FUTURE FOODS FROM EDIBLE INSECTS

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Locally available edible insects are regularly eaten by around two billion people (over a quarter of the global population) across continents such as Africa, Asia and Latin America. Over 1,900 insect species are eaten, helping to improve the quality of traditional diets.[1]

With future food production needing to double in order to sustain the growing population (estimated to reach nine billion people by 2050) and to reduce chronic hunger, edible insects are seen as part of the solution. Production systems and the science of insects are currently at a pioneering stage. By merging modern scientific methods with traditional knowledge, both developing and developed countries can benefit from insects as a food source. This begs the question, can insects overcome their taboo in Western cultures, to become mainstream foods?

WHICH INSECTS AND WHICH PRODUCTS?

Edible insects include familiar ones such as grasshoppers, ants and crickets, through to locusts, mealworms and termites. Table 1 shows the contribution to global consumption of the main orders of insects.

After harvesting, insects can be freeze-dried, sundried, or boiled. They can be eaten whole, e.g. stir-fried or roasted, or they may be processed into powders, granular or paste forms that can be incorporated into combination foods such as breads, tortillas and snack bars. There is also potential to extract protein, fats and chitin from insects for use as food ingredients that can be added to enrich foods.

Insects are already eaten as food in the USA and the UK. The current offer is mainly niche products and novelty snacks. Examples are cricket and mealworm powders, whole roasted crickets and mealworms, frozen blanched locusts for use in stir-fries and Bodhi protein bars made with cricket powder. Top end restaurants are also experimenting with whole insects and insect powders. And of course, cochineal (carminic acid) is a long-standing food colouring that is extracted from scale insects (*Dactylopious coccus*).

WHY EAT INSECTS?

Human entomophagy (eating of insects) tends to be traditional where conventional sources of protein such as meat and fish are unavailable or in low supply. While insects can make a significant nutritional contribution to many human populations they are also viewed as a delicacy. Two main advantages of potential relevance to developed countries are their high nutritional value and their contribution to sustainable diets.

Nutritional value

The Food and Agriculture Organisation of the United Nations (FAO), working with INFOODS (the International Network of Food Data Systems), established in 1984, has collected available nutritional data for edible insects as part of its programme to promote biodiversity. This includes collecting data on wild and underused foods at various levels including variety, cultivar and breed.[1]

Insects have a number of favourable nutritional attributes. The wide variation in nutritional content not only reflects the large variety of different species, but also differences within

Table 1: Commonly consumed insects

Insect Order	Proportion of global insect consumption	Insects
Coleoptera	31%	Beetles (inc mealworms)
Lepidoptera	18%	Caterpillars
Hymenoptera	14%	Bees, wasps, ants
Orthoptera	13%	Grasshoppers, locusts, crickets
Hemiptera	10%	Cicadas, leafhoppers, planthoppers, scale insects and true bugs
Isoptera	3%	Termites
Odonata	3%	Dragonflies
Diptera	2%	Flies
Other orders	5%	Other insects

Data from: FAO, 2013. Edible insects - Future prospects for food and reed security. FAO Forestry paper 171. Rome: FAO, 2013.

individual species which may be due to the metamorphic stage of the insects at harvesting (e.g. adult stage, larvae, pupae or eggs), to their habitat (e.g. wild or farmed), differences in their diet and how they are processed. Uniform feeding and controlled production leads to more reliable quality and consistency, which is important for food labelling and quality control.

In general, edible insects provide useful amounts of energy, protein of high value, unsaturated fats and an array of micronutrients. Reported energy values for a number of insect species range from 293 to 762kcal/100g dry weight.[2] On a fresh weight basis, the protein content of adult locusts, termites and grasshoppers compares favourably with beef and fish.[1]

As to protein quality, edible insects can provide a useful addition to traditional diets by increasing intake of the limiting amino acid. For example, many insect species are a good source of lysine and can thus supplement diets where the key staples are cereal proteins which are often low in lysine. In the UK, the limiting amino acid in the overall diet is threonine and many insect foods are a good source of this amino acid.

Edible insects are also a useful source of unsaturated fat and frequently provide the essential fatty acids linoleic and a-linolenic acid, the fatty acid composition being influenced by the insects' diet. The micronutrient content varies considerably by species and more research is needed, particularly into bioavailability. However, many edible insects are rich in iron and zinc, some providing more than red meats. Some species provide high levels of vitamin E and many insects are a good source of B vitamins, including some that provide useful amounts of vitamin B12.

Of particular interest is the generally high fibre content of insects. This is mainly in the form of chitin, a long-chain polymer of N-acetyl glucosamine which is a derivative of glucose. Chitin forms the main component of the exoskeleton of insects.

Table 2 overleaf shows the nutritional content of two example insect powders currently on the market in the UK, sourced from a controlled production system in Canada.

