DOI:10.22059/IJVM.2022.349929.1005318 Iranian Journal of Veterinary Medicine Original Article

Online ISSN: 2252-0554

Effect of Dietary Supplementation of *Silybum marianum* and Artichoke (*Cynara scolymus* L.) on Carcass Characteristics, Oxidative Stability, and Quality of Breast Meat in Japanese Quail

Fatemeh Salehi[1], Razieh Partovi[1], Saeed Seifi[2*]

1. *Department of Food Hygiene, Faculty of Veterinary Medicine, Amol University of Special Modern Technologies, Amol, Iran*
2. *Department of Clinical Science, Faculty of Veterinary Medicine, Amol University of Special Modern Technologies, Amol, Iran*

Running Title: Effect of natural ingredients on meat quality of Japanese quail

Abstract

BACKGROUND: Herbs are an important source of antioxidants and using them in the poultry diet can improve the final product's characteristics.

OBJECTIVES: This study investigated the effects of dietary supplementation of artichoke, *Silybum marianum*, and the mixture of artichoke and *Silybum marianum* on carcass characteristics, oxidative stability, and breast meat quality in Japanese quail.

METHODS: 120 one-day-old Japanese quail were studied in a completely randomized design with four experimental treatments (0%, 1.5% Artichoke, 1.5% *Silybum marianum*, 1.5% mixture of artichoke and *Silybum marianum*). Each treatment consisted of 3 replicates of 10 birds each. At the end of the experiment (day 42), the carcass characteristics of the birds were recorded, and the physical characteristics, chemical composition, color, and oxidative stability of breast meat were evaluated.

RESULTS: The results showed no significant difference among the experimental groups regarding pH, dry matter, ash, drip loss, and cooking loss. Dietary enrichment with artichoke and *Silybum marianum* caused a decrease in the mean body weight in the experimental treatments compared to the control group ($P<0.05$). Dietary supplementation with herbal powders increased the crude protein and fat content of breast meat, and group four (Artichoke + *Silybum marianum*) had a higher mean than other groups ($P<0.05$). The hardness of breast meat in the treatment groups has decreased compared to the control group. In comparison to the control group, the amount of lightness in the treatments has reduced, and redness and yellowness have increased. TBARS index showed a significant decrease in the investigated treatments compared to the control group ($P<0.05$).

CONCLUSIONS: Dietary supplementation of *Silybum marianum* and artichoke improved nutritional value and increased oxidative stability of breast meat in Japanese quail. Although they had some adverse effects on birds' weight gain and feed consumption.

KEYWORDS: Artichoke, Dietary enrichment, Meat quality, Oxidative stability, *Silybum marianum*

Introduction

One of the main concerns of poultry meat producers is the optimization of meat both qualitatively and quantitatively (Sabow *et al.*, 2021). Meat quality is potentially affected by breeding, genetics, environmental factors, slaughtering procedures and factors such as age, sex, feeding, and density of birds. Poultry meat has a high nutritional value and contains high amounts of protein, essential unsaturated fatty acids and minerals. In addition, the fat in poultry meat contains more unsaturated fatty acids than other animals, so it is susceptible to lipid oxidation (Amaral *et al*., 2018).

Poultry meat is a perishable product due to its carbohydrate, protein, lipid, and water content, and its preservation must have standards that maintain its quality until final consumption (Cartoni Mancinelli *et al*., 2022). Today, consumers look for characteristics such as color, taste, juiciness, crispness, and proper appearance in meat (Amaral *et al*., 2018). Nowadays, change in human lifestyle due to the consumption of prepared and fatty foods (fast foods) has led to an increase in metabolic and cardiovascular diseases. Therefore, special attention is paid to the research on reducing the amount of fat-cholesterol and significantly modifying the fatty acid composition of animal products such as meat (Cartoni Mancinelli *et al*., 2022). In recent years, quail production has found a special place in the poultry industry. Features such as short life cycle, high resistance to diseases, no need for multiple vaccinations (Ramankevich *et al*., 2022), small size, low nutritional needs and short incubation period have attracted the attention of farmers for raising of this bird. Quail meat is useful for all age groups because it contains many nutrients, including protein, vitamin B6, thiamin, niacin, pantothenic acid, and riboflavin. Breast meat in Japanese quail is an important source of essential substances including essential amino acids and unsaturated fatty acids. Factors such as rapid growth rate and high resistance to diseases have made this bird a suitable model for nutritional research (Shah *et al*., 2014). Due to public concerns regarding the possible effects of drug residues and antibiotic resistance, a new strategy of feeding animals with bioactive components was initiated (Nateghi *et al*., 2013). It is believed that using a diet supplemented with natural substances such as medicinal plants with antioxidant properties can be helpful for maintaining the quality of meat and increasing its shelf life. Many recent studies have shown that herbs and spices are valuable and safe additives to improve poultry health and growth rate (Sabow *et al*., 2021).

