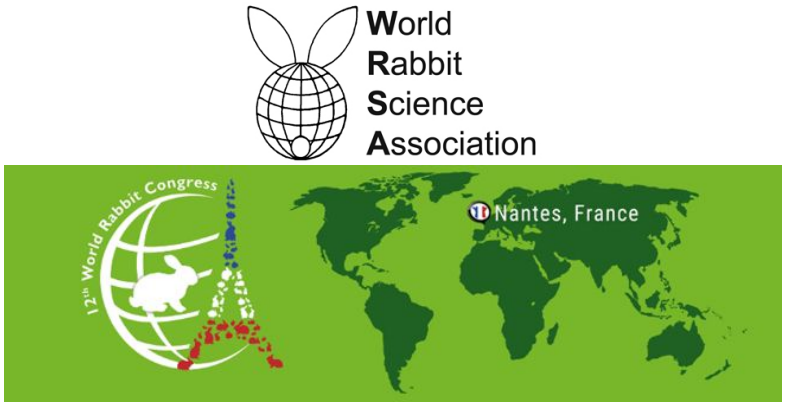

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EFFECT OF SILKWORM (*BOMBYX MORI*) OIL DIETARY INCLUSION ON LIVE PERFORMANCE AND CARCASS TRAITS OF GROWING RABBITS

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ABSTRACT

The objective of the study was to examine the effect of a complete dietary substitution of sunflower oil with silkworm (*Bombyx mori* L.) pupae oil (SWO) and evaluate the growth performance and carcass traits of growing rabbits. Weaned rabbits (5wk) were randomly divided into 2 groups (n=32 rabbits/group; pair-caged) which were both fed with a commercial pelleted diet containing 1.3% sunflower oil (Control) until 7 weeks of age. From 7 to 10 weeks of age, half of the rabbits continued to receive the Control diet, whereas the second group received a diet in which the sunflower oil was completely (1.30%) replaced by SWO. *Ad libitum* feeding was applied throughout the experiment and drinking water was also freely available from nipple drinkers. The individual body weight and on a cage basis feed intake of rabbits were measured weekly. Daily weight gain and feed conversion ratio were then calculated. Morbidity of animals was also monitored weekly, whereas mortality was checked daily. At 10 weeks of age, rabbits were slaughtered and dissected. Globally, the weight gain, feed intake and feed conversion ratio of rabbits were not influenced by the dietary inclusion of SWO. No morbidity and mortality were observed during the growing period in both groups. Carcass traits were also similar in the two experimental groups. In conclusion, SWO can be considered a promising feed ingredient for growing rabbits as it ensured satisfactory growth performance and carcass traits.

Key words: Silkworm oil, Rabbit nutrition, Growing rabbit, Growth performance, Carcass traits

INTRODUCTION

In recent decades several research have been investigated about alternative feedstuffs in animal nutrition. Insects are promising source of energy, protein, fat, minerals and vitamins, and have low environmental impact (Dobermann *et al.*, 2017). Their protein quality is generally high and lipids represent a good source of essential polyunsaturated fatty acids (PUFA). They are constituents of the natural diet of pigs, poultry and fish (Dobermann *et al.*, 2017), and a suitable replacement for fish and soybean meal in aquaculture and terrestrial livestock diets as a new protein source. Consumers generally accept to eat meat products from livestock fed insect meals (Szendrő, 2019). Dalle Zotte *et al*. (2018), Martins *et al.* (2018), Gasco *et al*. (2019) tested some insect meal/fat in rabbit diets. The most studied insect species to replace conventional protein sources are the black soldier fly (BSF; *Hermetia illucens*), the yellow mealworm (YM; *Tenebrio molitor*), and the house cricket (*Acheta domesticus*). Recently, the silkworm (*Bombyx mori* L.) is being also under study (Gugołek *et al*., 2019). Insect meal can be fullfat or defatted, the latter permits to obtain both insect processed animal proteins (PAPs) and fats/oils as valuable energy source and as source of essential fatty acids (FA). In rabbits, when the diet contained BSF larvae fat (instead of extruded linseed) growth performance and carcass traits were not affected, however the supplementation influenced the total tract apparent digestibility of the diets (Martins *et al*., 2018), and the FA profile and the oxidative stability of the meat (Dalle Zotte *et al*., 2018). Gasco *et al*. (2019) also did not find differences in growth

