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MEAT PERFORMANCE OF JAPANESE QUAILS AFTER THE APPLICATION OF BEE BREAD POWDER

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ABSTRACT
The aim of the study was the evaluation of meat performance of Japanese quails after the addition of bee bread powder into their diet. A total of 80 one day-old Japanese quails were randomly divided into 4 groups (n = 20): the control group (C) without additional supplementation, the experimental group E1 supplemented with 2 mg bee bread powder per 1 kg of feed mixture; the experimental group E2 supplemented with 4 mg bee bread powder per 1 kg of feed mixture and the experimental group E3 supplemented with 6 mg bee bread powder per 1 kg of feed mixture. The groups were kept under the same conditions and the quails were slaughtered at 56 days of age. Based on the results, we can conclude that the application of bee bread powder generally has not confirmed a positive effect on the meat performance of Japanese quails, regarding to the quantities of bee bread powder in the experimental groups.

Keywords: Japanese quail; meat performance; bee bread

INTRODUCTION
The poultry industry is considered to be one of the most advanced in the field of food industry and the increase in the production of poultry products has been remarkable. Today, products of different species of poultry, including quail products, are being marketed **(Genchev et al., 2008)**. Japanese quail (*Coturnix coturnix japonica*) is one of the most important species of poultry, which meat and eggs are mostly consumed in Asia, Europe, and America **(Minvielle, 2004; Kayang et al., 2004; Maiorano et al., 2012)**. The Japanese quail is characterized by its rapid growth, enabling quail to be marketed for consumption at 5 weeks of age, early sexual maturity resulting in a short generation interval, high rate of egg-laying and much much lower feed and space requirements than domestic **(Hrnčár et al., 2014)**. The valuable dietetic properties of quail meat are at the background of the increasing interest of consumers in this product. Quails can be used for meat production within a short period (4 – 5 weeks) and mature at an early age of 6 weeks so that female birds are usually in full production at approximately 8 weeks **(Jatoi et al., 2013)**. Japanese quails respond very quickly to the selection for higher body weight. **Anthony, Nestor and Marks (1996)** observed that some selected lines of Japanese quail produced heavier carcasses and more meat. The analysis of efficiency of quail meat production showed that it was the highest if the slaughtering was performed at 35 days of age **(Kajtazov and Genchev, 2004)**. The percentage content of edible meat in Japanese quail is very high: breasts ranging 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; Alkan et al., 2010)**. Boned meat of the valuable parts of the body (breasts and legs) amounts to 36% for the breasts and 15% for the legs **(Vaclovsky and Vejcik, 1999)**.

The major advantage of quail rearing is that it requires minimum space, less capital investments and shorter generation interval. Furthermore, they are characterized by their early sexual maturity, better disease resistance, better feed efficiency and faster growth rate **(Vali, 2008)**. The average weight of a Japanese quail is 250 g and lays 250 eggs per annum. It is the smallest avian species reared for egg and meat purposes. Quail meat possesses low number of calories with high protein content. The average dressed carcass yield is 65 – 70% **(Krishnan, 2019)**.

