



Insects in animal feed: Acceptance and its determinants among farmers, agriculture sector stakeholders and citizens

Wim Verbeke^{a,*}, Thomas Spranghers^{b,c}, Patrick De Clercq^b, Stefaan De Smet^c, Benedikt Sas^d, Mia Eeckhout^e

^a Department of Agricultural Economics, Ghent University, Coupure links 653, B-9000 Gent, Belgium

^b Department of Crop Protection, Ghent University, Coupure links 653, B-9000 Gent, Belgium

^c Department of Animal Production, Ghent University, Coupure links 653, B-9000 Gent, Belgium

^d Department of Food Quality and Food Safety, Ghent University, Coupure links 653, B-9000 Gent, Belgium

^e Department of Applied Biosciences, Ghent University, Valentin Vaerwyckweg 1, B-9000 Gent, Belgium

ARTICLE INFO

Article history:

Received 25 February 2015

Received in revised form 31 March 2015

Accepted 1 April 2015

Keywords:

Attitude
Feed
Insects
Livestock
Survey
Sustainability

ABSTRACT

The use of insects in animal feed is a potential avenue to improve the sustainability of animal diets and meet the growing global demand for livestock products. Yet, little is known about the attitudes towards and willingness-to-accept insect-based animal feed and foods. This study presents findings from cross-sectional data collected in January 2015 from a sample of 415 farmers, agriculture sector stakeholders and citizens in Flanders, Belgium. Attitudes towards the idea of using insects in animal feed were generally favourable, most notably for fish and poultry feed. Two thirds of the study participants were willing-to-accept the use of insects in animal feed. The foods obtained from animals fed on insect-based feed were widely accepted. Farmers were more critical – but still generally positive – as compared to stakeholders and citizens. Insect-based feed was perceived to be more sustainable, to have a better nutritive value, but a lower microbiological safety as compared to conventional feed. In addition, the resulting foods were perceived to be more sustainable, nutritious and healthy, but at the risk of presence of off-flavours and allergens. Perceived benefits of using insects in animal feed pertained mainly to lowering the dependency on protein imports, and better valorisation of organic waste. Benefit perceptions were stronger and outweighed risk perceptions as a determinant of accepting the use of insects in animal feed. However, the strongest determinant of acceptance was a person's own willingness-to-eat insect-based foods. Overall, the findings of this study indicate a positive atmosphere and momentum for change towards the adoption of insects as a new ingredient in animal feed.

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1. Introduction

Global agricultural production and demand for food and livestock products are expected to increase substantially in the coming decades owing to the growing world population, economic development, higher spending power and changing consumer preferences (Alexandratos and Bruinsma, 2012). Global demand for animal feed and feed ingredients, and pressure on natural resources and the ecosystem are expected to increase accordingly. Meeting these future demands and maintaining

* Corresponding author. Tel.: +32 9 264 6181; fax: +32 9 264 6246.
E-mail address: Wim.Verbeke@UGent.be (W. Verbeke).

legitimacy for intensive animal production requires innovation towards more sustainable animal diets (Makkar and Ankers, 2014). Whereas the European Union (EU) is self-sufficient in animal protein for human consumption, its dependency on the import of plant-based protein for use in animal feed is estimated around 70 percent (FEFAC, 2012; de Visser et al., 2014). Feed costs account for 50–70 percent of the total cost in animal production, and therefore, price changes of animal feed ingredients have a major impact on livestock farming profitability (FEFAC, 2012; Spring, 2013). These economic issues underscore the strategic importance of developing alternative protein strategies involving new protein sources in animal feed (EUFETEC, 2013). One potential solution is the use of insects as an ingredient for animal diets, primarily as an alternative to fishmeal, fish oil and soymeal (Makkar et al., 2014; Henry et al., 2015). The potential of insects, both for feed and food, has been widely acknowledged recently, for example in the 2013 'Edible insects' report published by the Food and Agriculture Organisation of the United Nations. The report recognised at the same time that, despite the large potential of insects, "insect rearing for food and feed remains a sector in its infancy, and key future challenges will likely emerge as the field evolves" (van Huis et al., 2013, p. xi). One of those challenges pertains to future marketplace acceptance, which is the focus of the present study.