performances, morbidity, mortality and blood parameters when soybean oil content of growing rabbit's diet was totally or partially replaced with BSF fat or YM larvae fat. In silk industry when silkworm is processed, dry pupae consists in a by-product. However, dried silkworm pupae are a rich source of protein and lipids (51.6-70.6 and 6.2-37.1%, respectively; Makkar *et al*., 2014) which makes interesting their incorporation in rabbits' diet. To the best of our knowledge, no studies have yet been carried out to determine the effects of dietary sunflower oil replacement by silkworm oil (SWO) on rabbits live performance. Therefore, the objective of the study was to examine the effect of complete dietary substitution of sunflower oil with SWO and evaluate the growth performance, carcass and meat quality traits of growing rabbits. The results of meat quality are presented elsewhere (Singh *et al*., 2020).

MATERIALS AND METHODS

Animals and experimental design

The experiment was conducted at the rabbit farm of the Kaposvár University (Hungary) using Pannon White growing rabbits. Weaned rabbits (5 wk) were pair-housed in wire mesh cages (0.61 x 0.32 m; 10.2 rabbits/m^2). The rabbits were randomly divided into 2 groups: in the Control group rabbits consumed a commercial pelleted diet containing the 1.3% sunflower oil from 5 to 10 weeks of age (DE: 9.14 MJ/kg; crude protein: 16.0%; crude fibre: 18.1%; crude fat: 3.8%). The second group (SWO) of rabbits received the Control diet from 5 to 7 weeks and then, from 7 to 10 weeks of age, they were fed with an experimental diet, identical of the Control group, except for the fact that the sunflower oil was completely replaced by the SWO. During the experiment, the ambient temperature range was 15-18 ^{o}C, and a 16L:8D lighting schedule was applied. Feed was provided *ad libitum* throughout the experiment and drinking water was also freely available from nipple drinkers. At 10 weeks of age, rabbits were slaughtered and carcasses were dissected according to the recommendations of the World Rabbit Science Association (Blasco and Ouhayoun, 1996). During the experiment, the individual body weight (BW) and cage-basis feed intake (FI) of rabbits were measured weekly. Daily weight gain (DWG) and feed conversion ratio (FCR) were then calculated. Morbidity of animals was monitored weekly too, whereas mortality was checked daily. At slaughter, the slaughter weight and the chilled carcass weight (24h chilling at 4 ^{o}C) of rabbits were recorded and used to calculate the dressing out percentage (DoP). After dissection, the different parts of the reference carcass (RC) were weighed and used to compute the ratios of parts to the RC.

Statistical Analysis

Production and carcass traits were evaluated with a One-way ANOVA using SPSS 10.0 software for Windows. The significance was calculated at the 5% confidence level.

RESULTS AND DISCUSSION

The live performance of growing rabbits is shown in Table 1. Overall, the 100% dietary substitution of sunflower oil with SWO provided comparable BW, DWG, FI and FCR in the two experimental groups. The sole, unexpected, difference was found in the DWG of rabbits at 7-8 weeks of age which was 5% higher in SWO than in Control rabbits ($P<0.05$). Moreover, no morbid rabbits were observed throughout the experiment which ensured absence of mortality in both dietary groups. Results of the present research agree with previous findings regarding the use of insect fats from BSF (3 and 6% inclusion levels; Martins *et al*., 2018), and from BSF and YM (0.75 and 1.5% inclusion levels for both insect oil sources; Gasco *et al*., 2019) into diets for growing rabbits. Furthermore, an experiment on rats (Longvah *et al*., 2012) highlighted that the dietary inclusion of 10% SWO did not affect growth performance, which was consistent with the present findings too. In the sole other experiment testing the use of *Bombyx mori* into rabbit diets, the 50 and 100% substitution of soybean meal with silkworm pupae meal (SWM) penalised FI, BW and BWG, which was attributable to the presence of chitin in the SWM, but improved FCR (Gugołek *et al*., 2019).