Artichoke (*Cynara scolymus* L.) is a member of the asteraceae family and widely grown in Mediterranean region, which was used since ancient times as a medicine to treat liver problems and indigestion (Nateghi *et al*., 2013). This plant is rich in natural antioxidants and is of great importance due to the presence of substances such as flavonoids (lutein and apigenin) and polyphenols (cynarin and chlorogenic acid). It's well-known that polyphenolic compounds have antioxidants, anti-tumor, and anti-microbial properties (Abbasi and Samadi, 2014).

Silybum marianum also belongs to the asteraceae family is a therapeutic herb with a 2000-year history of use. This plant grows widely in the northern and southern regions of Iran. The most important flavonoids in *Silybum marianum* fruit are silybin, silychristin, and silydianin, which are collectively called silymarin. About 1.5 to 3% of bioactive components in *Silybum* *marianum* is silymarin. Silymarin protects the liver from toxic agents and also helps in its regeneration (Janocha *et al*., 2021). Also, silymarin has antioxidant and anti-inflammatory properties and reduces blood cholesterol (Hosseinian *et al*., 2021).

The present study was carried out to investigate the effect of dietary enrichment with artichoke and *Silybum marianum* and the mixture of them and its effect on carcass characteristics, oxidative stability and quality of breast meat in Japanese quail.

Materials and Methods:

Experimental design

A total of 120 unsexed one-day-old Japanese quail chicks purchased from a local hatchery were used in the present study. The experiment was performed as a completely randomized design with treatments (0%, 1.5% artichoke, 1.5% *Silybum marianum*, 1.5% mixture of artichoke and *Silybum marianum*) and three replicates (10 birds in each). The birds were allowed to have free access to water and food along with the trial. A basal diet was formulated to meet the nutrient recommendations for quial (NRC, 1994). At the end of the experiment (day 42), 12 birds from each treatment (Four birds per replicate) were weighed and humanely sacrificed, and factors such as: live weight, carcass weight, breast muscle weight, and thigh muscle weight were recorded.

The breast muscle was placed in polyethylene bags and kept in the refrigerator for further tests. The experimental protocol was approved by the Animal Care Committee of Amol University of Special Modern Technologies (Code: Ir.ausmt.rec.1400.16).

Physical characteristics of breast meat

To measure the pH value, five grams of breast meat were homogenized with 25 mL of distilled water in a Stomaker and after filtering, the pH of each sample was measured at room temperature with a pH meter (Jenway 3505, Staffordshire, England) (Mehri *et al.*, 2015). For the determination of drip loss, the weight loss of meat after 24 hours at 4°C was calculated as a percentage. To measure the cooking loss, a piece of breast meat was weighed and placed in a water bath (Memmert, WNB14, Germany) at a temperature of 75°C for 1 hour. Then the sample was cooled at room temperature for 30 minutes. The difference between the weight of meat before and after this process is described as cooking loss (Pastorelli *et al.*, 2016).

Chemical composition of breast meat

Moisture, ash, protein and fat values of breast meat samples were measured according to the Association of Official Analytical Chemists (AOAC) standard methods (AOAC, 2000).

Meat textural characteristics

Evaluation of the texture characteristics of breast meat was done using a texture analyzer (Texture Pro CTV1.2 Build 9, Brookfield Engineering Laboratories, Inc., MA, USA). The samples with an approximate thickness of 1 cm and a diameter of 3 cm were compressed to 50% of their original thickness at room temperature. The force-time deformation curve was drawn using a 25 kg cell load and a speed of 2 mm/s (Partovi *et al*., 2019).

Evaluation of meat color

The color of the quail breast meat samples was measured by considering the parameters (a*, b*, L*) with a colorimeter (Konica Minolta, CR 400, Japan). The parameter a* showed (redness), b* (yellowness) and L* (lightness) (AOAC, 2000).

Phenolic compounds

Cupric ion reduction method was used to determine the amount of phenolic compounds (Vlaicu *et al*., 2022). This method is based on the reduction of Cu (II) to Cu (I). The samples were mixed with CuCl2 solution and neocuproine reagent in ammonium acetate buffer. Then incubated for 20 minutes at 50°C and the absorbance was read at 450 nm.