A huge amount of antibiotics has been used to control diseases and to improve performances in livestock. Antibiotics are microbial metabolites that can inhibit the growth of other microorganisms even in low concentrations **(Nir and Ve-Senkoylu, 2000)**. But by long-term use, may cause some side effects of antibiotics, to occure residues in meat and the development of drug-resistance bacteria and reduction in the ability to cure these bacterial diseases in humans **(Donoghue Dan, 2003)**. To meet consumers' demands, in 2006, the European Union introduced a total ban regarding to usage of feed antibiotics. However, a ban on the use of antibiotics, as growth promoters, has led to a need for finding additives, yet safe for improving production performances without negative effects on animal health and welfare, the quality of food of an animal origin, human health and the environment **(El-Medany et al., 2017)**. Bee products seem to be an effective natural alternative to antibiotic growth promoters **(Babaei et al., 2016; Haščík et al., 2016a, Haščík et al., 2017)**. Bee bread (ambrosia) is a unique fermented bee product that mainly includes pollen, honey, and secretions of bees' salivary glands **(Vásquez and Olofsson, 2009; Barajas, Cortes-Rodriguez and Rodríguez-Sandoval, 2012)**. It is the result of lactic fermentation of pollen, collected by bees from flowers of melliferous plants and mixed by their digestive enzymes, then they are carried into the hive and kept with a thin layer of honey and bee wax. Bee bread is the main food in the hive, especially for larvae and young bees that produce royal jelly **(Kieliszek et al., 2018)**. Bee bread (BB) represents a richer source of high nutritional and functional compounds for human and honeybees than fresh pollen **(Markiewicz-Żukowska et al., 2013; Podrižnik and Božič, 2015; Denisow and Denisow–Pietrzyk, 2016; Sobral et al., 2017; Kieliszek et al., 2018)**. Compared to fresh pollen, it is characterized by a lower amount of complex polysaccharides, a shift in amino acids, proteins and lipids profiles, and an increase of simple carbohydrates and titratable acidity **(Human and Nicolson, 2006; Anđelković et al., 2012; Lee et al., 2015)**. BB is also characterized by a higher nutritional value, better digestibility, and richer chemical composition than pollen **(Habryka, Kruczek and Drygas, 2016)**. The BB results into a stable food, due to the high concentration of simple sugars (35 – 61% dry weight), low pH (3.8 – 4.3), and the presence of antimicrobial compounds **(Vásquez and Olofsson, 2009; Anderson et al., 2014; Podrižnik and Božič, 2015)**. Bee bread is the source of protein, fats, and vitamins. Although the composition of bee pollen and bee bread are similar, there are some differences. Bee bread contains less protein than bee pollen, but bee bread proteins are easier to digest **(Saa-Otero, Díaz-Losada and Fernández-Gómez, 2000; Bogdanov, 2011)**. **Nagai et al. (2004)** stated that BB contains approximately 20% protein, 3% lipids, 24 – 35% carbohydrates, 3% minerals, and vitamins. Fully balanced proteins contain all of the necessary amino acids, vitamins (C, B_1, B_2, E, K, biotin, nicotinic and folic acid), pantothenic acid, pigments, and other biologically active compounds, such as polyphenols (phenolic acid and flavonoids), carotenoids, sterols. Furthermore, enzymes (saccharase, amylase, phosphatases), are also present. In addition, BB contains more than 25 different micro- and macro- elements, such as Fe, Ca, P, K, Cu, Zn, Se, and Mg. The potential application of bee bread, as food and a nutraceutical supplement, greatly depends on its chemical composition, which varies directly with the flora of the region and the time of collection by the bees **(Markiewicz-Żukowska et al., 2013; Čeksterytė et al., 2016; Sobral et al., 2017)**. The activity of pollen (the number of vitamins and enzymes) decreases after 2 or 3 months of storage. Bee bread keeps its activity longer **(Bogdanov, 2011)**. Biologically active substances present in BB are associated with several medicinal benefits. BB has hepatoprotective, immuno-modulating, antiradiation, and adaptogenic properties **(Berene, Daberte and Siksna, 2014; Bogdanov, 2015)**. BB helps to regulate lipid metabolism and has also a positive effect on the cardiovascular system **(Nagai et al., 2004; Baltrušaitytė, Venskutonis and Čeksterytė, 2007; Tomás et al., 2017)**. BB has shown to possess *in vitro* antibacterial **(Baltrušaitytė, Venskutonis and Čeksterytė, 2007; Zerdani et al., 2011)**, antioxidant **(Zuluaga, Serrato and Quicazan, 2015; Tomás et al., 2017) and antitumor (Markiewicz-Żukowska et al., 2013; Sobral et al., 2017)** proprieties.

The aim was the evaluation of meat performance of Japanese quails after the addition of bee bread powder (perga) into their diet.

Scientific hypothesis

We expect a significant effect of bee bread on the meat performance of Japanese quails, especially on the valuable meat parts such as breast and thigh muscles.

