Potential sources of protein for animal feed: Insects

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- There is a need to develop alternative sources of protein for livestock feed as reliance on existing imported sources may expose the UK to future economic and supply chain insecurities.
- Farming insects could limit the land use requirement for animal feed production, freeing up land to grow crops for human consumption.
- As insects can be fed on organic waste material, it may offer a real option for managing a growing waste burden by recycling valuable materials which would otherwise be lost.
- Whilst currently prohibited by EU law, the use of insects for animal feed may soon become possible as evidence for safe usage continues to grow.

The demand for meat and animal products globally is increasing due to shifts in the pattern of meat consumption in developing countries, with global consumption rates projected to double by 2050. Managing this demand raises some potential challenges, particularly with regard to global agricultural land use.

Using protein from vegetable sources such as soybean is currently very successful in terms of animal production, due to its high levels of protein and a favourable amino acid profile, but this crop is potentially detrimental for the UK in terms of economics and food security, and damaging on a global scale in terms of environmental impact. Worldwide currently, 35% of crop production is allocated to animal feed and 65% to human food. This ratio changes significantly for developed countries, where it favours the production of animal feeds at a ratio nearer 60:40, due to greater demand for livestock products. From this current picture we can estimate that the proportion of land utilised to produce food for livestock, to satisfy growing demands for meat products, is likely to continue to increase.

Across Europe there is a very real risk from competition for available protein resources for animal feed. Currently, around 70% of protein for livestock is imported; as the world's population grows, and the proportion of the global population which can afford livestock products increases, then this competition would be expected to result in higher prices and increasing uncertainty with regard to supply chain stability. As such, if UK agriculture is going to continue to satisfy the demand for meat and animal products, then novel sources of protein will need to be identified and developed.

Insects as a protein source for livestock feed.

Insects are invertebrates with an exoskeleton, a three-part segmented body, and three pairs of jointed legs such as flies or beetles. There are estimated to be somewhere in the region of 2000 species of edible insect in the world; of these species, those considered the most suitable for the purposes of

animal feed production include meal worms (Common: *Tenenbrio molitor*, Giant: *Zophobas morio,* and Lesser: *Alphitobus diaperinus*), and larvae from the black soldier fly (*Hermetia illucens*) or Housefly (*Musca domestica*).

Most research has focussed on either the black soldier fly (BSF) or housefly as these species have high and rapid reproductory rates. Female BSF produce around 1000 eggs and at 29°C can develop from egg to adult in 38 days. The house fly can also produce many eggs (reports vary, but between 500 - 2000 eggs per adult female) and have a larval cycle which lasts 5-6 days, meaning short conversion times. This is potentially beneficial in terms of production sustainability; should a colony collapse or a crop fail, then recovery times are potentially short.

There are several key ways that farming insects could be a beneficial alternative for agricultural production of protein. The mass farming of insects requires between 50-90% less land than conventional agriculture per kilogram of protein and could reduce greenhouse gas emissions from the livestock industry by 50% by 2050. It may also offer practical solutions to agricultural waste production, as fly larvae can reduce organic waste by around 60% in 10 days. In addition, this approach may offer the potential for greater automation with regard to production, facilitating the shift towards a more controllable and predictable manufacturing style system.

Nutritional profiles

Whilst there is a potentially a huge variety of edible insect fauna, these species have been under investigated from a nutritional point of view. The research which has been conducted demonstrates great potential. One study of 78 species of edible insects from Mexico found that protein digestibility varied between 76% and 98% and essential amino acid content scores ranged between 46% to 96%; which is higher than the 40% of total amino acid content specified by the FAO for a food to be considered of high nutritional quality. Edible insect species are also typically high in fat, with a saturated to unsaturated fatty acid ratio of less than 40%, and high in important minerals such as potassium, calcium and magnesium.