Carotenoid content

The meat was homogenized by a homogenizer (Omni International, THP 115, USA) to determine the carotenoid level. This calculation was done based on the standard curve of βcarotene and at 470 nm using a spectrophotometer (PG Instruments Ltd, T80 UV-Vis, England). The concentration of carotenoid pigments was obtained using a standard curve calculated using a commercial carotene reagent (Partovi *et al*., 2020).

Vitamin E

To measure the amount of vitamin E, 10 mg of breast meat was homogenized in a homogenizer (Omni International, THP 115, USA). Then, the samples were exposed to iron (Fe^3) solution, 2,4,6-tripyridyl–s-triazine and acetate buffer (pH= 4). The standard curve was prepared with appropriate concentrations of vitamin E. The absorbance of the samples was read at 595 nm (Shah *et al*., 2014).

Lipid peroxidation

Two grams of breast muscle were mixed with 5 mL of 20% trichloroacetic acid solution in a blender for 2 minutes, then the container was washed with 5 mLof distilled water and added to the previous mixture. Finally, the whole mixture was filtered with Whatman No. 41 filter paper with a diameter of 9 cm. Five ml of filtered extract (breast muscle trichloroacetic acid extract) was mixed with 5 ml of 0.01 M thiobarbituric acid solution in a test tube and placed in a 100°C bath for 1 hour to develop color. The resulting color was read at a wavelength of 532 nm (Amaral *et al*., 2018).

Statistical analysis

The Shapiro-Wilk test was performed to check the normality of the data and the Levene's test was performed to check the equality of variances. Parameters related to carcass characteristics, oxidative stability and quality of breast meat in Japanese quail were analyzed using one-way ANOVA parametric test and if there was a significant difference between the means, Tukey's post hoc test was used to compare them. The results were expressed based on the mean and standard deviation. Data analysis was done using SPSS version 26 statistical software (SPSS Inc., Chicago, IL, USA). In all analyses, a significance level of less than 0.05% was considered.

Results

Table 1 shows the effects of using artichoke and *Silybum marianum* and the mixture of them in quail diet on final weight, breast and thigh muscle weight. The difference between the average live weight in the control group and other groups is statistically significant ($P<0.05$). Breast and thigh weight was significantly higher in the control group compared to other groups ($P<0.05$), but no significant difference was seen among the treatments.

According to Table 2, there was no significant difference among the studied groups in pH, dry matter, ash, drip loss and cooking loss. Protein content of the treatments was significantly ($P<0.05$) higher than the control group and the highest (20.08%) and the lowest (18.20%)

contents were observed for T4 and control, respectively. Breast meat fat content of the treatments was significantly ($P<0.05$) higher than the control group and the highest amount of fat was found for T4 (9.90%). The hardness of breast meat in the treatment groups has decreased compared to the control group, and a significant difference was observed between the control group and groups 3 and 4 ($P<0.05$). L* value of the treatments was lower than that of the control, while a* and b* values of the treatments were higher than those of the control.

As seen in Table 3, the use of artichoke and *Silybum marianum* in the diet caused a statistically significant difference between all groups in phenol and carotenoid levels ($P<0.05$) and the highest amount was seen in the *Silybum marianum* group. Vitamin E slightly increased in the treatment groups compared to the control group, but was not significant ($P>0.05$). TBARS index showed a significant decrease in the treatments compared to the control group ($P<0.05$).

Discussion:

The results indicated that artichoke and *Silybum marianum* powder had negative impact on growth performance of Japanese quail which is in line with the results of Gharahveysi (2018) who showed that the use of *Silybum marianum* fruit in the diet causes weight loss in broiler chickens. Abbasi and Samadi (2014), reported that the use of artichoke does not affect the growth performance of Japanese quail. Melo and Harkes (2007) reported similar results when using artichoke in the diet. Schiavone *et al*. (2007) did not observe any effect of supplemental

Silybum marianum on weight gain and feed conversion ratio of broiler chicken, which is consistent with the results of the present study. Similar to the results of the present research, Zaker-Esteghamati *et al*. (2021) stated that supplemental artichoke and *Silybum marianum* in broiler diets did not affect the performance. However, in some studies, it has been reported that the supplementation of artichoke or *Silybum marianum* in the diet can improve performance (Janocha *et al*., 2021). The difference between various studies can be caused by the difference in the conditions of the experiments and the type of substance used (powder or extract). The decrease in final weight in treatments 2, 3 and 4 can be caused by the decrease in feed consumption due to the change in the taste of the diet caused by the addition of artichoke and *Silybum marianum*. Moreover, one of the other reasons for reducing the final weight can be the increase in dietary fiber due to the use of artichoke or *Silybum marianum*. By increasing the amount of fiber in the diet, more of the consumed food is fermented, and as a result, the amount of energy required for growth and weight gain is reduced (Zdanowska-Sąsiadek *et al*., 2019).

