Lipid oxidation measurement*	Storage (days)	C	R1	R2	R3
Peroxide ($meqO_2$/kg)	0	3.45 ± 0.42^{X}	3.46 ± 0.12^{X}	4.10 ± 0.78^{X}	3.30 ± 0.46^{X}
	3	2.33 ± 0.30^{Y}	2.13 ± 0.81^{Y}	1.80 ± 0.40^{YZ}	2.13 ± 0.46^{Y}
	5	$1.03\pm0.06^{d,Z}$	$1.79\pm0.02^{b,Y}$	$1.57\pm0.06^{c,Z}$	$2.00\pm0.01^{a,Y}$
	7	$2.16\pm0.20^{b,Y}$	$1.33\pm0.10^{c,Y}$	$2.50\pm0.19^{a,Y}$	$1.33\pm0.11^{c,Y}$
TBARS (mg MA/kg)	0	$1.27\pm0.04^{a,Z}$	$0.26\pm0.11^{b,Z}$	$0.29\pm0.01^{b,Z}$	$0.14\pm0.01^{c,T}$
	3	$1.46\pm0.11^{a,Y}$	$0.43\pm0.06^{b,Y}$	$0.24\pm0.01^{c,T}$	$0.25\pm0.01^{c,Z}$
	5	$0.90\pm0.03^{a,T}$	$0.58\pm0.02^{b,X}$	$0.52\pm0.03^{c,Y}$	$0.58\pm0.16^{b,Y}$
	7	$1.91\pm0.02^{a,X}$	$0.63\pm0.01^{c,X}$	$0.64\pm0.01^{c,X}$	$0.67\pm0.01^{b,X}$

TBARS: thiobarbituric acid reactive substances. C: distilled water. R1: 6.67% rosehip tea. R2: 10% rosehip tea. R3: 13.33% rosehip tea. $^{a-d}$ Different letters in the same row indicate a significant difference ($P < 0.05$). $^{X-T}$ Different letters in the same column indicate a significant difference ($P < 0.05$).

chemical process that occurs in meat products, leading to the development of off-flavours, rancidity, and a decline in overall quality (*Gray et al*., 1996).

4. Conclusion

The findings of our study demonstrated that marinating turkey breast slices with rosehip infusion had antioxidative effects, attributed to the high phenolic content of rosehip. The marination process effectively reduced peroxide values after 5 days of storage. Additionally, TBARS values significantly decreased during storage. However, the incorporation of rosehip tea had a notable impact on the color parameters, while pH values decreased with increasing rosehip concentration. Further research should focus on investigating the effects of marinating with rosehip tea on the physicochemical, antimicrobial and technological properties of the product, as well as its application in various meat products.

Disclosure statement: No potential conflict of interest was reported by the authors.

References

Afrin, S., Gasparrini, M., Forbes-Hernandez, T. Y., Reboredo-Rodriguez, P., Mezzetti, B., Varela-López, A. & Battino, M. (2016). Promising health benefits of the strawberry: a focus on clinical studies. *Journal of Agricultural and Food Chemistry*, 64(22), 4435–4449.

Alvarado, C. & McKee, S. (2007). Marination to improve functional properties and safety of poultry meat. *Journal of Applied Poultry Research*, 16(1), 113–120.

AOAC, (2012). 19th ed. Association of Official Analytical Chemists. Gaithersburg. MD. USA.

Arcanjo, N. M., Ventanas, S., González-Mohíno, A., Madruga, M. S. & Estévez, M. (2019). Benefits of wine-based marination of strip steaks prior to roasting: inhibition of protein oxidation and impact on sensory properties. *Journal of the Science of Food and Agriculture*, 99(3), 1108–1116.

Augustyńska-Prejsnar, A., Hanus, P., Sokołowicz, Z. & Kačániová, M. (2021). Assessment of technological characteristics and microbiological quality of marinated turkey meat with the use of dairy products and lemon juice. *Animal Bioscience*, 34(12), 2003.

Barbanti, D. & Pasquini, M. (2005). Influence of cooking conditions on cooking loss and tenderness of raw and marinated chicken breast meat. *LWT-Food Science and Technology*, 38(8), 895–901.

Blackhurst, D. M., Pietersen, R. D., O'Neill, F. H. & Marais, A. D. (2011). Marinating beef with South African red wine may protect against lipid peroxidation during cooking. *African Journal of Food Science*, 5(12), 650–656.

Çelen, M. F., Söğüt, B., Zorba, Ö., Demirulus, H. & Tekeli, A. (2016). Comparison of normal and PSE turkey breast meat for chemical composition. pH, color, myoglobin and drip loss. *Revista Brasileira de Zootecnia*, 45, 441–444.

Cho, J., Kim, H. J., Kwon, J. S., Kim, H. J. & Jang, A. (2021). Effect of marination with black currant juice on the formation of biogenic amines in pork belly during refrigerated storage. *Food Science of Animal Resources*, 41(5), 763.

Çınar, S. (2022). Turunç Suyu (Citrus aurantium L.) ile marinasyonunun tavuk göğüs eti üzerine etkisi (Master's thesis, Fen Bilimleri Enstitüsü).

Fan, C., Pacier, C. & Martirosyan, D. M. (2014). Rose hip (Rosa canina L): A functional food perspective. *Functional Foods in Health and Disease*, 4(12), 493–509.

Gök, V. & Bor, Y. (2016). Effect of marination with fruit and vegetable juice on some quality characteristics of turkey breast meat. *Brazilian Journal of Poultry Science*, 18, 481–488.

Goli, T., Bohuon, P., Ricci, J., Trystram, G. & Collignan, A. (2011). Mass transfer dynamics during the acidic marination of turkey meat. *Journal of Food Engineering*, 104(1), 161–168.