Table 1. Effect of the dietary replacement of sunflower oil with silkworm oil (1.3%) on the production performance of growing rabbits

	Experimental groups[1]		SE	P
	Control	SWO		
Body weight, g				
5 wk	881	881	8.50	0.971
6 wk	1226	1242	11.7	0.482
7 wk	1598	1615	12.3	0.476
8 wk	1924	1959	12.4	0.161
9 wk	2250	2291	14.1	0.147
10 wk	2506	2544	15.8	0.234
Daily weight gain, g				
5-6 wk	49.3	51.6	0.93	0.219
6-7 wk	53.1	53.3	0.73	0.918
7-8 wk	46.6	49.0	0.60	0.040
8-9 wk	46.7	47.5	0.82	0.594
9-10 wk	36.6	36.1	0.83	0.783
5-10 wk	46.4	47.5	0.39	0.178
Daily feed intake, g				
5-6 wk	85	86	0.93	0.704
6-7 wk	113	115	1.28	0.541
7-8 wk	123	126	1.28	0.230
8-9 wk	144	147	1.77	0.413
9-10 wk	142	142	1.63	0.942
5-10 wk	121	123	1.12	0.449
Feed conversion ratio				
5-6 wk	1.74	1.67	0.02	0.091
6-7 wk	2.15	2.16	0.03	0.840
7-8 wk	2.64	2.57	0.03	0.286
8-9 wk	3.10	3.10	0.03	0.992
9-10 wk	3.91	3.95	0.06	0.740
5-10 wk	2.61	2.59	0.02	0.531

Animals received the Control diet until 7 weeks of age, then Control and SWO diets between 7 and 10 weeks of age. Body weight and daily weight gain measurements on 32 rabbits per experimental group; daily feed intake and feed conversion ratio measurements on 16 cages per experimental group.

The carcass traits of rabbits fed with Control and SWO diets are shown in Table 2. Similarly to what it was found for live performance, also in this case Control and SWO rabbits showed similar results: the slaughter weight of rabbits was not affected by the dietary treatments as well as the chilled and reference carcass yields, and the fat depots.

Consistently with the present findings, Martins *et al*. (2018) also did not find any differences in carcass traits of rabbits fed with two dietary inclusion levels of BSF larvae fat. Diversely, the complete dietary substitution of soybean meal with SWM lowered overall carcass traits of rabbits, as a result of the reduced growth, possibly due to the presence of chitin in the SWM which tends to reduce the nutrients assimilation (Gugołek *et al*., 2019).

Table 2. Effect of the dietary replacement of sunflower oil with silkworm oil (1.30%) on the carcass traits of growing rabbits

	Experimental groups		SE	P
	Control	SWO		
N.	32	32		
Slaughter weight (SW), g	2547	2593	15.5	0.135
Chilled carcass (CC), g	1550	1564	11.0	0.530
Reference carcass (RC), g	1335	1346	9.81	0.573
Dressing out percentage (CC to SW), %	60.8	60.3	0.19	0.153
Ratio to RC, %				
Fore part	28.4	28.3	0.12	0.546
Mid part	30.9	30.9	0.14	0.773
Hind part	39.0	39.2	0.10	0.441
Perirenal fat	1.28	1.21	0.05	0.424
Scapular fat	0.39	0.37	0.02	0.673

CONCLUSIONS

The oil obtained from the silkworm pupae can be considered a promising alternative feed ingredient for diets intended for growing rabbits, as it provides growth performance and carcass traits comparable to those obtained using a conventional commercial diet.