The amount of pH, dry matter, ash, leachate loss, and loss from cooking breast meat was not affected by adding artichoke and *Silybum marianum* to the diet. Samadi *et al*. (2016) similarly stated that the dietary levels of artichoke leaf powder do not affect the pH and moisture content of breast meat in Japanese quail. Abbasi and Samadi (2014) showed that the use of 1.5% and 3% levels of artichoke in Japanese quails did not affect the pH of breast and thigh meat, which is consistent with the present results. The amount of crude protein and fat in the treatment groups were significantly higher than the control group, and the highest amount was related to the mixed of Artichoke and *Silybum marianum* group. Following decrease of feed consumption, the rate of feed passage through the digestive tract slows down, and the activity of pancreatic enzymes increases, thus subsequently increasing in feed digestibility. Maybe this mechanism has been effective in increasing the amount of crude protein and fat in breast meat.

The breast meat of the control group was characterized by a higher shear force compared to the other groups. The lowest (*P*<0.05) shear force was found for the breasts of birds receiving the mixture of artichoke and *Silybum marianum*. These results support the findings of a previous study (Zdanowska-Sąsiadek *et al*., 2019) which indicated that the application of the vegetable and herbs mixtures improved meat physiochemical characteristics. Tenderness is one of the most important properties of meat quality. Due to stress, muscle fibers are shrinking and this can have a direct effect on the increase in meat hardness. The use of herbs that have strong antioxidant properties may reduce the effects of stress and improve meat tenderness (Shah *et al*., 2014).

All the color indexes of the treatments were significantly different from the control (*P*<0.05). The L* value of the treatments was lower than the control group, while a* and b* values of the treatments were higher than the control group. The color of meat is one of the important factors in customer satisfaction of food products (Partovi *et al*., 2021). Various factors such as genotype and age, rearing conditions and diet have an effect on meat color. The reason for the change in meat color is the oxidation of red oxymyoglobin to metmyoglobin, which causes brown color in the meat. Natural antioxidants have been reported to increase redness and delay metmyoglobin formation, thereby preventing meat discoloration. Janocha *et al*. (2021) reported that the use of *Silybum marianum* seeds in feeding broiler chickens decreased the L* index and increased a* and b* indexes in meat, which is similar to the results of the present study (Janocha *et al*., 2021).

The highest amount of phenol and carotenoid was seen in the *Silybum marianum* group and, all treatments showed a significant increase compared to the control group. Essential oils that contain phenolic compounds prevent oxidation by deactivating fat-free radicals and proxy radicals and increasing the reductive power. Polyphenols, having antioxidant properties, increase the shelf life of meat. Hajipour Deh Balayi et al. (2014) showed that thyme and oregano prevented the oxidation of meat fat due to their antioxidant properties. Also, Starcevic *et al*. (2014) stated that the inclusion of phenolic compounds reduces lipid oxidation. The positive effects are different depending on the phenolic compound used. Natural phenolic compounds range from simple molecules such as phenolic acids to highly polymerized compounds such as tannins and proanthocyanidins. Nabi *et al*. (2020) conducted studies on the effect of carotenoids in the poultry industry, which showed that carotenoids are another group of natural plant compounds with antioxidant properties, and birds are unable to synthesize carotenoids in their bodies, so these pigments must be obtained through diet. Also, the use of carotenoid supplements in the diet of birds improves the performance and quality of their eggs and meat.

Studies conducted by Rajput *et al*. (2014) on the effects of carotenoids in the meat of broiler chickens under coccidiosis stress showed that these compounds can reduce the activity of free radicals produced by oxidative stress caused by coccidiosis. Results of the present study showed that dietary enrichment with artichoke and *Silybum marianum* increased the amount of vitamin E in breast meat, but this difference was not significant. Vitamin E is one of the soluble antioxidants in the cell membrane that prevents the oxidation of membrane phospholipids. Oxidation of meat reduces sensitivity to hydrolysis and reduces water storage between myofibrils. Sanobar Kelati *et al*. (2013) showed that adding vitamin E to the diet increased this vitamin in meat and tissues, and vitamin E, which acts as an antioxidant in eliminating free radicals, caused oxidative stability and increased the duration of meat preservation and quality. Abbasi and Samadi (2014) showed that artichoke leaf powder does not improve oxidative stability, but vitamin E reduces oxidative degradation and then increases oxidative stability.

