

The effect of xanthohumol on carcass and oxidation parameters in the meat of Japanese quail

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In recent years, the addition of different plant extracts has become an inherent practice in poultry production. Not only as they represent a source of energy but also the beneficial content of improving the growth and quality of meat. The aim of our study was determined the effect of xanthohumol on body weight, percentage of valuable parts of muscle, content of meat of Japanese quail (*Coturnix japonica*), and oxidation processes in meat during cold storage for 7 days at 4 °C. In the comparison of groups of quails with supplementation of xanthohumol in water and in feed, the higher protein content in meat we detected in group with feed supplementation ($P < 0.05$). Xanthohumol, administered in feed and water, did not affect the weight, percentage of valuable parts of muscle, pH of meat, water content, fat and ash in meat. The fat oxidation, and value of TBARS were lower in quails with feed supplementation in compare to control group ($P < 0.05$).

Keywords: prenylflavonoids, xanthohumol, hops, Japanese quails, carcass value

1 Introduction

Hops have been used as a medicinal plant for a long history owing to its richness in a variety of phenolic compounds (Zanoli and Zavatti, 2008). The dried hops contain 4–14% polyphenols, mainly phenolic acids, prenylated chalcones, flavonoids, catechins, and proanthocyanidins (Nikolic and van Breemen, 2013). Xanthohumol is a prenylated chalcone that occurs only in the hop plant (*Humulus lupulus*), especially in the female inflorescences. Xanthohumol and its related prenylflavonoids are important for the ingredient of beer and have received much attention as cancer chemopreventive agents (Ayabe et. al., 2010). However, the beneficial pharmacological properties of xanthohumol were not appreciated until 1990s, including antioxidant, anti-inflammatory, antibacterial, antiviral, antifungal, and antiplasmodial activity (Liu et al., 2015; Jiang et al., 2018). In recent years, there has been an increasing interest in the use of dried hops in the food industry therefore, the aim of study was determined the effect of xanthohumol on body weight, carcass parameters and oxidation processes in meat of Japanese quails.

2 Material and methods

2.1 Experimental animals

Sixty Japanese quails breeds lines Faraon and Manchurian golden quail were included in the experiment, which were divided into three groups, the first with the addition of xanthohumol in feed, the second with xanthohumol in drinking water and the third control, without addition of xanthohumol. The formed groups of quails were housed in cage boxes (1.5 × 1.5 m) lined with 5 cm litter of shawdust and straw. All groups we fed complete feed for quail MINI in the size of granules 1–3 mm (producer De Heus a.s., CZ). The feed dose consisted of wheat, maize, vegetable oil

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and fat (sunflower seed), soya extracted scrap, distillery dark draff, extracted scrap of shelled sunflower seed, calcium carbonate, wheat germ, fishmeal, monocalcium phosphate, sodium chloride. Additives added to feed intended for the feeding of Japanese quail are as follows: vitamin A, vitamin D3, vitamin E, copper sulphate, zinc sulphate, Zn, Fe, Se, I, manganese oxide, ferrous sulphate, sodium selenite, calcium iodate. The content of analytical constituents in feed is as follows: crude protein 23.6%, oils and fats 3.4%, fiber 3.5%, ash 8%, lysine 1.41%, methionine 0.56%, calcium 1.5%, phosphorus 0.86%, sodium 0.14%.

During the experiment, quail had access to feed and water *ad libitum*. Feed supplemented with xanthohumol has been administered for 52 days, from the 8th day of quail age. After completion of supplementation, quails aged 60 days we killed by decapitation. The carcass we weighed after dissection. The weight of the carcass breast and thigh muscles (with bones and boneless) was recorded separately.

2.2 The processing of hop extract

Hop extract containing 75% xanthohumol has been used in monitoring. This extract has been processed at a higher temperature with KOLLIDON VA64 to improve its water solubility and bioavailability (EP171766458.4). The used extrudate contained 10% xanthohumol extract.