Insects are already used in animal feed for aquaculture and poultry in many parts of the world. For recent overviews of the state-of-the-art on the use of insects in animal feed, we refer to van Huis et al. (2013) and Makkar et al. (2014). Substantial benefits have been attributed to the use of insects in animal diets (Stocks, 2014). Although the total environmental impact of insect rearing is still discussed (van Huis et al., 2015), e.g. depending on rearing systems considered, the value of substrates used and of products obtained (Muys and Roffeis, 2014), there is a consensus that insects can be grown on low valuable by-products or organic waste from agriculture and the food industry, producing valuable protein with a nutritive value comparable to soybean meal. Insects are a good source of amino acids, fatty acids and micronutrients (Rumpold and Schlüter, 2013a). The waste from insect rearing can be used as an organic fertilizer, resulting in a closed circle principle (Sheppard et al., 2002; Newton et al., 2005; Rumpold and Schlüter, 2013b). In comparison to livestock for human consumption, insects are more efficient in converting feed into biomass; they can be reared on smaller surfaces resulting in a higher yield per hectare than common crops such as soybeans, and have an emission of greenhouse gasses and ammonia per kg meat that is lower than for pigs or cattle (Oonincx et al., 2010; van Huis et al., 2013).

Yet, little is known about possible risks. Although the rearing of insects for use in animal feed is believed to be promising, researchers, stakeholders and policy makers are wary of feed and food safety hazards associated with the use of insects. Several studies and reviews referred to possible chemical and microbiological safety risks, allergenicity risks in animals and humans, risks of deficiencies in particular amino acids, or problems of digestibility and palatability, most of which are not yet well understood or fully manageable (Klunder et al., 2012; Rumpold and Schlüter, 2013a; Charlton, 2014; Charlton et al., 2015; Henry et al., 2015). The breeding and rearing of insects might also impact on the biodiversity considering the possibility of accidental release of non-native species (van Huis et al., 2013, p. 157). The introduction and use of non-native species should therefore be subjected to a risk assessment procedure, which could in part follow that developed for arthropod biological control agents (van Lenteren et al., 2003; De Clercq et al., 2011). Alternatively, the focus could be shifted towards the use of native species.

Challenges facing the introduction of insects in animal feed relate to the development and application of appropriate technologies in handling, processing and storage of insects subsequent to harvesting. Technologies for animal feed production and feeding systems might require adaptations to this new ingredient without loss of efficiency and product quality, while providing the same guarantees in terms of hazard identification, risk assessment and traceability. In case of large-scale adoption of insects as feed ingredient, insect-rearing facilities need up-scaling into economically viable businesses. However, these technological challenges may fade against the challenges related to the legislative environment and marketplace acceptance (van Huis et al., 2013, p. 154). The use of insects in animal feed within the EU was prohibited following the EU transmissible spongiform encephalopathy (TSE) regulation EC 999/2001 and consecutive EU regulations on processed animal protein (PAP), which led to insects being categorised as ingredients that cannot enter the food chain (Veldkamp et al., 2012). However, regulation EC 56/2013 has opened the debate by indicating that a lifting of the ban on the use of PAP from non-ruminants in non-ruminant feed could be considered under strict conditions. Consequently, the use of PAP from non-ruminant animals, including insects, was re-authorised for feeding aquaculture animals as of June 2013. It has been expected that an extension to pig and poultry feed might be considered at the earliest by 2015 (Smith and Pryor, 2013).

While several feed companies, e.g. in The Netherlands, have committed to include insects in their livestock feed and have everything in place to take off as soon as the EU legislation allows to do so (AllAboutFeed, 2014), little is known about the reactions of farmers, stakeholders and citizen/consumers towards the use of insects in animal feed. Such reactions are likely to determine the future success of using insect-based feed for different species, as well as the marketplace acceptance of foods obtained from animals raised on insect-based feed. While studies have shown that the adoption of insects or insect-based foods by consumers cannot be taken for granted (Schösler et al., 2012; Verbeke, 2015; Tan et al., 2015), very little is known at present about intentions to adopt insect-based feed in livestock production and the resulting livestock products.

The objective of this study is to investigate farmers', agriculture sector stakeholders' and citizens'/consumers' acceptance of using insects in animal feed, and of food products obtained from animals fed on insect-based feed. Specific objectives are to (1) assess the attitudes towards the use of insects in animal feed, (2) assess the perceived benefits and risks from using insects in animal feed, (3) measure attribute beliefs of animal feed with insects, of animals fed on insect-based feed, and of the resulting animal products, (4) explore willingness-to-accept and adopt the use of insect-based animal feed and related

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