Results showed that the TBARS index decreased significantly in all treatments compared to the control group. Malondialdehyde is the end product of lipid oxidation. According to the studies conducted by Samadi *et al*. (2016) on the effects of artichoke powder on the quality of Japanese quail breast and thigh meat, the amount of malondialdehyde, pH, water holding capacity and moisture content of breast meat in Japanese quail were influenced by the dietary levels of artichoke powder and vitamin E, but the amount of malondialdehyde in thigh meat was significantly reduced. Hajipour DehBalayi *et al*. (2014) conducted a study on the effect of thyme and oregano essential oil on the quality of Japanese quail meat and concluded that the essential oil of these plants has a positive effect on the quality of quail meat and reduces the thiobarbituric acid index. Sabobar Kelati *et al*. (2013) showed that with the increase of vitamin E level in the Japanese quail diet, the amount of malondialdehyde decreased significantly.

Conclusion

Dietary supplementation of artichoke and *Silybum marianum* improved the quantitative and qualitative characteristics of breast meat in Japanese quail. Both plants improved the oxidative stability of breast meat in Japanese quail and *Silybum marianum* was significantly better than artichoke in this regard.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgments

This research work was supported by a research grant from Amol University of Special Modern Technologies, Amol, Iran.

References

- Abbasi, F. & Samadi, F. (2014). Effect of different levels of artichoke (*Cynara scolymus* L.) leaf powder on the performance and meat quality of Japanese quail. *Poultry Science Journal*, 2(2), 95-111. https://doi.org/10.22069/PSJ.2014.1959.
- Amaral, A. B., da Silva, M. V., & da Silva Lannes, S. C. (2018). Lipid oxidation in meat: mechanisms and protective factors – a review. *Food Science and Technology*, 38, 1-15. https://doi.org/10.1590/fst.32518.
- AOAC, Official Method No. 950.46 – AOAC methods for moisture determination (2000a). Official Methods of Analysis, Assoc. of Official Analytical Chemists, Gaithersburg MD.
- AOAC, Official Method No. 960.39 – AOAC methods for fat determination (2000b). Official Methods of Analysis, Assoc. of Official Analytical Chemists, Gaithersburg MD.
- AOAC, Official Method No. 942.05 – AOAC methods for ash determination (2000c). Official Methods of Analysis, Assoc. of Official Analytical Chemists, Gaithersburg MD.
- AOAC, Official Method No. 981.10 – AOAC methods for protein determination (2000d). Official Methods of Analysis, Assoc. of Official Analytical Chemists, Gaithersburg MD.
- Cartoni Mancinelli, A., Mattioli, S., Twining, C., Dal Bosco, A., Donoghue, A. M., Arsi, K., Angelucci, E., Chiattelli, D., & Castellini, C. (2022). Poultry meat and eggs as an alternative source of n-3 long-chain polyunsaturated fatty acids for human nutrition. *Nutrients*, 14(9), 1969. https:// doi.org/10.3390/nu14091969.
- Gharahveysi, S. H. (2018). Effects of milk thistle powder on performance, blood parameters and liver enzymes of broiler chickens. *Animal Production*. 19, 879–889. https://doi.org/10.22059/jap.2018.225325.623153.
- Hajipour dehbalaei, S. H., Afsharmanesh, M., & Sami, M. (2014). The effect of essential oils of thyme, oregano and their mixture on the quality of quail meat in comparison with the antibiotic virginiamycin. *Food Hygiene*, 5(4), 45-54. (In Persian).