ACKNOWLEDGEMENTS

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12th World Rabbit Congress

Nantes (France)
3-5 November 2021

Introduction

- Alternative feedstuffs in animal nutrition

  - ➢ Insects (protein, fat)

  - ✓ black soldier fly *(Hermetia illucens)*,
  - ✓ yellow mealworm *(Tenebrio molitor)*,
  - ✓ house cricket *(Acheta domesticus)*,
  - ✓ silkworm *(Bombyx mori L.)*.

Aim

? Effects of dietary sunflower oil replacement by silkworm oil (SWO) on rabbits live performance? ?

? ? ?

Materials and methods

Kaposvár University (Hungary)

Pannon White growing rabbits (5-10 wk)

2 rabbits/cage (10 rabbits/m^2)

Pelleted feed and water *ad libitum*

Experimental design

Control

❖ **Control diet**: 5-10 weeks

DE:	9.14 MJ/kg
Crude protein:	16.0 %
Crude fibre:	18.1 %
Crude fat:	3.8 %

1.3 % sunflower oil

Silkworm oil (SWO)

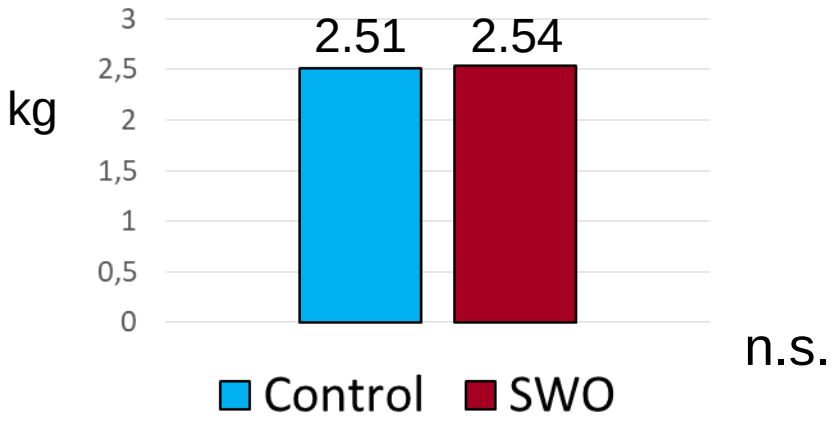
❖ **Control diet**: 5-7 weeks

❖ **SWO diet**: 7-10 weeks

1.3 % silkworm oil
(without sunflower oil)

Results – Production performance

Body weight (10 wk)



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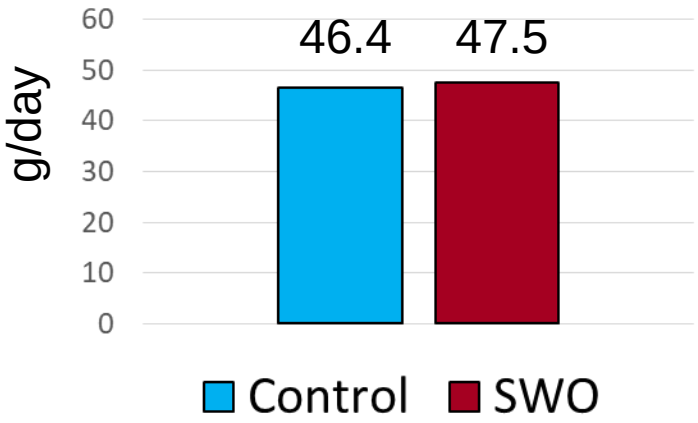
Weight gain (5-10 wk)



