

## THE EFFECT OF INSECT MEALS ON PERFORMANCE PARAMETERS OF JAPANESE QUAILS (*COTURNIX JAPONICA*)

LENKA KUDLOVÁ, JAKUB NOVOTNÝ, ELIŠKA KROTKÁ,  
LUKÁŠ ČUMPLÍK, NIKOLA DVOŘÁČKOVÁ, ONDŘEJ  
ŠŤASTNÍK

Department of Animal Nutrition and Forage Production, Faculty of  
AgriSciences, Mendel University in Brno, Zemědělská 1, 613 00 Brno,  
Czech Republic

*Corresponding email address: [xkudlov1@mendelu.cz](mailto:xkudlov1@mendelu.cz)*

### ABSTRACT

The influence of defatted mealworm meal or defatted black soldier fly larvae meal on performance parameters of Japanese quails was evaluated. Unsexed Japanese quails ( $n = 300$ ) were divided in to 3 experimental groups: 1) control group without insect meal, 2) group with 10% defatted mealworm meal and 3) group with 10% defatted black soldier fly larvae meal. The experiment lasted for 40 days. The group with defatted mealworm meal had higher carcass yield than control group ( $p < 0.05$ ). Growth performance, other carcass traits and weight of liver, heart and gizzard were not affected by experimental diets.

**Keywords:** mealworm; black soldier fly; growth; carcass traits; poultry nutrition

## INTRODUCTION

In poultry nutrition, insect can be used as an alternative protein source (Khan, 2018; Elahi *et al.*, 2022). The insect is also a source of essential amino acids, fats, monounsaturated and polyunsaturated fatty acids, minerals and vitamins (Rumpold and Schlüter, 2013; Zielińska *et al.*, 2015). A black soldier fly (*Hermetia illucens* Linnaeus, 1758), a housefly (*Musca domestica* Linnaeus, 1758), a yellow mealworm (*Tenebrio molitor* Linnaeus, 1758), a lesser mealworm (*Alphitobius diaperinus* Panzer, 1797), a house cricket (*Acheta domesticus* Linnaeus, 1758), a banded cricket (*Gryllodes sigillatus* Walker, 1869), a field cricket (*Gryllus assimilis* Fabricius, 1775) and a silkworm (*Bombyx mori* Linnaeus, 1758) are permitted species of insect as feed for non-ruminant animals in the European Union (Commission Regulation (EU) 2017/893; Commission Regulation (EU) 2021/1925). The Commission Regulation (EU) 2021/1372 allows the inclusion of processed animal protein from insects in poultry diets.

There are not many studies dealing with the inclusion of insect meal in quail diets and the results are quite inconsistent. For example, Silva *et al* (2024) found out the effect of black soldier fly larvae meal on growth performance of Japanese quails, but the relative weight of the digestive organs was not affected by insect meal. Experimental diets with mealworm meal had an effect on final body weight, body weight gain, and feed conversion ratio (FCR), but no effect on feed intake, carcass weight, and carcass yield of Japanese quails (Sabirli and Cufadar, 2019). Zadeh *et al.* (2019) noted the effect of mealworm meal not only on body weight, weight gain and FCR, but also on feed intake, carcass, breast and legs yields. Mealworm meal had no effect on

relative weight of internal organs. On the contrary, Cullere *et al.* (2016) did not notice the effect of the defatted black soldier fly larvae meal on slaughter weight, body weight gain, feed intake, FCR, carcass weight and yield, and breast weight and yield of Japanese quails.

The aim of this study was to evaluate the effect of two insect meals in diets Japanese quails on performance parameters.

## **MATERIAL AND METHODS**

### *Animals and experimental conditions*

A total of 300 seven days old Japanese quails (*Coturnix japonica*) of both sexes were randomly divided in to 3 experimental groups (in total 100 quails per feeding group). The quails were housed in floor system with deep bedding. Microclimate conditions (temperature, humidity) and lighting programme were set according to technological instruction (Hyánková and Hort, 1999). All quails were fed a commercial starter diet for the first week. The quails were fed with experimental starter diets from 7<sup>th</sup> to 19<sup>th</sup> day of age and experimental grower diets from 20<sup>th</sup> to 47<sup>th</sup> day of age. The quails had unlimited access to the feed and water. The feed consumption was daily recorded, and the quails were weighed every week. At the end of the experiment, the quails were slaughtered.

