PRODUCTION OF INSECT LARVAE SUITABLE FOR LIVESTOCK FEEDING ON A MEAT AND BONE MEAL SUBSTRATE

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Abstract

Interest in the possibility of using insects as a link in the food chain for animals is constantly growing. Based on numerous studies, insects have been shown to be a high-quality feed source for livestock and their use as a sustainable feed ingredient is technically feasible. Insect larvae can be reared on low-grade bio-waste and can turn this bio-waste into high quality proteins. Meat and bone meal was previously used as a valuable feed before there was a legislative restriction and now is usually disposed of as waste by incineration. It would be more advantageous to use this material more efficiently, in contrast to direct feeding to pigs and poultry, which is prohibited, to transform it into insect meal, which is more acceptable in terms of legislation and safety. We have decided to verify the possibility of breeding fly larvae (Lucilia sericata) on meat bone meal substrate, check the production in terms of risks and describe the resulting material. Based on the results of the experiment, we can state that such larval production is possible, but the native substrate needs to be modified to increase larval survival and improve development. The obtained raw material is a valuable high protein feed ingredient.

Key Words: insect larvae; meat and bone meal; feeding value

In the last few decades, edible insects have been used as an alternative nutritional source for both food and animal feed (Veldkamp and Bosch, 2015; Nowak et al., 2016). According to the results so far, insects can be considered as a suitable feed for monogasters. Investigating its effect on the animal performance, searching for the most suitable species or substrates for rearing is a current topic of research. Manufacturing processes are being developed and there are already commercially available technologies that can be used with minor modifications. The attention paid to it is growing, the reasons being the economic costs of protein sources, which are constantly increasing, problems with import of raw materials and food competition.

Meat and bone meal (MBM) is the final product of the disposal of dead animals. Even in high-quality farms, it is not possible to prevent a certain proportion of animal deaths, and the production of meat and bone meal is therefore an inevitable part of animal husbandry in developed countries. MBM was previously used as a valuable feed, but its incorrect use, especially for ruminant nutrition, the occurrence of BSE and public fear led to legislation ban the feeding of MBM. It was later relaxed, but the relaxation does not apply to MBM made from cadavers. The meal is usually disposed of as waste by incineration. The maximum possible benefit is therefore thermal energy, if this material is used in a biogas station then possible electrical energy. It would be more advantageous to use this material more efficiently, in contrast to direct feeding to pigs and poultry, which is prohibited, to transform it into insect meal, which is more acceptable in terms of legislation and safety.

The task of the research is to check the production in terms of risks and describe the resulting material. Last but not least, there was

necessary to investigate the possibility of breeding fly larvae on MBM substrate, which is not entirely natural for them. Larvae are a rich source of protein and lipids and can be fed directly or dried and ground. Due to their high ability to bind to heavy metals and various chemical substances in their body, they could be used as carriers of iron supplements, but also antibiotics or other drugs. Fly larvae are relatively easy to raise in the laboratory or on commercial farms, have short developmental cycles, and are relatively tolerant of a wide range of rearing conditions.

The paper presents a pilot study focused on the possibility of rearing fly larvae on MBM. The main reason is that fly larvae are a natural component of the food of pigs, chickens or fish and have a number of advantages if we consider them as an ingredient in traditional feeds.

The aim of the study was to verify the possibility of breeding fly larvae on meat bone meal substrate and describe the resulting material.

Material and Methods

For the experiment, the family Calliphoridae was chosen, whose larvae are necrophagous and naturally feed on the flesh of dead vertebrates. Depending on the species, a single female could lay about 200 eggs at a time and 1,000 to 1,800 eggs in her lifetime. Only the larva needs 0.2 g to 0.3 g of fresh flesh to grow to the post-feeding stage. In the end, more than 300 kg of larvae is obtained from a kilogram of eggs within a few days. The first experiments were performed with the species Lucilia sericata (Meigen, 1826) (Diptera: Calliphoridae), which is common in our urbanized habitats and is often used in worm debridement therapy.

Climatic chamber Panasonic MLR 352H was used for the experiment under these conditions - temperature 25 °C, humidity 50%, light : dark – 12 : 12 hours. Native MBM with a content of 4-7% moisture, 48 % protein and 9 % fat was used as a substrate.

The larvae were harvested before they pupate and subsequently killed by freezing in accordance with the legislative regulations for the production of edible insects and stored at a temperature of -18 °C for 1 month. After thawing, drying and milling into meal was carried out. A basic chemical analysis was performed. The content of dry matter, protein, lipids, ash and fiber were determined according to standard methodology. The amino acid content was determined by an analyzer AAA 400 (INGOS s.r.o. Praha) after hydrolysis with 6 M HCl according to standard method.