2.3 Analysis of nutritional composition and oxidative stability in meat

For the analysis of nutritional composition and oxidative stability in meat, samples were taken from the breast and thigh muscles. The dry matter content was determined by drying muscle samples at 105 °C for 16 hours. The protein content we evaluated by using KJELTEC AUTO 1030 ANALYZER (TECATOR Co., Sweden). The fat content we determined by the Soxhlet extraction method (Veterinary Laboratory Methodology, 1990). The pH value was determined by directly inserting the pH-meter probe into the thoracic muscle. The pH of the meat was recorded immediately, 24 hours after slaughter, using a pH meter (inoLab pH 720, WTW) equipped with electrode Ingold messtechnik AG (Udorf, Switzerland). After every 20 measurements, the pH-meter was calibrated using standard solutions of pH values 4 and 7 (Ingold Messtechnik AG, Udorf, Switzerland). Muscle samples were vacuum packed in polyethylene bags and stored at 4 °C for 7 days. Lipid oxidation we monitored by measuring with using TBARS, spectrometrically at 532 nm (Helios, Thermo spectronic, UK) according to Marcinčák et al. (2006).

2.4 Statistical analysis

The obtained data was statistically analysed with using GraphPad PrismSoftware, version 4.00 (GraphPad Prism, 2003). One-way variance analysis (ANOVA) with a post hoc Tukey test for multiple comparisons we used to evaluate the statistical significance of the differences between the three groups (XH-feed, XH-water and control). The results of the statistical analyses are given in tables such as mean (M) and standard deviation (SD). Differences between mean values were determined at the level $P < 0.05$.

3 Results and discussion

According to Babangida and Ubosi (2005), the Japanese quail has the potential to serve as an excellent and affordable source of animal protein. The percentage content of edible meat in Japanese quail is very high. Breasts amounts to 37.3–38.7% of the body, legs 22.7–24.6% and the carcass, neck and wings in total 35.9–37.8% (Panda and Singh, 1990). The boned meat of the valuable parts of the body (breasts and legs) amounts to 36% for the breasts and 15% for the legs (Vaclovský and Vejck, 1999). We have not determined significantly differences in weight of the studied muscle body parts (Table 1).

Table 1 The effect of supplementation of water and feed with xanthohumol on the breast and thigh muscle weight

Parameters	Unit	XH-diet	XH-water	Control
		M ±SD	M ±SD	M ±SD
Breast with bone	g	76.5 ±7.1	70.1 ±5.2	71.7 ±6.7
Breast boneless	g	55.7 ±6.3	54.0 ±4.6	54.3 ±5.4
Thigh with bone	g	46.5 ±4.5	47.8 ±2.7	43.5 ±5.1
Thigh boneless	g	32.6 ±3.6	31.8 ±2.5	31.2 ±3.5

Results are presented as mean ±SD; XH – xanthohumol

When assessing the percentage of breast and thigh muscle with bone, we found similar results, when assessing the percentage of boneless muscle, we obtained slightly lower values than the authors mentioned above (Table 2).

One of criteria for meat evaluation is protein content, which is 23% in breast vs 18.7% in thigh meat (Choudhary and Mahadevan, 1986). The difference is attributed by authors mainly to mineral content (1.05% vs 1.35%), and fat content (3.1% vs 5%). In comparison of protein content in meat we detected significant differences on value $P < 0.05$ (Table 3), predominantly in group of quails with supplementation with xanthohumol in feed. Supplementation of xanthohumol in water did not affect the protein content of the meat. The water, fat and ash content of valuable parts of the carcass has not been affected by the supplementation of xanthohumol in feed and water.