### *Experimental diets*

In the experiment three diets were used: 1) control diet without insect meal, 2) diet with 10% defatted mealworm meal (TM) and 3) diet with 10% defatted black soldier fly larvae meal (HI). The quails were fed a non-pelleted feed mixture that corresponded to their nutrient

requirements. Compounds and chemical composition of diets are shown in Table 1.

**Table 1.** Compounds and chemical composition of experimental diets (100% dry matter)

| Compound (%)                  | Starter |       |       | Grower  |       |       |
|-------------------------------|---------|-------|-------|---------|-------|-------|
|                               | Control | TM    | HI    | Control | TM    | HI    |
| Wheat                         | 5.00    | 14.15 | 8.40  | 10.00   | 20.05 | 14.60 |
| Maize                         | 34.93   | 36.50 | 36.60 | 47.02   | 47.25 | 47.90 |
| Rapeseed oil                  | 4.00    | 1.69  | 2.50  | 3.18    | 1.06  | 1.20  |
| Soybean meal                  | 53.00   | 34.61 | 39.00 | 36.50   | 18.54 | 22.85 |
| Mealworm meal                 | -       | 10.00 | -     | -       | 10.00 | -     |
| Black soldier fly larvae meal | -       | -     | 10.00 | -       | -     | 10.00 |
| Premix*                       | 3.00    | 3.00  | 3.00  | 3.00    | 3.00  | 3.00  |
| DL-methionine                 | 0.07    | 0.05  | 0.30  | 0.20    | 0.10  | 0.25  |
| L-Lysine                      | -       | -     | 0.20  | 0.10    | -     | 0.20  |
| Crude protein                 | 29.73   | 29.34 | 29.52 | 23.20   | 23.01 | 23.11 |
| Ether extract                 | 7.27    | 5.17  | 6.28  | 6.35    | 3.97  | 4.28  |
| Crude fibre                   | 4.27    | 4.61  | 4.63  | 4.36    | 4.45  | 4.62  |
| Crude ash                     | 7.28    | 7.08  | 7.40  | 6.37    | 6.40  | 6.38  |

Legend: TM – 10% defatted mealworm meal; HI – 10% defatted black soldier fly larvae meal.

\***Composition of premix for starter** (per kg): Lysine 6.7%; Methionine 8.3%; Threonine 3.0%; calcium 21.0%; phosphorus 3.5%; sodium 4.2%; copper 500 mg; iron 2,500 mg; zinc 3,300 mg; manganese 3,300 mg; iodine 34.25 mg; selenium 6 mg; retinol 280,000 IU (international unit); calciferol 166,700 IU; tocopherol 1,500 mg; phylloquinone 50 mg; thiamine 140 mg; riboflavin 280 mg; pyridoxin 200 mg; cobalamin 1,000 µg; biotin 7 mg; niacinamide 1,200 mg; folic acid 60 mg; calcium pantothenate 450 mg; choline chloride 6,000 mg. **Composition of premix for grower** (per kg): Lysine 7%; Methionine 7.5%; Threonine 3.1%; calcium 19.0%; phosphorus 3.3%; sodium 4.6%; copper 500 mg; iron 2,500 mg; zinc 3,300 mg; manganese 3,300 mg; iodine 34.20 mg; selenium 12 mg; retinol 280,000 IU (international unit); calciferol 165,000 IU; tocopherol 1,500 mg; phylloquinone 44 mg; thiamine 135 mg; riboflavin 280 mg; pyridoxin 200 mg; cobalamin 960 µg; biotin 6 mg; niacinamide 1,200 mg; folic acid 55 mg; calcium pantothenate 445 mg; choline chloride 6,000 mg.

### *Sample collection*

The 6 individuals from each group were selected for evaluation carcass traits and organ weights. The carcass and organs (liver, heart and gizzard) were weighed. The gizzards were weighed with the cuticle. Carcass yields were calculated as a percentage of live weight. The breast and legs were weighed, and the breast and legs yields were calculated as a percentage of carcass weight. The legs were weighed with bones.

### *Statistical analysis*

The data were processed by Microsoft Excel (USA) and TIBCO Statistica version 14.0 (USA). A one-way analysis of variance (ANOVA) and Scheffé's test were used to determine statistically differences between groups. The value  $p < 0.05$  was regarded as a statistically significant difference.