MATERIAL AND METHODOLOGY

Animals and experimental design

Animals and diet

The experiment was carried out in the test poultry station at the Research Institute of Animal Production in Nitra. A total of 80 Japanese quails were included in the experiment. The quails were divided into four groups (10 males and 10 females in each group), as follows: the control group received no additives (C), the experimental group E1 received bee bread powder at a dose of 2 g per 1 kg of feed mixture, experimental group E2 received 4 g of bee bread powder per 1 kg of feed mixture and E3 group 6 g bee bread powder per 1 kg of feed mixture. Bee bread was of Slovak origin (Medula Ltd., Bratislava). The groups were kept under the same conditions. The quails were reared using a cage technology, each cage was equipped with a feed disperser and water intake was ensured ad libitum through a self-feed pump up to 56 days of age.

Table 1 shows the list of the ingredients and nutrient content of the basal diets (HYD-07, HYD-11), formulated to provide the nutrient requirements of quails according to the recommended reference levels. The feed mixture was produced without any antibiotics and coccidiostats.

Slaughter and measurements

At the end of the 56-day feeding period, twenty quails from each group (10 males, 10 females) were weighed and slaughtered at the slaughterhouse of the Slovak University of Agriculture in Nitra. After evisceration, the carcasses were kept at approximately 18 °C for 1 h *post mortem*. After that, the carcasses were weighed and stored at 4 °C until 24 h *post mortem*. All the weighting measurements were performed using the precision balance Kern 440 (Kern & Sohn, Germany) with an accuracy of 0.01 g. The carcass yield was calculated by dividing carcass weight with giblets and abdominal fat weight by live body weight.

Statistical analysis

The data were analyzed using the ANOVA Processed with SAS software (version 9.3, by application Enterprise Guide 4.2). Mean values and standard deviation (SD) are reported in tables. Differences between treatments were tested for significance. The level of significance was established at $p \leq 0.05$.

RESULTS AND DISCUSSION

The results of the meat performance of quails without (control group) and after application of bee bread powder (experimental groups) in their nutrition are shown in Table 2. The main indicator of the quality of poultry meat is the category of a carcass, which is determined by its nutritional status **(Maiorano and Bednarczyk, 2013)**. Generally, in quail boneless meat yields is about 77% of carcass weight, the breast muscle represents 50% of the total carcass meat yield, while leg muscle contributes about 30% **(Shanaway, 1994)**. In the case of broiler chicken, the content of muscle tissue of the carcass varies between 40% and 70% **(Maiorano and Bednarczyk, 2013)**. Generally, due to the economic reasons, broiler quails are slaughtered at approx. 5 – 6 weeks of age **(Genchev et al., 2008)**. Under the good condition of feeding and environmental conditions, the body weight gain of quails increases till the 4th week, then starts decreasing **(Shanaway, 1994; Seker et al., 2007)**.

We can conclude that application of bee bread powder in the diet of Japanese quails without gender difference did not have a significant effect on the achieved live weight except for the experimental group E2 with the addition of 2 $g.kg^{-1}$, where were achieved negative significant differences (- 20.35 g) compared to the control group.

The similar results of live weight were achieved in Japanese quails by sex, where male and female in group E2 achieved significantly the lowest live weight (male 170.32 g and female 185.06 g) among the experimental groups. The carcass yield in Japanese quail ranges from 60 to 70 –75% depending on slaughtering age, line, and sex **(Maiorano et al., 2009; Alkan et al., 2013)**. The effect of sex on slaughtering and carcass characteristics are well known in quail, and was reported as highly significant **(Khaldari et al., 2010; Narinc et al., 2010)**. The tendency of the carcass weight of Japanese quails was similar to that in live weight. Carcass yield, except for the experimental group E3 (68.89%), was at least 70% in all other experimental groups and no significant differences in this indicator were found between groups ($p \geq 0.05$). The highest carcass yield without sex difference was in the E2 group (71.84%). Considering sex, in male the highest carcass yield was in the control group (73.40%) and the lowest in the E3 group (71.70%). In female, the carcass yield was the highest in group E2 (70.73%) and again the lowest in the E3 group (66.08%).