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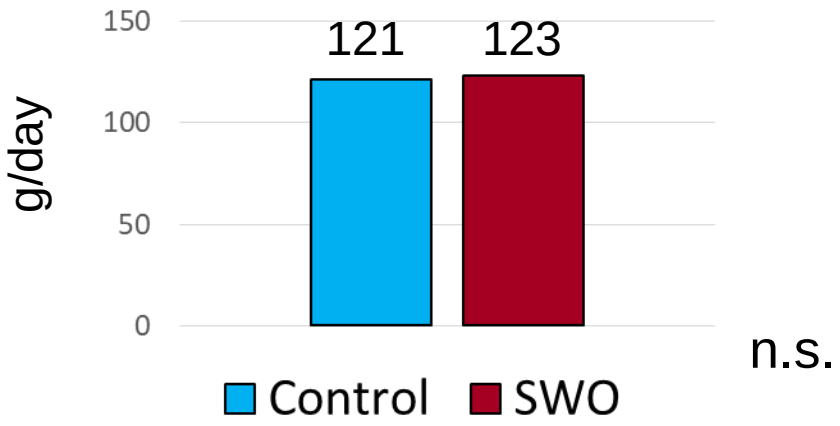
Feed intake (5-10 wk)



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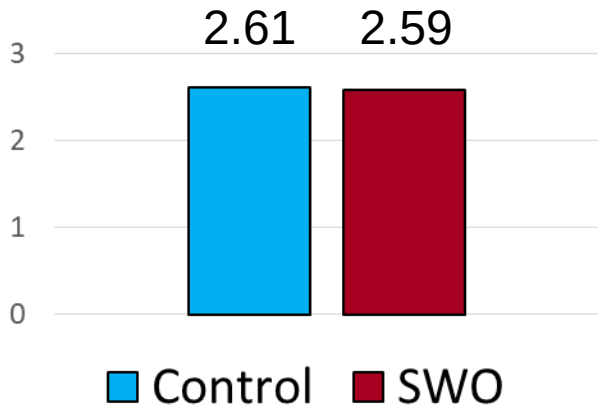
Feed conversion ratio (5-10 wk)



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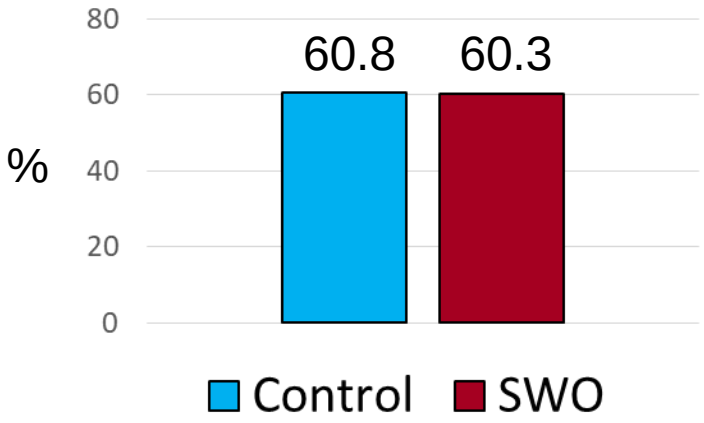
Results – Carcass traits

Dressing out percentage (CC to SW)



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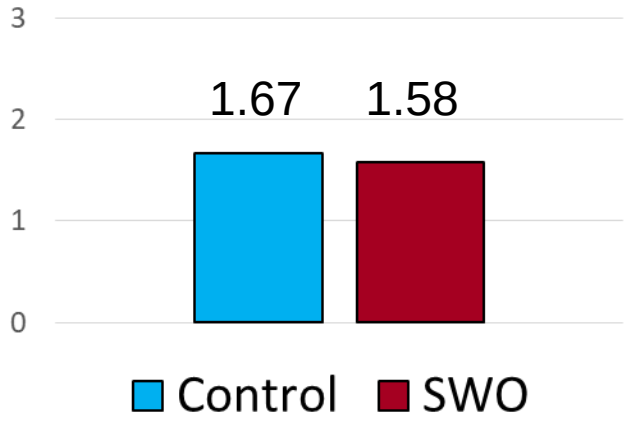
Ratio of perirenal+scapular fats to RC



n.s.

Conclusion

- ✓ The oil obtained from the silkworm pupae can be considered a promising alternative feed ingredient for diets intended for growing rabbits.

- ✓ It provides growth performance and carcass traits comparable to those obtained using a commercial diet with sunflower oil.

Thank you for attention!