## **RESULTS AND DISCUSSION**

There were no statistically significant differences between feed consumption values in the experiment ( $p > 0.05$ ). In the control group, the average daily feed consumption during the experiment was 24.77 g/bird, in the TM group 25.81 g/bird and in the HI group 25.32 g/bird. Table 2 shows insect meals had no effect ( $p > 0.05$ ) on final weight, average gain and FCR of Japanese quails. The same conclusion was reached by Cullere *et al.* (2016), who fed quails with 10% and 15% defatted black soldier fly larvae meal in diet. Sabirli and Cufadar (2019) found out that mealworm meal influenced final body weight, body weight gain and FCR, where quails fed 2% of mealworm meal had higher final body weight and body weight gain and quails fed

4% and 6% of mealworm meal had worse FCR than other groups. Silva *et al.* (2024) reported the positive effect of black soldier fly larvae meal on body weight, body weight gain and FCR than control group. Zadeh *et al.* (2019) also reported influence of mealworm meal on body weight, daily weight gain, FCR and additionally daily feed consumption. Groups of quails fed 22.5 g and 30 g of mealworm meal had higher body weight and weight gain than other groups. Additionally group with 30 g of mealworm meal in diet had lower feed consumption and better FCR than other experimental groups.

**Table 2.** Growth performance of Japanese quails

| Group              | Control           | TM                | HI                |
|--------------------|-------------------|-------------------|-------------------|
| n                  | 100               | 100               | 100               |
| Mean $\pm$ SE      |                   |                   |                   |
| Initial weight (g) | 27.16 $\pm$ 0.71  | 27.40 $\pm$ 0.56  | 27.36 $\pm$ 0.59  |
| Final weight (g)   | 252.10 $\pm$ 3.08 | 248.60 $\pm$ 3.08 | 255.94 $\pm$ 3.16 |
| Average gain (g)   | 224.94 $\pm$ 3.40 | 221.20 $\pm$ 2.62 | 228.58 $\pm$ 2.17 |
| FCR                | 4.41 $\pm$ 0.08   | 4.67 $\pm$ 0.07   | 4.43 $\pm$ 0.07   |

*No statistically significant differences ( $p > 0.05$ ); TM – 10% defatted mealworm meal; HI – 10% defatted black soldier fly larvae meal; n – number of cases; SE – standard error; FCR – feed conversion ratio*

In the experiment the carcass yield was influenced. TM group had higher carcass yield compared to control group ( $p < 0.05$ ). Other carcass traits were without significant differences between experimental groups ( $p > 0.05$ ) (Table 3). Zadeh *et al.* (2019) also found out the effect of mealworm meal on carcass traits, where group of quails fed 30 g mealworm meal in diet had higher carcass yield, breast yield and legs yield compared to other groups. In contrast,

Cullere *et al.* (2016) and Sabirli and Cufadar (2019) did not find out an effect of insect meal on carcass traits.

**Table 3.** Carcass traits of Japanese quails

| Group              | Control                       | TM                            | HI                             |
|--------------------|-------------------------------|-------------------------------|--------------------------------|
| n                  | 6                             | 6                             | 6                              |
| Mean $\pm$ SE      |                               |                               |                                |
| Body weight (g)    | 239.83 $\pm$ 5.14             | 234.50 $\pm$ 3.55             | 246.33 $\pm$ 2.62              |
| Carcass weight (g) | 162.52 $\pm$ 3.50             | 167.14 $\pm$ 2.86             | 171.86 $\pm$ 2.09              |
| Carcass yield (%)  | 67.79 $\pm$ 0.84 <sup>a</sup> | 71.27 $\pm$ 0.53 <sup>b</sup> | 69.77 $\pm$ 0.35 <sup>ab</sup> |
| Breast weight (g)  | 20.76 $\pm$ 0.84              | 21.79 $\pm$ 0.21              | 22.35 $\pm$ 0.78               |
| Breast yield (%)   | 25.51 $\pm$ 0.67              | 26.09 $\pm$ 0.35              | 26.02 $\pm$ 0.91               |
| Legs weight (g)    | 17.05 $\pm$ 0.42              | 17.31 $\pm$ 0.56              | 18.48 $\pm$ 0.52               |
| Legs yield (%)     | 21.01 $\pm$ 0.61              | 20.74 $\pm$ 0.74              | 21.49 $\pm$ 0.42               |

<sup>a, b</sup> – means statistically significant difference ( $p < 0.05$ ); TM – 10% defatted mealworm meal; HI – 10% defatted black soldier fly larvae meal; n – number of cases; SE – standard error

**Table 4.** Weight of organs of Japanese quails

| Group         | Control         | TM              | HI              |
|---------------|-----------------|-----------------|-----------------|
| n             | 6               | 6               | 6               |
| Mean $\pm$ SE |                 |                 |                 |
| Liver (g)     | 5.11 $\pm$ 0.45 | 4.61 $\pm$ 0.18 | 4.50 $\pm$ 0.44 |
| Heart (g)     | 2.17 $\pm$ 0.05 | 2.20 $\pm$ 0.10 | 2.14 $\pm$ 0.10 |
| Gizzard (g)   | 4.47 $\pm$ 0.28 | 4.43 $\pm$ 0.16 | 4.13 $\pm$ 0.29 |