For the sexual dimorphism, females are heavier than males, but the latter are characterized by higher carcass yield **(Marks, 1993)**. Despite that Japanese quail is not a species with a high slaughter yield, the percentage of edible meat is high. It was reported that breasts represent a considerable part of the carcass in Japanese quail **(Vali et al., 2005; Khaldari et al., 2010)** and this is a clear advantage because breast meat is favorable among consumers. The incidence on the carcass of breast muscle is ranging from 25 to 36% and for legs is ranging from 16 to 22% in Japanese quail of different ages **(Genchev et al., 2008; Alkan et al., 2013)**. An important indicator of meat performance is also the weight of valuable parts (breasts, thighs), which was significantly ($p \geq 0.05$) smaller in all experimental groups without sex difference, except for the E1 group with breast weight (52.87) versus the control group (52.57 g).

Table 1 Composition of basal diet and nutrient content of feed mixtures HYD-07 and HYD-11 per kg of diet.

Ingredients (%)	**Starter feed mixture (HYD-07) (1^{st} to 21^{st} day)**	**Finisher feed mixture (HYD-11) (22^{nd} to 56^{th} day)**
Wheat	13	15
Maize	34.8	32
Soybean meal (48% CP)	23	19.2
Fish meal (71% CP)	5	3
Malt flower	2	3
Rapeseed meal	5	7
Sunflower meal	5	4.5
Monocalcium phosphate	1	1
Fodder salt	0.2	0.3
Animal fat Bergafat	5	4
Calcium carbonate	5	10
Premix Euromix[1]	1	1
Crude protein	245	200
Fibre	50	60
Ash	140	160
Ca	8	35
P	6.5	5
Na	0.9	1.6
Lysine	14.1	11
Methionine + Cysteine	9.5	7.9
Linolic acid	10	10
ME_N ($MJ.kg^{-1}$)	12.1	11.7

Notes: CP = crude protein; Ca = calcium; P = phosphorus; Na = natrium; ME_N = nitrogen-corrected metabolizable energy; MJ = megajoule; [1]active substances per kilogram of premix: vitamin A 15 000 IU; vitamin E 20 mg; vitamin D3 2 000 IU; riboflavin 6 mg; cobalamin 20 μg; Mn 60 mg; Zn 40 mg; Fe 40 mg; Cu 6 mg; I 1 mg; Se 0.2 mg.

Based on evaluating the weight of the breast muscle regarding to the sex, we can conclude that males gained the highest value in the control group (51.81 g) and the lowest in the group E2 (46.73 g).

On the other hand, females gained the highest value in the E1 group (54.46 g) and lowest in the E2 group (47.42 g). Without sex differences, the highest values of thigh weight of Japanese quail were found in the control group (30.41 g) and the lowest in the E2 group (28.74 g). Regarding to sex, thigh weight was again the highest in the control group (29.92 g) and the lowest in the E2 group (28.49 g). In females, the thigh weight was the highest in E1 group (31.28 g) and the lowest in E2 group (28.98 g).

Based on the overall evaluation of the individual groups of experiments in the achieved meat yield of Japanese quails, the worst was the E2 group with the addition of 4 g bee bread powder per 1 kg of feed mixture.

There are no relevant researches on meat performance characteristics of Japanese quails with the addition of bee bread into their diet. However, this quail is widely used for other researches and therefore other natural supplements were tested in their diet.

Denli et al. (2005) reported a higher carcass weight (+8.2%), without significantly better carcass yield after propolis supplementation. **Canogullari et al. (2009)** reported a better weight gain after an average of 1% propolis supplementation into Japanese quail's diet. They also reported that live weight (246.3 g), carcass weight (181.7 g), carcass yield (73.7 g), liver yield (4.91 g), heart yield (2.18 g) and gizzard yield (5.45 g) were not significantly affected by selected supplementation. **Canogullari et al. (2009)** also observed pollen supplementation into quail´s diet in an amount from 5 to 20 g per kg of feed. In comparison with propolis, they found a similar weight gain, worse live weight (237.5 g) and carcass weight (177.3 g), but better carcass yield. The yield of mentioned three giblets was also higher (5.58 g, 2.31 g and 5.58 g, respectively). **Silici et al. (2007)** reported that propolis had no detrimental effect on the health but did not improve the performance parameters of quail in the first 35 days of age.

