

Insects as sustainable feed and food

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Insects are one of the proposed responses to the increasing request of alternative feed/food productions with high production yield and low environmental impact. Insect production offers a new sustainable alternative for unexploited or underexploited resources, in accordance with the waste hierarchy principles. Insects constitute a reliable alternative or addition to feed due to their nutritional characteristics (e.g. protein content, amino acid profile and/or digestibility levels). Edible insects may be part of human foods mostly as ingredients in already well-known products or integration of insect-based foods into existing diets. In the near future research is needed to increase knowledges and support the insect industry to a considerably scale up to reach competitive price and high-quality products.

Keywords: entomophagy, novel food, environment, protein, fat

1 Insect farming

With the world population expected to exceed 9.7 billion by 2050, food production needs to increase by 70%. Food system is under pressure and several national/international organizations found in insects a potential answer to respond to the demand for sustainable and high-quality nutrient to feed a growing population (van Huis et al., 2013). In the last years research projects and publications on insects as food and feed drastically increased, leading to improve knowledges and contributing to strengthen the sector. Benefits in rearing insects as food and feed are due to their capacity to produce high nutritive outputs without requesting high nutritional feeds (also called substrates); indeed, insects could be fed on alternative substances not used for animals. Moreover, one of the main positive characteristics of insects is the capacity to highly convert feeds in animal proteins, fats and other components. Feed conversion ratio (FCR) could vary in relation to the studied insect and to the environment and substrate quality, but it roughly ranges from 1 to 2, and thus it is lower than beef (typically, FCR from 6.0 to 10.0) and pigs (FCR from 2.7 to 5.0), and very competitive with chicken (FCR from 1.7 to 2.0) and farmed fish (FCR from 1.0 to 2.4). Insects mostly convert feed more efficiently due to their characteristics to be poikilothermic, thus they do not invest metabolic energy to maintain a constant body temperature (van Huis, 2013). Moreover, insects seem to have a low environmental impact as their greenhouse gas emissions, water print and land print compare more favourably than conventional livestock. On the other hand, some risks could be pose in relation to the insect farming, as the use of not endemic species, with the rise of possible fall-out to humans, animals, plants, biodiversity or environment (van Huis & Oonincx, 2017).

2 Insects as feed

Insects are part of natural diets of several animals. Conversely, their use as feed in livestock productions is still low due to regulation/laws which do not list insects as an available ingredient. Insects could be used as feed supplementation, alive or dead, or as feed ingredient as whole body (full meal), protein meal, oil, or other derived products. Research has focused on their use mainly in three production sectors: aquaculture, aviculture, pig farming (Sogari et al., 2019; van Huis, 2020). As farmed animals require precise feed nutritional values, the research projects focused principally on the substitution of already used protein/fat ingredients with insects' ones. Indeed, the use of insects

protein meals or fat oil could be promoted as substitution of soy-fish-maize-wheat meal-oil in order to lower the environmental impact (use of land, water, sea) and also restore animal welfare as several carnivore or omnivorous species are fed exclusively with feeds made of plants raw ingredients (Kroeckel et al., 2012; van Huis & Oonincx, 2017).

Research articles and reviews on the use of insects as feed is growing daily, nonetheless research are still needed to increase knowledges about all the insect's feed production sections (Finke et al., 2015; Gasco et al., 2020; Lock et al., 2018; van Huis & Oonincx, 2017; van Huis & Tomberlin, 2017).

3 Insects as food

Worldwide more than 2,000 species of insects are consumed as food, mostly in Asia, Africa, and Latin America. Entomophagy, the habit of eating insects, was abandoned by Western world several centuries ago. Historically, insects were harvested from nature and due to environmental reasons, the harvesting yield in temperate zones was lower than in the tropics, as insects size is smaller, their occurrence is less clumped and they are unavailable in winter time. Insects for human consumption show good potential as nutritive and sustainable efficient source. It is not easy to estimate the real percentage of people that nowadays practice entomophagy; recently this habit was reintroduced into Western countries and it is gaining interest mostly in young people (Mancini et al., 2019; van Huis, 2020). Western countries consumers are more interested in farmed insects where a close environment (farm) could assure a total control of the production and safety of the products (Murefu et al., 2019; Nischalke et al., 2020). Even if insects seem to pose a low risk of transmitting zoonotic diseases, allergies mostly comparable to those related to crustaceans (invertebrates) may occur. Consumers' willingness to eat will drive the entire market, even though insect-based food (e.g. whole, roasted, burgers, protein snacks) or already well-known foods supplemented with insect powder/oil (e.g. pizza, pasta, bread, cookies) are in the future prospect of reaching our tables.

4 Present to future perspective in Europe

In the last years, several European entrepreneurs started companies in insect sector, pushing European commission to regulate the emission of these products into the market. In brief, at the time of writing this article, insects intended to be used as feed or food must be reared in accordance to the feed's regulations as for the other livestock, thus no completely unused substrate could be employed in insect farming (as slaughterhouse residues, catering waste containing fish and meat, manure, etc.). Measures are being taken to create a healthier, more sustainable food production and consumption system which produces less waste as currently one-third of all food is wasted. There is a widely conviction that when completely unused substrates will be allowed in insect farming, we will see an incredible increase of this sector, with the possibility to also reduce waste treatment.

Legally recorded through the Regulation (EU) 68/2013 which establishes the Catalogue of feed materials, 'whole insects', i.e. 'Terrestrial invertebrates, dead' to be used as feeding ingredient must undergo 'light' treatment (e.g. freeze-drying). Therefore, insects cannot be ground into meal or oil, as no processing that could alter the physical characteristics of the product can be used. Since July 2017 (Regulation No 2017/893) insects' processed animal protein may be used in aquaculture feeds. It is expected in next years a new implemented regulation on poultry and pig feedings that will allow the use of insects ingredients in these two important animal productions. Secondly, it is also expected an extension of the substrate allowed in insect rearing for feed production via a specific revision of the catalogue of feed materials.

National transitory laws and "Novel food" regulation (EU 2015/2283) are introducing insects as food in all the EU countries, but market is not already tested to check the consumers' willingness to eat. As rich source of protein, fiber and fatty acids, insects can be a solution to the several issues related to nutrition and human impacts in the future. We just have to take the first bite.

5 Conclusion

Insects sector is developing fast and in the next years an intensive industrial insect farming is expected. Feed and food safety and legislations must move up in relation to the future productions taking in consideration not only biological and chemical risks but also welfare issues. Consumers' point of view must be taken into account, and marketing and communication strategies must be tailor-made to ameliorate perception of insects. As proposed by emeritus Professor Arnold van Huis "The sector can only progress when the insect industry, the academic world, governmental organisations and public society closely cooperate" (van Huis, 2020).

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