No statistically significant differences ( $p > 0.05$ ); TM – 10% defatted mealworm meal; HI – 10% defatted black soldier fly larvae meal; n – number of cases; SE – standard error

In Table 4 is shown that the weight of liver, heart and gizzard of Japanese quails were not affected by experimental diets ( $p > 0.05$ ). In studies Zadeh *et al.* (2019) with mealworm meal and Silva *et al.* (2024) with black soldier fly larvae meal in diets of Japanese quails also found out no effect of insect meals on relative weight of gizzard, liver and heart.

## CONCLUSION

The influence of 10% defatted mealworm meal or defatted black soldier fly larvae meal on performance parameters of Japanese quails was evaluated. Carcass yield was higher in group with 10% defatted mealworm meal compared to control group. The insect meals did not have any negative effects on other performance parameters like growth, other carcass traits and weight of liver, heart and gizzard.

## ACKNOWLEDGEMENT

The project was supported by the Internal Grant Agency of the Faculty AgriScience (Mendel University in Brno) no. IGA24-AF-IP-061:” The effect of addition of insect meal on performance and health parameters to Japanese quails (*Coturnix japonica*) diets“.

## REFERENCES

- Commission Regulation (EU) 2017/893 of 24 May 2017 amending Annexes I and IV to Regulation (EC) No 999/2001 of the European Parliament and of the Council and Annexes X, XIV and XV to Commission Regulation (EU) No 142/2011 as regards the provisions on processed animal protein.
- Commission Regulation (EU) 2021/1372 of 17 August 2021 amending Annexes IV to Regulation (EC) No 999/2001 of the European Parliament and of the Council as regards the prohibition to feed non-



ruminant farmed animals, other than fur animals, with protein derived from animals.

- Commission Regulation (EU) 2021/1925 of 5 November 2021 amending certain Annexes to Regulation (EU) No 142/2011 as regards the requirements for placing on the market of certain insect products and the adaptation of a containment method.
- Cullere, M., Tasoniero, G., Giaccone, V., Miotti-Scapin, R., Claeys, E., De Smet, S., Dalle Zotte, A. (2016): Black soldier fly as dietary protein source for broiler quails: apparent digestibility, excreta microbial load, feed choice, performance, carcass and meat traits. *Animal* 10.12, 1923–1930.
- Elahi, U., Xu, C.C., Wang, J., Lin, J., Wu, S.G., Zhang, H.J., Qi, G.H. (2022): Insect meal as a feed ingredient for poultry. *Animal Bioscience* 35.2, 332–346.
- Hyánková, L., Hort, J. (1999): *Stručný průvodce pro začínající chovatele japonských křepelek masného typu. Výzkumný ústav živočišné výroby, Praha, Czechia (in Czech)*. ISBN 80-238-4006-1.
- Khan, S.H. (2018): Recent advances in role of insects as alternative protein source in poultry nutrition. *Journal of Applied Animal Research* 46.1, 1144–1157.
- Rumpold, B.A., Schlüter, O.K. (2013): Nutritional composition and safety aspects of edible insects. *Molecular Nutrition & Food Research* 57, 802–823.
- Sabirli, H., Cufadar, Y. (2019): The Effects of Addition to Different Levels of Mealworm (*Tenebrio molitor*) to Quail Diets on Performance and Carcass Traits. *Selcuk Journal of Agriculture and Food Sciences* 33.3, 248–251.
- Silva, B.C.R., Paulino, M.T.F., da Silva, L.A.L., Andrade, J.M.M., Marcato, S.M. (2024): Black soldier fly (*Hermetia illucens*) larvae meal improves quail growth performance. *Tropical Animal Health and Production* 56.2, 65.
- Zadeh, Z.S., Kheiri, F., Faghani, M. (2019): Use of yellow mealworm (*Tenebrio molitor*) as a protein source on growth performance, carcass traits, meat quality and intestinal morphology of Japanese quails (*Coturnix japonica*). *Veterinary and Animal Science* 8, 100066.
- Zielińska, E., Baraniak, B., Karaś, M., Rybczyńska, K., Jakubczyk, A. (2015): Selected species of edible insects as a source of nutrient composition. *Food Research International* 77, 460–466.