In comparison to broiler chickens, **Haščík et al. (2012)** revealed that the use of 400 mg.kg^{-1} of bee pollen as a dietary supplement in broilers led to an increase in the live body weight, carcass weight, giblets weight and carcass yield in males, but it had a negative impact on females, as it decreased the body weight of the hens. **Haščík et al. (2016c)** used 400 mg of propolis extract per 1 kg of feed mixture in broiler chickens' diet. Compared with the control group (control – experimental group), they found higher live weight (2270.20 – 2316.90 g), carcass weight (1629.80 – 1669.10 g), a similar carcass yield (78.54 – 78.31%), a higher giblet weight (152.08 – 155.64 g), a similar weight of liver, gizzard and heart, respectively (40.91 – 40.61; 26.00 – 25.09 and 10.72 – 10.88 g).

Similarly to the present findings, **Haščík et al. (2014)** demonstrated that propolis extract supplementation (200, 300, 400 mg.kg^{-1}) increased the body weight of broiler chickens (2354.6 – 2382.9 g) in comparison with 2272.89 g in the control group. Slightly increased ($p \leq 0.05$) when the chickens were fed with the combination of humic acid with garlic powder (E2; 1.97 g.100g^{-1} resp. 1.02 g.100g^{-1}) and humic acid plus oregano leaf powder (E3; 2.02 g.100g^{-1}, resp. 1.05 g.100g^{-1}). The content of mentioned AAs has decreased ($p \leq 0.05$) after the addition of humic acids (E1; 1.81 g.100g^{-1}, resp. 0.94 g.100g^{-1}) in comparison with the control group.

Except for bee products, other natural supplements were tested in Japanese quails' diet. Dietary supplementation with thyme, in the form of essential oil, did not lead to any significant improvement of carcass weight or carcass yield **(Denli et al., 2004; Sengül et al., 2008),** but on the other hand, the newer research carried out by **Khaksar et al. (2012)** shows a significant improvement in live body weight, carcass yield and even breasts yield**. Chantiratikul et al. (2010)** figured out that duckweed may affect carcass yield (76.7%) of Japanese quail, though not significantly.

Ghazaghi et al. (2014) claimed that peppermint *Mentha spicata* can significantly decrease feed intake without negative effects on carcass, breast and leg yields. But unfortunately, dietary supplementation with peppermint *Mentha piperita* significantly increased feed intake with a decrease of breast and leg yields **(Mehri et al., 2015)**. Green tea is known for its content of bioflavonoids, catechin and epicatechin and was tested by several authors as a dietary supplement in broiler chickens' diet **(Haščík et al., 2016b)**. However, in Japanese quail, it did not improve neither carcass (66.4%), nor giblet yields **(Kara et al., 2016)**. Comparing with our study, a canola-based diet led to a higher carcass weight (133.0 g) similar heart (1.7 g) and lower liver and gizzard weight (4.2 and 3.1 g) **(Mnisi and Mlambo, 2018)**. Both cinnamon essential oil and powder supplementations (100 mg.kg^{-1} and 2 g.kg^{-1} of feed) increased a live weight of Japanese quails **(Mehdipour, Afsharmanesh and Sami, 2013)**. Live body weight and carcass yield were significantly increased after the addition of a chickpea into the Japanese quail diet **(Obregón et al., 2012)**, while in our study this was not observed. Also, earthworm's powder can significantly improve the carcass yield of Japanese quail **(Morón-Fuenmayor et al., 2008; Díaz-Cuellar et al., 2009)**. **Partovi and Seifi (2018)** claimed, that in comparison with the control group, diet supplementation with *E. purpurea* extract at all concentrations decreased total feed intake ($p = 0.0017$) and that there wasn't a significant difference between experimental groups. Diet supplementation with *E. purpurea* extract decreased dressing percentage and the difference was significant between the control group with 0.025% and 0.05% groups. Diet supplementation at 0.2% caused a significant increase in dressing percentage in comparison to 0.025% and 0.05% of *E. purpurea* extract groups, yet the dressing percentage did not reach that of a control group ($p < 0.05$).