- Hosseinian, S. A., Abdi Hacheso, B., Nazifi, S., Hashemi Hazaveh, S. A., Hashemi Tabar, S. H., & Rezapoor, R. (2021). Cardioprotective and hepatoprotective activity of silymarin in broiler chickens fed on mash and pellet diets. *Iranian Journal of Veterinary Medicine*. 15(1), 104-121. https://doi: 10.22059/ijvm.2020.302033.1005084.
- Janocha, A., Milczarek, A., & Pietrusiak, D. (2021). Impact of milk thistle (*Silybum marianum* [L.] Gaertn.) seeds in broiler chicken diets on rearing results, carcass composition, and meat quality. *Animals*. 11, 1-16. https://doi.org/10.3390/ani11061550.
- Mehri, M., Sabaghi, V., & Bagherzade-kasmani, F. (2015). *Mentha piperita* (peppermint) in growing Japanese quails' diet: Serum biochemistry, meat quality, humoral immunity. *Animal Feed Science and Technology*, 206, 57–66. https:// doi.org/10.1016/j.anifeedsci.2015.05.022.
- Melo, J. E. & Harkes, R. (2007). Productive evaluation of broiler chickens consuming artichoke extract (*Cynara scolymus* L.) during the first three weeks of life. XX Congreso Latinoamericano de avicultura.
- Nabi, F., Arain, M., Nasir Rajput, N., Alagawany, M., Soomro, J., Umer, M., Soomro, F., Wang, Z. H., Ye, R., & Liu, J. (2020). Health benefits of carotenoids and potential application in poultry industry. *Journal of Animal Physiology and Animal Nutrition*, 104, 1809-1818. https:// doi.org/10.1111/jpn.13375.
- Nateghi, R, Samadi, F., Ganji., F., & Zerehdaran, S. (2013). Hepatoprotective effects of *Cynara scolymus* L. extract on CCL_4 induced liver injury in broiler chickens. *International Journal of Agri Science*, 3(9), 678-688.
- Partovi, R., Seifi, S., Pabast, M., & Babaei, A. (2019). Effects of dietary supplementation with nanocurcumin on quality and safety of meat from broiler chicken infected with *Eimeria* species. *Journal of Food Safety*, 39(6), 1-9. https:// doi.org/10.1111/jfs.12703.
- Partovi, R., Seifi, S., Pabast, M., Mohajer, A., & Sadighara, P. (2020). Effect of dietary supplementation of nanocurcumin on oxidant stability of broiler chicken breast meat infected with *Eimeria* species. *Veterinary Research Forum*, 11(2), 159-163. https://doi.org/10.30466/vrf.2018.86733.2125.
- Partovi, R., Seifi, S., Alian, S., & Nikpay, A. (2021). Appraisal of dietary prebiotic supplementation on meat properties and carcass characteristics of broiler chickens after experimental infection with eimeria species. *Iranian Journal of Veterinary Medicine*, *15(3)*, 346-357. https://doi: 10.22059/ijvm.2020.303786.1005095.

- Pastorelli, G., Rossi, R., Ratti, S., & Corino, C. (2016). Plant extracts in heavy pig feeding: Effects on quality of meat and Cremona salami. *Animal Production Science*, 56(7), 1199–1207. https://doi.org/10.1071/AN14532.
- Rajput, N., Ali, S., Naeem, M., Khan, M. A., & Wang, T. (2014). The effect of dietary supplementation with the natural carotenoids curcumin and lutein on pigmentation, oxidative stability and quality of meat from broiler chickens affected by a coccidiosis challenge. *British Poultry Science*, 55(4): 501–509. https://doi.org/10.1080/00071668.2014.925537.
- Ramankevich, A., Wengerska, K., Rokicka, K., Drabik, K., Kasperek, K., Ziemiańska, A., & Batkowska, J. (2022). Environmental enrichment as part of the improvement of the welfare of Japanese quails. *Animals*, 12(15), 1963. https://doi.org/10.3390/ani12151963
- Sabow, A., Abdulla, N., & Ahmed, B. (2021). The carcass and meat quality characteristics of Japanese quail fed a diet supplemented with powdered *Lactuca seriola* leaves. *Potravinarstvo Slovak Journal of Food Sciences*, 15, 521-527. https://doi.org/10.1111/asj.12496.
- Samadi, F., Abbasi, F., & Samadi, S. (2016). The effect of artichoke leaf powder levels on thigh and breast meat quality and fatty acid profile of Japanese quail breast meat. *Iranian Journal of Animal Sciences*, 47(1), 103-111. (In Persian). https://doi.org/10.22059/ijas.2016.61661.
- Senobar Kalati, H., Shams Sharq, M., Dastar, B., & Zerehdaran, S. (2012). Effect of different levels of selenium and vitamin E on yield and meat quality in Japanese quail. *Iranian Journal of Animal Science Research*, 4(1), 8-16. (In Persian). https://doi.org/10.22067/IJASR.V4I1.13907.
- Schiavone, A., Righi, F., Quarantelli, A., Bruni, R., Serventi, P., & Fusari, A. (2007). Use of *Silybum marianum* fruit extract in broiler chicken nutrition: influence on performance and meat quality. *Journal of Animal Physiology and Animal Nutrition*, 91(5-6), 256-62. https://doi.org/10.1111/j.1439-0396.2007.00701.x.
- Shah, M. A., Bosco, S. J. D., Mir, S. A. (2014). Plant extracts as natural antioxidants in meat and meat products. Meat Science, 98, 21-33. https://doi.org/10.1016/j.meatsci.2014.03.020.
- Starčević, K., Krstulović, L., Brozić, D., Maurić, M., Stojević, Z., Mikulec, Ž., & Mašek, T. (2014). Production performance, meat composition and oxidative susceptibility in broiler chicken fed with different phenolic compounds. *Journal of the Science of Food and Agriculture*, 95(6), 1172–1178. https://doi.org/10.1002/jsfa.6805.