Housefly larvae are rich in digestible protein (98.5% protein digestibility in the larval stage), key amino acids (with a higher percentage of essential than non-essential amino acids), essential fats and micronutrients, which makes them ideal as a component of animal feed. House fly larvae meal has a protein content in the region of 37.5 – 63.1 %, with a nutritional content which is comparable to high quality fish meal, in both AMEn (apparent metabolisable energy, nitrogen corrected) and amino acid digestibility. House fly larvae also contain high levels of key amino acids such as methionine and lysine, whereas plant based sources of protein are often low in these key compounds.

In addition to such favourable nutrient statuses, products derived from invertebrates have numerous other potential applications and uses. Insect derived oils, particularly those from BSF, possess high levels of lauric acid, a medium chain fatty acid which is most commonly found in coconut fat and has recognised antibacterial properties. Certain species of insect produce bioactive antimicrobial or

antifungal peptides or polypeptides, probably as a necessary mechanism for dealing with food materials which are decaying and potentially harmful, suggesting that in the future insect derived products may even offer a means to combat antibiotic resistant infection.

Production efficiency

Fly larvae particularly can be raised on a wide range of waste products, which may offer a solution to

the growing problem of organic waste. This may mean that protein production for livestock feed can be generated from the by-products and waste arising from human consumption activities, currently in the region of 8.65 million tonnes (approx. 135 kg per person) per year for the UK. This offers an opportunity to recover value from materials through biological reprocessing, which would otherwise be disposed of. Furthermore, this approach could reduce the burden on existing production systems where the generation of waste material such as manure (approx. 80 million tonnes produced in the UK annually) is a significant problem.

To test whether livestock can be successfully reared on insect protein feeding trials for fish, pig and poultry have been undertaken as part of ProteInsect project. Salmon were successfully fed on a diet of up to 50% insect meal without any adverse effect on fish performance, indicating that this could replace around 50% of fish meal currently used in salmon aquaculture. For both the pig and poultry trials, no significant differences were observed in several key performance indicators denoting animal performance, including weight gain, between groups reared on current commercial diets and those containing insect meal. Additionally, a significant increase in favourable gastro-intestinal tract microorganisms such as lactobacilli, were observed for piglets fed on insect meal. These findings are potentially of great importance; monogastric livestock such as pigs and poultry are predicted to increase the most in terms of future meat demand (approximately 3/4 of the annual increased demand for meat products). Protein from insects can therefore be utilised effectively for these livestock, and in the case of poultry primarily would form part of a more natural diet.

Summary

The potential to effectively reclaim or recycle valuable nutrients and materials through the process of bio-conversion or biological reprocessing makes this approach to protein production of significant interest. As such, this could offer a mechanism to simultaneously extract protein from of a wide range of waste materials and by-products, whilst substantially reducing waste burdens which is a growing problem.

Much concern is typically raised with regard to whether western society can adapt to the consumption of insects as a protein source. Whilst direct consumption may remain an issue, public perceptions regarding the use of insects in animal feed are encouraging. 72.6% of people who responded to a survey conducted as part of the ProteInsect project would be willing to eat fish, pork or chicken which were raised on diets containing insect protein and 65.8% said they thought that fly larvae are a suitable

source of animal feed protein. This demonstrates that whilst there is a significant stigma associated with direct consumption of insects by humans, this does not carry over to animal feed.

The major issue with regard to utilising this protein source currently is existing EU legislation. Under regulation EC999/2001 the production of animal feed containing insects is not possible and further work is needed to confirm that there are no potential food safety issues with regard to using insects as a feed source. However, a recent report by the European Food Standards Agency has indicated limited risk from the introduction of insects into the food chain that were fed on food or feed grade materials. Research into the potential effects of bioaccumulation has also demonstrated no influence of harmful chemical contaminants. Therefore as the evidence base continues to grow regarding the safety of this approach, and the need for alternative protein sources becomes more acute, then changes in the current legislation may very well be expected.

Think Climate

Farming insects for livestock feed could reduce environmental damage and green house gas emissions, whilst providing future protein security!

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