Table 2 The percentage comparison of breast and thigh muscle weight with bone, and boneless to carcass body weight

Parameters	Unit	XH-diet	XH-water	Control
		M \pm SD	M \pm SD	M \pm SD
Breast with bone	%	35.74 \pm 4.77	34.61 \pm 3.64	35.72 \pm 4.80
Breast boneless	%	28.74 \pm 4.24	28.95 \pm 3.22	29.48 \pm 3.88
Thigh with bone	%	25.65 \pm 3.02	26.78 \pm 1.88	25.61 \pm 3.64
Thigh boneless	%	20.96 \pm 2.42	21.16 \pm 1.74	21.19 \pm 2.50

Results are presented as mean \pm SD; XH – xanthohumol

Table 3 The effect of supplementation with xanthohumol on pH value, composition of meat and the changes in meat decomposition 24 hours and 7 days after slaughtering

Parameters	Unit	XH-diet	XH-water	Control
		M \pm SD	M \pm SD	M \pm SD
pH		6.01 \pm 0.08	6.12 \pm 0.10	6.07 \pm 0.06
Moisture	%	71.84 \pm 1.02	72.68 \pm 1.15	72.94 \pm 1.06
Crude protein	%	23.87 \pm 0.89 ^{a,c}	21.45 \pm 1.51 ^c	21.39 \pm 1.08 ^a
Crude fat	%	3.38 \pm 0.25	3.58 \pm 0.21	3.46 \pm 0.17
Ash	%	2.36 \pm 0.08	2.30 \pm 0.10	2.28 \pm 0.09
TBARS (1 st day)	mg/kg	0.120 \pm 0.015	0.128 \pm 0.019	0.125 \pm 0.015
TBARS (7 th day)	mg/kg	0.138 \pm 0.023 ^{a,c}	0.150 \pm 0.035 ^{b,c}	0.164 \pm 0.038 ^{a,b}

TBARS* – thiobarbituric acid reactive substances mg MDA/kg tissue; XH – xanthohumol. Results are presented as mean \pm SD; a, b, c – values in a row sharing different letters are significantly different ($P < 0.05$)

One of the most critical factors affecting the quality of the meat after slaughter are the oxidation and maturation processes. In muscle foods, oxidative reactions continue postmortem and are a leading cause of quality deterioration during processing and storage. The muscles fibres are subjected to biochemical changes in the meat. The conversion of the muscle to a meat during the ripening process is an energy demanding process. The energy is provided by degradation of glycogen in the muscle. Energy-rich phosphates are participating on the enzymatic degradation of glycogen to the lactic acid following decrease of pH. The decreasing of pH value has been a big effect on the different chemical and biochemical processes in the (Simpson, 2012).

Supplementation of xanthohumol in water and feed did not affect the pH value in the meat in experiment. Oxidation of lipids is an important quality indicator of fats, meat, and meat products because oxidized lipids not only change the colour, aroma, flavour, texture (sensory properties), and even the nutritive value of the foods, but also generate a lot of harmful biological effects on human health. Products of oxidation are harmful to health due to carcinogenic and atherosclerotic effects, alteration in the composition of cell membranes, or the reduction in high-density lipoproteins (Tkáčová and Angelovičová, 2013).

Malondialdehyde (MDA) is one of the most abundant aldehydes generated during secondary lipid oxidation and also probably the most commonly used as an oxidation marker (Barriuso et al., 2013). The MDA concentration depended

on lipid content in samples. The presence of oxidized lipids in the diet of humans and animals resulted in an increase of thiobarbituric acid reactive substances (TBARS) in plasma and tissue (Ruban, 2009).

The results of determination of TBARS, expressed as the amount of MDA (malonaldehyd), as the main degradation products of polysaturated fatty acids, are given in Table 3. For quail groups with xanthohumol supplementation in feed and water, we found lower TBARS in meat after seven days of refrigeration storage compared to meat in control group ($P < 0.05$).

4 Conclusions

Supplementation of feed with xanthohumol positively affected the protein content of valuable parts of the carcass of Japanese quails, while water supplementation there was no significant increase in protein values in meat. The oxidation processes of fats during refrigeration storage were most pronounced in the control group, the supplementation of feed and water with xanthohumol reduced oxidation processes in meat ($P < 0.05$). Oxidation processes were positively influenced mainly in the group of quails with supplementation of feed. Xanthohumol, administered in feed and water, did not affect the weight, percentage of valuable parts of muscle, pH of meat, water content, fat and ash.

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