Gómez-Salazar, J. A., Ochoa-Montes, D. A., Cerón-García, A., Ozuna, C. & Sosa-Morales, M. E. (2018). Effect of acid marination assisted by power ultrasound on the quality of rabbit meat. *Journal of Food Quality*, 1–6.

Grajeda-Iglesias, C., Salas, E., Barouh, N., Baréa, B., Panya, A. & Figueroa-Espinoza, M. C. (2016). Antioxidant activity of protocatechuates evaluated by DPPH, ORAC, and CAT methods. *Food Chemistry*, 194, 749–757.

Gray, J. I., Gomaa, E. A. & Buckley, D. J. (1996). Oxidative quality and shelf life of meats. *Meat Science*, 43, 111–123.

İlyasoğlu, H. (2014). Antioxidant effect of rosehip seed powder in raw and cooked meatballs during refrigerated storage. *Turkish Journal of Veterinary & Animal Sciences*, 38(1), 73–76.

Kaewthong, P. & Wattanachant, S. (2018). Optimizing the electrical conductivity of marinade solution for water-holding capacity of broiler breast meat. Poultry Science, 97(2), 701–708.

Kalaycıoğlu, Z. & Erim, F. B. (2017). Total phenolic contents, antioxidant activities, and bioactive ingredients of juices from pomegranate cultivars worldwide. *Food Chemistry*, 221, 496–507.

Karhan, M., Aksu, M., Tetik, N. & Turhan, I. (2004). Kinetic modeling of anaerobic thermal degradation of ascorbic acid in rose hip (Rosa Canina L) pulp. *Journal of Food quality*, 27(5), 311–319.

Koczka, N., Stefanovits-Bányai, É. & Ombódi, A. (2018). Total polyphenol content and antioxidant capacity of rosehips of some Rosa species. *Medicines*, 5(3), 84.

Moeini, R., Zamindar, N. & Aarabi Najvani, F. (2022). The effect of marination by using ginger extract and citric acid on physicochemical characteristics of camel meat. *Food Science and Technology International*, 10820132221136590.

Nile, S. H. & Park, S. W. (2014). Edible berries: Bioactive components and their effect on human health. *Nutrition*, 30(2), 134–144.

Oblakova, M., Ribarski, S., Oblakov, N. & Hristakieva, P. (2016). Chemical composition and quality of turkey-broiler meat from crosses of layer light (LL) and meat heavy (MH) turkey. *Trakia Journal of Sciences,* 2, 142–147.

Önenç, A., Serdaroğlu, M. & Abdraimov, K. (2004). Effect of various additives to marinating baths on some properties of cattle meat. *European Food Research and Technology*, 218, 114 –117.

Orhan, D. D., Özlük, Ö. & Coskun, S. H. (2012). Antioxidant capacities. ascorbic acid and total phenol contents of the plants sold as rose hip in Turkey. *FABAD Journal of Pharmaceutical Sciences,* 37(3), 161.

Rasuli, N., Bintoro, V. P., Purnomoadi, A. & Nurwantoro, N. (2021). The shelf life of buffalo meat marinated with pomegranate (Punica granatum) peel extract. *Journal of Advanced Veterinary and Animal Research*, 8(4), 612.

Rivera Toapanta, E. A., Oruna, M. J., Terriente, C., Gonzalez, J., Guerrero, L., Claret Coma, A. & Oliver, A. (2022). Effects of rose hip (Rosa canina L.) extract as a natural ingredient on the nutritional composition, oxidative stability and sensory attributes of raw and cooked pork patties from Majorcan Black pig breed under retail conditions. *Acta Scientific Nutritional Health*.

Santos, D. I., Fraqueza, M. J., Pissarra, H., Saraiva, J. A., Vicente, A. A. & Moldão-Martins, M. (2020). Optimization of the effect of pineapple by-products enhanced in bromelain by hydrostatic pressure on the texture and overall quality of silverside beef cut. *Foods*, 9(12), 1752.

Saricaoglu, F. T., Atalar, I., Yilmaz, V. A., Odabas, H. I. & Gul, O. (2019). Application of multi pass high pressure homogenization to improve stability, physical and bioactive properties of rosehip (Rosa canina L.) nectar. *Food Chemistry*, 282, 67–75.

Serdaroğlu, M., Abdraimov, K. & Onenc, A. (2007). The effects of marinating with citric acid solutions and grapefruit juice on cooking and eating quality of turkey breast. *Journal of Muscle foods*, 18(2), 162–172.

Unal, K., Alagöz, E., Çelik, İ. & Sarıçoban, C. (2022). Marination with citric acid, lemon, and grapefruit affects the sensory, textural, and microstructure characteristics of poultry meat. *British Poultry Science*, 63(1), 31–38.

Van de Velde, F., Esposito, D., Grace, M. H., Pirovani, M. E. & Lila, M. A. (2019). Anti-inflammatory and wound healing properties of polyphenolic extracts from strawberry and blackberry fruits. *Food Research International*, 121, 453–462.

Vlaicu, P. A., Untea, A. E., Turcu, R. P., Panaite, T. D. & Saracila, M. (2022). Rosehip (Rosa canina L.) Meal as a Natural Antioxidant on Lipid and Protein Quality and Shelf-Life of Polyunsaturated Fatty Acids Enriched Eggs. *Antioxidants*, 11(10), 1948.

Witte, V. C., Krause, G. F. & Bailey, M. E. (1970). A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. *Journal of Food Science*, 35(5), 582–585.

Yılmaz, F. M., Karaaslan, M. & Vardin, H. (2015). Optimization of extraction parameters on the isolation of phenolic compounds from sour cherry (Prunus cerasus L.) pomace. *Journal of Food Science and Technology*, 52, 2851–2859.