Sustainability

With increasing emphasis on sustainable diets, i.e. diets that contribute to food and nutrition security, while having a low environmental impact and respecting biodiversity and ecosystems,[3] edible insects are generally considered to be prime candidates as both food staples and dietary supplements.[1] Rearing insects is thought to result in lower ammonia and lower greenhouse gas emissions than arise from farming pigs or cattle, with less land and water required. There is also the possibility to rear insets on organic side-streams and the potential to reduce environmental contamination.[1]

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It goes without saying that introducing a new food comes with a range of challenges. The Food Standards Agency (FSA) has recently called for information about insects for human consumption and attention is being focused on knowledge development for the possibilities of consuming insects in the UK.

CURRENT REGULATORY STATUS IN EUROPE

Whole insects and whole insect powders do not currently fall within novel foods provisions. However, they will fall under the scope of the new novel food regulations that were adopted in 2015,[4] that come into force in January 2018. As insects are already on the EU market, there is a two-year period to submit a dossier requesting authorisation. Extracts such as proteins and oils are not currently allowed to be sold in the EU and will also require novel foods approval. A further main use for insects is as a feed source for animals and fish and the regulatory status of insects for this purpose is currently being reviewed.

EFSA published an opinion on the risk profile of insects as food and animal feed.[5] It was noted that there is no systematically collected data on human consumption of insects. EFSA reviewed a wide range of potential safety issues and recommended that research is undertaken to address the gaps in the data. However, the FSA has indicated that it is not aware of any public health concerns.

NEW FOODS AND CONSUMER ACCEPTANCE

There are various examples of new foods introduced to the UK market in recent decades. Foods may be classed as 'new' for different reasons. An obvious example is food produced by a new technology, e.g. genetic modification (GM). Tomato puree produced from GM tomatoes introduced in the 1990s was initially well accepted, being slightly cheaper than conventional tomato puree. However, the introduction of the more ubiquitous GM soya with no consumer benefits resulted in rejection of GM foods and a prolonged absence of GM technology from the market.[6]

A number of novel foods and ingredients, i.e. not previously on the EU market before May 1997, have also been granted approval, such as chia seeds, noni juice, plant sterols, new sweeteners and new sources of micronutrients.

The genuinely new food Quorn was successfully introduced in the 1980s, gaining consumer acceptance as a meat alternative. It has since become well established in many different global markets, offering the clear consumer benefits of excellent eating quality, combined with a low fat content and containing useful amounts of fibre.[7,8]

Exotic meats have also been introduced to the UK in the past decade or so, such as kangaroo, crocodile and bison, though these remain as niche products.

Table 2: Nutritional value of insect powders available in the UK

Nutrient	Cricket Powder	Mealworm Powder
Energy (kcal)	472	436
Fat (g)	24	18.9
Saturates (g)	8.5	4.1
Monounsaturates (g)	5.1	6.5
Polyunsaturates (g)	9.1	7.3
Omega – 3 fatty acids (g)	2.8	N/A
Omega – 6 fatty acids (g)	6.3	N/A
Carbohydrates (g)	8.4	15.4
Sugars (g)	0.5	0
Fibre (g)	6	8.7
Protein (g)	59	55
Salt (g)	0.9	0.5
Calcium (mg)	110/0	81.0
Iron (mg)	2.5	3.7
Potassium (g)	1.1	1.1
Vitamin B12 (ìg)	31.0	N/A

Data from Mophagy (www.mophagy.com).

So, the use of insects as food certainly has potential as an emerging food source, depending of course on consumer acceptance. Alongside crustaceans, insects are also classed as arthropods. This raises the question that if as a society we are okay with eating shellfish, such as winkles, lobsters, crabs and crayfish, and with eating snails, then why not insects? We tend to view insects as pests and carriers of diseases and the thought of eating insects is initially repulsive to many people. So can this be overcome? Consumer research suggests that processing insects so that they are unrecognisable may make them more acceptable, and that males are more likely than females to consider trying them, as are people interested in food sustainability, those already familiar with insects from other food cultures and those who want to reduce their intake of red meat.[9]

CAN INSECT FOODS PLAY A ROLE IN THE UK DIET?

As well as the challenge of consumer acceptance, insect foods are relatively expensive in comparison with traditional meats. Scaling up production to reduce costs will involve many different disciplines and such challenges are currently being addressed.

Can we overcome these barriers to accept insects as foods and if so, what roles could they play in the UK diet where we already have a varied food supply and a large choice of nutritious foods? Insects undoubtedly have novelty value and will be of interest to 'foodies' and the more adventurous among the population. But can they become more than niche products? Edible insects are certainly valuable nutritionally and could supply additional protein, fats and micronutrients to population groups with specific needs such as the elderly and patient groups on special diets or recovering from illness. They could also be useful for sports foods. Use of insect powders to enrich traditional foods that we are used to eating may be a way to introduce them to the diet in a more acceptable way for consumers.

So, how adventurous is the UK population - well, let's wait and see!