Research of **Sahin et al., (2003)** showed that dietary supplementation with vitamin C and folic acid is not suitable for Japanese quails because it led to a decrease of live body weight, carcass weight and carcass yield. Dietary L - carnitine supplementation (30, 40 and 50 mg.kg^{-1}) led to a decrease of live body weight (185.83 – 194.44 g) and also carcass weight (119.32 – 121.92 g), but caused an increase of giblets like liver (~2.60 g), heart (~0.92 g) and gizzard (~2.00 g) in comparison to the control group **(Sarica et al., 2005)**.

Table 2 Effect of bee bread powder on meat performance parameters of quails.

Parameter	Sex	C	E1	E2	E3	*p*-value
Live body weight (g)	Male	184.26 ±7.03^{a}	183.58 ±4.80^{a}	170.32 ±4.88^{b}	184.80 ±3.93^{a}	0.0335
	Female	211.82 ±10.84^{a}	209.30 ±3.12^{a}	185.06 ±7.30^{b}	208.38 ±5.82^{a}	0.0335
	♂+♀	198.04 ±16.89^{a}	196.44 ±14.08^{a}	177.69 ±9.73^{b}	196.59 ±13.28^{a}	0.0147
Carcass weight (g)	Male	122.04 ±6.33	121.44 ±4.38	113.11 ±5.43	120.56 ±2.49	0.0663
	Female	128.13 ±9.50^{ac}	129.62 ±10.91^{a}	116.50 ±3.96^{bc}	123.42 ±9.69^{ab}	0.0472
	♂+♀	125.08 ±8.26^{a}	125.53 ±8.95^{a}	114.81 ±4.82^{b}	121.99 ±6.84^{a}	0.0054
Giblets weight (g)	Male	13.22 ±0.68^{a}	13.12 ±0.36^{a}	11.17 ±0.65^{b}	11.90 ±0.63^{a}	0.0335
	Female	14.70 ±1.08	13.58 ±1.69	14.30 ±1.51	14.36 ±0.85	0.2417
	♂+♀	13.96 ±1.15	13.35 ±1.18	12.74 ±1.98	12.74 ±1.98	0.1670
Carcass yield (%)	Male	73.40 ±0.97	73.30 ±1.15	72.95 ±1.24	71.70 ±1.85	0.1290
	Female	67.39 ±1.80	68.40 ±5.43	70.73 ±2.48	66.08 ±3.72	0.0928
	♂+♀	70.40 ±3.45	70.85 ±4.51	71.84 ±2.19	68.89 ±4.05	0.0917
Liver (g)	Male	4.20 ±0.43^{ac}	4.28 ±0.28^{a}	3.38 ±0.45^{bc}	3.53 ±0.41^{bc}	0.0335
	Female	5.61 ±0.82	4.70 ±0.55	5.68 ±0.94	5.56 ±0.71	0.1280
	♂+♀	1.79 ±0.25	4.49 ±0.47	4.53 ±1.40	4.54 ±1.19	0.4370
Gizzard (g)	Male	3.57 ±0.27^{a}	3.75 ±0.47^{a}	2.88 ±0.42^{b}	3.13 ±0.57^{ab}	0.0335
	Female	3.88 ±0.29	3.76 ±0.53	3.32 ±0.52	3.55 ±0.30	0.1290
	♂+♀	3.73 ±0.31^{a}	3.76 ±0.47^{a}	3.10 ±0.50^{b}	3.34 ±0.48^{ab}	0.0106
Heart (g)	Male	1.79 ±0.26	1.74 ±0.23	1.62 ±0.21	1.71 ±0.10	0.5452
	Female	1.78 ±0.27	1.71 ±0.26	1.61 ±0.21	1.61 ±0.24	0.5464
	♂+♀	1.79 ±0.25	1.72 ±0.23	1.61 ±0.20	1.66 ±0.19	0.3027
Neck (g)	Male	3.66 ±0.26	3.35 ±0.24	3.29 ±0.34	3.54 ±0.41	0.0928
	Female	3.43 ±0.40	3.40 ±0.56	3.70 ±0.48	3.64 ±0.59	0.3704
	♂+♀	3.54 ±0.34	3.38 ±0.41	3.50 ±0.45	3.59 ±0.48	0.2556
Breast (g)	Male	51.81 ±2.70	51.28 ±3.71	46.73 ±2.21	49.85 ±2.17	0.0663
	Female	53.32 ±3.65	54.46 ±5.38	47.42 ±4.03	51.03 ±4.92	0.0928
	♂+♀	52.57 ±3.13^{a}	52.87 ±4.67^{a}	47.08 ±3.08^{b}	50.44 ±3.64^{ab}	0.0076
Thigh (g)	Male	29.92 ±1.88	29.14 ±0.87	28.49 ±2.28	29.90 ±1.20	0.3235
	Female	30.89 ±3.02	31.28 ±2.89	28.98 ±1.29	30.48 ±3.16	0.4250
	♂+♀	30.41 ±2.43	30.21 ±2.31	28.74 ±1.76	30.19 ±2.27	0.2274