Results and Discussion

Preliminary results have shown that MBM cannot be fed in its native state because it is so dry that egg and first instar larval mortality reaches 80% to 100%. Therefore, humidified MBM (approximately 70%) was used in the following tests and egg and first instar larval mortality was reduced by 50% to 70%. Nevertheless, we could observe that the entire developmental cycle was still negatively affected, as only half of all larvae developed to the second instar and a third to a quarter to the third (final) instar. The breeding masks in the MBM humidifier revealed another problem. Moistened MBM molds easily and quickly, and although it should contain enough of the required nutrients, all immature stages were small and delayed in their development. In the following experiments, we can try to modify the state of MBM to be firmer or, conversely, fluffier, possibly mixed with sawdust for better moisture control, as well as other species from the Calliphoridae family or the Sarcophagidae and Muscidae families could be tested.

The nutritional composition of insects is very diverse, depending mainly on the type of insect, feed and breeding quality (Mlček et al., 2021). Chemical analysis of the meal obtained from the larvae produced in the experiment revealed the content of basic nutrients. The results are presented in Tab.1. The meal is very rich in

proteins (53.4%). Protein representation is higher than reported by sources in the literature for Hermetia illucens (De Marco et al., 2015; Wang and Shelomi, 2017; Rawski et al., 2020). Similar values can be found in the literature for tenebrio molitor larvae (Ramos-Elorduy et al., 2002; De Marco et al., 2015; Bovera et al., 2016; Yoo et al., 2019; Sedgh-Gooya et al., 2020). On the contrary, the fat content was very low compared to the mentioned insect species. Fat content is commonly between 10 and 50% for edible insects (Yin et al., 2017).

The content of lysine, which reached 3.3 % in the obtained meal, is certainly worth emphasizing. Threonine content was 2.6%. The amino acid content of edible insects is 10–70%, and essential amino acid content is 10–30%. Most of the amino acid ratios for insect are appropriate and have approached or even exceeded that of the WHO/FAO required ratio (Yin et al., 2017). Compared to soybean meal, insect proteins are generally lower in arginine and cysteine (except mealworm larvae) and higher in methionine and tyrosine. The Essential Amino Acid Index (EAAI) of insects (Black soldier, Yellow mealworm larvae and Common housefly larvae) is above 1 indicating that protein sources provided in general more of the essential amino acids than required for broilers as well as growing pigs (Veldkamp et al., 2012).

Edible insects are rich in mineral elements, including Ca, P, Fe and zinc, etc. It is reported that feed insects can fulfil the requirement of animals' Fe, Cu, Zn and Mg mineral elements (Barker et al., 1998). The content of mineral substances in insect meal produced in the experiment is shown in Tab. 2.

Table 1. Nutritional composition of insect meal

Composition (%)	Dry matter	Crude protein	Crude fat	Crude fiber	Crude ash	Lysine
Meat and bone meal	96	47.6	8.8	1.4–2.2	14.5	2.3
Lucilia Sericata larvae	95	53.4	7.1	7.6	4.7	3.3
Tenebrio molitor larvae [1, 2, 3, 4, 5]	94	47.1–55.3	22.9–36.8	5.0–7.5	2.6–6.9	1.8–5.7
Hermetia illucens [2, 6, 7]	93	35.9–48.1	36.8–48.1	6.5	4.9–8.4	1.8–2.1

Source: [1] Ramos-Elorduy et al.(2002), [2] De Marco et al. (2015), [3] Bovera et al.(2016), [4] Yoo et al.(2019), [5] Sedgh-Gooya et al. (2020), [6] Wang and Shelomi (2017), [7] Rawski et al. (2020).

Table 2. The content of mineral substances in insect meal

Content of mineral elements	P (%)	K (%)	Na (%)	Ca (%)	Mg (%)	Cu mg/kg	Zn mg/kg	Fe mg/kg	Mn mg/kg
	0.469	0.743	0.513	0.471	0.142	55.89	11.22	123.4	17.7

Conclusion

We found that the production of lucilia sericata larvae on meat and bone meal substrate is technically possible. This would make it possible to produce a quality source of nutrient-rich feed and at the same time use the substrate that is now disposed of as waste. The main bottlenecks are likely to be in the area of legislation.

Based on the obtained results, it is necessary to adjust the condition of the MBM substrate in the following experiments to increase larval survival and improve development. We would also like to test other species from the family Calliphoridae or the families Sarcophagidae and Muscidae. At the same time, the risk of pathogen transmission should be investigated using microbial analyzes and controlled contamination of the substrate.

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