- Vlaicu, P. A., Untea, A. E., Turcu, R. P., Saracila, M., Panaite, T. D., & Cornescu, G. M. (2022). Nutritional composition and bioactive compounds of basil, thyme and sage plant additives and their functionality on broiler thigh meat quality. *Foods*, 11(8), 1105. https://doi.org/10.3390/foods11081105.
- Zaker-Esteghamati, H., Seidavi, A., & Bouyeh, M. (2021). The effects of *Cynara scolymus* and *Silybum marianum* on growth, carcass and organ characteristics, immunity, blood constitutes, liver enzymes, jejunum morphology, and fatty acid profile of breast meat in broilers. *Food Science & Nutrition*, 9, 6692–6706. https://doi.org/10.1002/fsn3.2620.
- Zdanowska- Sąsiadek, Z., Lipi´nska-Palka, P., Damaziak, K., Michalczuk, M., Grzybek, W., Kruzi´nska, B., Jasi´nska, K., Róg, D., Kordos, K., & abek, K. (2019). Antioxidant effects of phytogenic herbal-vegetable mixtures additives used in chicken feed on breast meat quality. *Animal Science Papers and Reports*, 37, 393–408.

Table 1: Effect of dietary supplementation with artichoke and *Silybum marianum* on carcass characteristics of Japanese quail

Experimental groups	**1**	**2**	**3**	**4**	**P-value**
Final weight (g)	199.88±1.50^{a}	162.00±8.94^{b}	164.80±6.26^{b}	168.00±18.00^{b}	0.001
Breast weight (g)	29.20±1.34^{a}	21.80±1.78^{b}	22.20±1.09^{b}	23.20±1.78^{b}	0.001

Thigh weight (g)	15.40±1.002^a	12.00±1.41^b	13.20±1.09^b	13.20±2.28^b	0.02

Group 1: Control, Group 2: Artichoke (1.5%), Group 3: *Silybum marianum* (1.5%), Group 4: Artichoke + *Silybum marianum* (1.5%). Different letters ^{a,b} in each row indicate significant differences (*P*<0.05).

Table 2: Effect of dietary supplementation with Artichoke, *Silybum marianum* and Artichoke + *Silybum marianum* on physical characteristics, chemical composition, texture, and color properties of Japanese quail breast meat

Experimental groups	**1**	**2**	**3**	**4**	**P-value**
pH	6.30±0.36^a	6.65±0.14^a	6.52±0.14^a	6.63±0.17^a	0.08
Dry matter (%)	75.20±1.30^a	75.50±0.60^a	75.61±0.64^a	74.99±3.52^a	0.95
Ash (%)	1.52±0.32^a	1.48±0.30^a	1.68±0.14^a	1.68±0.30^a	0.56
Drip loss (%)	2.10±0.44^a	2.23±0.57^a	2.14±0.51^a	2.31±0.30^a	0.89
Cooking loss (%)	1.56±0.38^a	1.90±0.55^a	1.68±0.37^a	2.55±0.84^a	0.06

Crude protein (%)	18.20±0.05^{b}	19.42±0.23^{a}	19.64±0.11^{a}	20.08±0.59^{a}	0.001
Fat (%)	9.10±0.05^{b}	9.69±0.12^{a}	9.79±0.10^{a}	9.90±0.11^{a}	0.001
Hardness (N)	9.17±0.10^{a}	8.93±0.15^{a}	8.19±0.13^{c}	8.55±0.34^{b}	0.001
L *	64.73±0.17^{a}	57.12±2.45^{b}	58.60±0.53^{b}	57.72±0.93^{b}	0.001
a *	4.45±0.32^{d}	6.12±0.22^{a}	5.21±0.32^{c}	5.69±0.13^{b}	0.001
b *	12.40±0.16^{d}	14.30±0.22^{c}	16.07±0.19^{b}	17.69±0.24^{a}	0.001

Group 1: Control, Group 2: Artichoke (1.5%), Group 3: *Silybum marianum* (1.5%), Group 4: Artichoke + *Silybum marianum* (1.5%). Different letters ^{a,b,c,d} in each row indicate significant differences ($P<0.05$).

