Research in Veterinary Science 155 (2023) 124–125

Contents lists available at ScienceDirect

Research in Veterinary Science

journal homepage: www.elsevier.com/locate/rvsc

# Insects in ruminant nutrition as an urgent measure in the light of the scarcity of raw feedstock

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ARTICLE INFO

*Keywords:*
Ruminants
Insects
Nutrition
Circular economy

## 1. Introduction

Global population growth will lead to an increase in demand for animal-based foods, such as meat and milk from ruminants, which will require restructuring some of the components of the ration (Castillo et al., 2017; Van Huis, 2020). This need is controversial for several reasons: 1) contribution to the depletion of environmental resources; 2) competition of protein sources with human food or fuel increasing prices for farmers, minimising farm profitability.

The year 2022 will be remembered in the European agricultural sector as disastrous due to: 1) the Russia-Ukraine war, increasing the price of cereals; 2) the persistent drought leading to a reduction in crops; 3) the fires causing land degradation and 4) the environmental pressure on this sector as a source of methane emissions which contributes to increasing the Greenhouse Gases (GHG). Although methane remains in the atmosphere for a short time and is emitted in smaller amounts than other elements such as $CO_2$ or N, its capacity to trap heat in the atmosphere is 28 times greater.

The Food and Agriculture Organization (FAO) in 2013 established that *entomophagy* was a solution to fight human hunger. Crunchy snacks, energy bars, hamburgers or loaves of bread based on crickets, ants or worms are some of the proposals that emerged over the last few years in the market. Concerning animal nutrition, insects are using as feed for selected animal productions, such as aquaculture, hens, rabbits, pigs and pets (Ahmed et al., 2021). Nevertheless, their consumption as an alternative source of nutrients for ruminants is not so widespread (Domingues et al., 2020). It could be a solution to the current situation due to its high protein and lipid contents (Makkar et al., 2014) and the low amount of land and water required for its production compared to traditional crops. Insects can efficiently convert organic by-product residues into usable nutrient sources, they have a fast growth time, and their production generates less GHG emissions.

Several studies show that local waste, such as from restaurants, agriculture/crop production, wholesale markets or chicken manure serve as substrate for insect production (Gasco et al., 2020). Black soldier fly larvae cultured in chicken manure, contains lactic acid-producing bacteria, which can act as probiotic, and bacteriocins, effective against intestinal infections (Astuti and Wiryawan, 2022).

This report aims to offer an analysis of the current situation in the ruminant production framework based on the studies carried out in different countries, which demonstrates that the introduction of insects into their ration is a profitable and environmentally friendly solution.

## 2. Legal framework

On July 2018, the European Food Safety Authority (EFSA Panel on Nutrition) indicated that dried yellow mealworm (*Tenebrio molitor* larva) could be novel food as a whole insect, dried or in powder form consumed by the general population.

The European Union (EU) sets the species allowed and their requirements: not to be pathogenic or have adverse effects on plants, animals, or human health; not to be vectors of human or animal/plant pathogens, nor be protected or defined as invasive non-native species. The allowed species are black soldier fly (*Hermetia illucens*), house fly (*Musca domestica*), mealworm (*Tenebrio molitor*), bed beetle (*Alphitobius diaperinus*), house cricket (*Acheta domesticus*).

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https://doi.org/10.1016/j.rvsc.2023.01.012
Received 21 September 2022; Received in revised form 4 January 2023; Accepted 14 January 2023
Available online 18 January 2023

The EU restriction on ruminants is probably due to the residual shadow of mad cow disease. In the USA, only the black soldier fly (*Hermetia illucens*) is included in aquaculture (trout or salmon). In Canada, *Hermetia illucens* larvae are authorised in aquaculture and poultry. Brazil has not developed specific legislation this respect, and they are only allowed in non-ruminant animals (Domingues et al., 2020). In countries such as China or South Korea there are no limitations (Gasco et al., 2020).

## 3. What do insect meal could provide for cattle?

The nutritional composition of each insect varies depending on the species. The review of Makkar et al. (2014), describes the characteristics of each one. What is common to all of them is 1) The crude protein (CP) content of insect meals is high, varying from 42% to 63%, similar as is in soymeal, common in ruminant rations; 2) In insect meals, the linoleic acid concentration is higher than offered by soybean oil or sunflower oil confirmed by the studies of Ahmed et al. (2021); 3) Their palatability is good; 4) Can be a source of high-value bioactive compounds such as peptides with immunostimulatory and anti-microbial effects. Other nutritional benefits are given by chitin (the main component of their exoskeleton), which is rich in fibre, promoting the growth of certain groups of bacteria, with advantageous effects on intestinal health and the immune system (Gasco et al., 2020).

Research in ruminants (cows, steers and goats) has confirmed these properties adding others of great interest.

The *in vitro* study of Jayanegara et al. (2017) assessing different species (*Gryllus assimilis*, *Tenebrio molitor*, and black soldier fly larvae) on rumen digestibility and methane emissions compared with soya meal, at 12, 24, and 48 hours, revealed that methane emissions were lower than those emitted by the cereal, varying the amount in this order: crickets < flies < maggots.

In USA, Fukuda et al. (2022) assessing the effects of black soldier fly larvae as a protein supplement in beef steers found that the intake of animals receiving insect meals increased, favouring weight gain. In terms of digestibility, the introduction of insect meal had no negative effects on rumen ammonia-N production, volatile fatty acid production or rumen pH.

Finally, the *in vitro* study carried out by Renna et al. (2022) in goats using meals of *Hermetia illucens*, *Musca domestica* and *Tenebrio molitor* confirms the above data, assessing the high contents of polyunsaturated fatty acids (PUFAs) which is interesting face to improve the quality of ruminant-derived food products.

This field of ruminant nutrition offers many opportunities within *circular economy* or *eco-friendly* animal production. More studies on all kind of ruminants are imperative.

## 4. Conclusions

In the current geopolitical and environmental moments in which ruminant farming is complicated, the introduction of insects in their ration, permitted by health regulations, is a viable and reasonable solution.

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