Notes: Values are shown as mean ± *SD* (standard deviation); C = control group; E1, E2, E3 = experimental groups; a, b, c = means within a row with different superscripts differ significantly at $p \leq 0.05$, one-way ANOVA.

Raji et al. (2015) observed much lower meat performance characteristics of Japanese quails in comparison with our research. They examined live weight, carcass weight, carcass yields and the weight of the breast and thigh muscle, according to their sex, color type, weight group, and age.

The average live weight was 130.56 g (ranging from 97.19 to 162.67 g); carcass weight of 91.65 g (ranging from 67.60 to 119.54); carcass yield 70.24% (ranging from 68.02 to 72.17); breast muscle weight 27.48 g (ranging from 15.76 to 39.32 g); and thigh muscle weight 19.89 (ranging from 12.61 to 29.30 g).

Some of our results were compared with the results of **Lember and Laan (2012)** who compared male and female carcass characteristics of Estonian, Pharaoh and French White quails. For example, the live body and carcass weight of Estonian quail respectively were similar to our results (comparison of males – females): live body weight 184.4 – 208.6 g and carcass weight 119.1 – 128.8 g. According to the control slaughter, the heaviest quails at the age of 42 days were French white quails (261.2 – 302.4 g), their carcasses were also the biggest (169.8 – 185.8). Females of all quail strains in this study had a bigger live weight at the age of 6 weeks. The lowest weights of the breast and thigh muscle were in Estonian quail male (37.4 and 24.4 g), while the highest in French White (63.0 and 38.5 g). **Nasr et al. (2017)** observed performance, carcass traits, meat quality and amino acid profile of different Japanese quails' strains. There was no significant difference among the quail chicks body weight of different plumages colour at 1 day of age. While at the 6th week of age, the white quail had the highest body weight (205.16 g) and the brown quail had the lowest body weight (174.68 g). The white quail had the highest weight of slaughter and carcass, dressing percentage, carcass yield, weight of liver, gizzard, heart and spleen (197.27 g, 169.27 g, 91%, 82%, 6.63 g, 6.53 g, 2.27 g and 0.40 g, respectively) when compared with the other plumage colours.

CONCLUSION

Based on the results of the experiment, we can conclude that the application of 2, 4 and 6 mg bee bread powderon 1 kg the feed mixture in the nutrition of Japanese quails did not have a positive effect on their achieved meat performance. We propose not to apply this preparation in the amount we tested in their nutrition, respectively to look for other alternative solutions for its application in quails nutrition, alternatively others poultry species.

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Compliance with ethical standards

Birds care, manipulation and handling complied with the regulations of the European Parliament and the European Council Directive on the protection of animals used for scientific purposes (2010/63/EU). The research Animal Ethic Committee of Research Institution approved this experiment.

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