Table 3: Effect of dietary supplementation with Artichoke, *Silybum marianum* and Artichoke + *Silybum marianum* on oxidative stability of Japanese quail breast meat

Experimental groups	**1**	**2**	**3**	**4**	**P-value**
Phenol (ppm)	77.85±1.52^{d}	866.16±10.01^{c}	1290.94±8.70^{a}	1163.30±55.38^{b}	**0.001**
Carotenoid (ppm)	88.84±0.62^{d}	100.04±1.12^{c}	115.76±1.96^{a}	112.63±1.72^{b}	**0.001**

TBARS (mg MDA/kg)	0.33±0.01^{a}	0.18±0.01^{b}	0.17±0.01^{b}	0.18±0.02^{b}	**0.001**
Vitamin E (mg/100g)	0.58±0.02	0.63±0.03	0.63±0.03	0.62±0.02	**0.06**

Group 1: Control, Group 2: Artichoke (1.5%), Group 3: *Silybum marianum* (1.5%), Group 4: Artichoke + *Silybum marianum* (1.5%). Different letters ^{a,b,c,d} in each row indicate significant differences ($P<0.05$).

تأثیر افزودن جیره‌ای گیاه خارمریم و آرتیشو بر ویژگی های لاشه، ثبات اکسیداتیو و کیفیت گوشت سینه بلدرچین ژاپنی

فاطمه صالحی[1]، راضیه پرتوی[1]، سعید سیفی[2]*

[1] گروه بهداشت مواد غذایی، دانشکده دامپزشکی، دانشگاه تخصصی فناوریهای نوین آمل، آمل، ایران.

[2] گروه علوم درمانگاهی، دانشکده دامپزشکی، دانشگاه تخصصی فناوریهای نوین آمل، آمل، ایران.

زمینه مطالعه: گیاهان دارویی منبع مهمی از آنتی اکسیدان ها هستند و استفاده از آنها در جیره طیور می تواند به بهبود ویژگی های محصول نهایی کمک کند.

هدف: این پژوهش به منظور بررسی اثر افزودن جیره‌ای گیاه آرتیشو، خارمریم و مخلوط آرتیشو و خارمریم بر ویژگی های لاشه، ثبات اکسیداتیو و کیفیت گوشت سینه بلدرچین ژاپنی انجام شد.

روش کار: تعداد 120 قطعه بلدرچین ژاپنی یک‌روزه در قالب طرح کاملاً تصادفی با چهار تیمار آزمایشی (سطوح صفر، 1/5 درصد آرتیشو، 1/5 درصد خار مریم، 1/5 درصد مخلوط آرتیشو و خار مریم) و سه تکرار (تعداد 10 قطعه بلدرچین در هر تکرار) مورد مطالعه قرار گرفتند. در پایان آزمایش (روز 42)، 12 پرنده از هر تیمار (چهار پرنده از هر تکرار) وزن‌کشی و کشتار شده و خصوصیات فیزیکی، شیمیایی، رنگ و ثبات اکسیداتیو مورد ارزیابی قرار گرفت.

نتایج: نتایج حاصل از این آزمایش نشان داد که از نظر متغیرهای pH، ماده خشک، خاکستر، افت شیرابه و افت حاصل از پخت اختلاف معنی داری بین گروه های مورد مطالعه دیده نشد. وزن سینه در تمام تیمارها نسبت به گروه کنترل کمتر بوده است ($P< 0/05$). از نظر میزان پروتئین و چربی اختلاف معنی داری بین گروه کنترل و تمام تیمارها وجود داشت و گروه آرتیشو+خارمریم میانگین بیشتری نسبت به سایر گروه ها داشت ($P< 0/05$). میزان سختی گوشت سینه در گروه های تیمار نسبت به گروه کنترل کاهش یافته است. میزان روشنایی در تیمارها در مقایسه با گروه کنترل کاهش و میزان قرمزی و زردی افزایش یافته است. غنی سازی جیره با آرتیشو و خار مریم موجب ایجاد اختلاف آماری معنی دار بین تمام گروه ها از نظر میزان فنول و کاروتنوئید شد و در گروه خارمریم بیشترین میزان دیده شد. شاخص TBARS در تیمارهای مورد بررسی نسبت به گروه کنترل کاهش معنادار نشان داد ($P< 0/05$).

نتیجه گیری نهایی: غنی سازی جیره با گیاه خارمریم و آرتیشو موجب بهبود ارزش تغذیه ای و افزایش ثبات اکسیداتیو گوشت سینه بلدرچین ژاپنی شد. اگرچه آنها اثرات نامطلوبی روی وزن گیری و مصرف خوراک پرندگان داشتند.

کلمات کلیدی: آرتیشو، غنی سازی جیره، کیفیت گوشت، ثبات اکسیداتیو، خار مریم