FOOD SCIENCE
FACT SHEET

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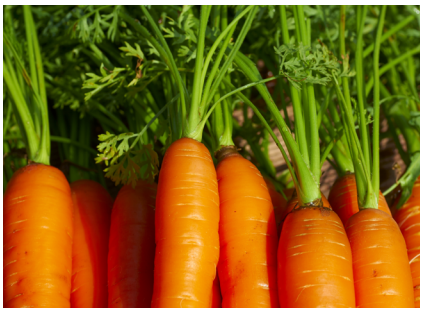

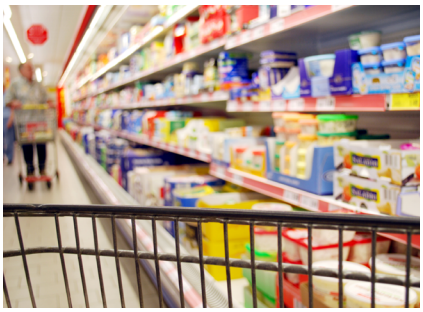

SHEET NUMBER 13

This Food Science Fact Sheet is one of a series compiled by Institute of Food Science and Technology, providing clear, concise and scientifically reliable information on key food science topics for consumers.

Protein food sources

What are proteins?

They are macronutrient molecules made up of chains of individual amino acids. Our bodies cannot directly absorb proteins from the diet so they must be broken down into amino acids, mainly in the stomach. In addition to their structural function in muscles, they make up bodily hormones, enzymes (needed for facilitating chemical reactions), and can even provide energy when fasting or deprived of carbohydrates.

Why are they important?

Of the 20 amino acids in our diet, 9 of them are known as 'essential' as they cannot be made by our bodies. They must therefore be obtained by eating a 'complete' protein (one that provides all the essential amino acids) or by combining 2 or more incomplete sources. Best practice is to diversify sources and consider the content per serving, quality, amino acid digestibility, as well as quantities of other ingredients in the food or meal, such as sodium (salt) and sugars.

Sources

Animal proteins are generally highly absorbable whilst plant-based proteins are low in saturated fat and relatively resource efficient.

In addition to meat, poultry, fish and shellfish, eggs, milk/milk products and their plant-based alternatives (cheese, yogurt, desserts, custards etc.), legumes (beans, lentils), nuts, seeds and gluten (found in wheat), a few others are explored below:

Soya beans are eaten whole (edamame), fermented to produce bean curd (tofu) and tempeh, and soy sauce, or hulled, defatted, roasted, ground into meal/flour and then used as soya protein which can be further processed into a concentrate or isolate (for making meat analogues). They are low in saturated fat and contain all the essential amino acids. Soya is a recognised allergen in the UK and EU.

Textured vegetable protein (TVP), often sold as mince and chunks, can be made from wheat or corn, but is usually made from soya and used as a meat replacer due to its elasticity, fibrous texture, and hydration properties. It is made by passing a dough, containing soya flour, water and salt, through high-pressure extruders, then cut to size and dried.

Lupin bean is a high-protein and fibre rich legume commonly consumed in Southern Europe and Asia. The flour is often used to make gluten-free products. Lupin is a recognised allergen in Europe, and more likely to affect those with peanut allergies.

Insect eating (entomophagy) occurs in many parts of the world including Australia, Africa and Asia. There are about 1900 edible documented species, although research into their toxicity and properties is minimal. A few species have gained EU approval for human consumption. Once harvested, they are sun or freeze-dried and can be consumed whole (or with wings and legs removed), dried (paste or powder) and used to fortify foods or as a protein extract. When consumed fresh, they are usually boiled, fried, or roasted. Food safety aspects, such as exposure to hazards, e.g. environmental pesticides, are more controlled with farmed insects. They are land efficient, complete sources of protein and contain sufficient essential amino acids, calcium, iron and zinc.

Single cell proteins are produced in microbial, fungal or algal cells. One common example is yeast extract obtained from spent yeast from brewing processes.

Protein food sources

Algal proteins are derived from microalgae, which are small protein-rich organisms that grow in fresh and seawater and feed on carbon dioxide (CO_2), making them environmentally viable. Rich in essential amino acids, they can be grown in bioreactors and require less land to grow than soya beans, for example. Digestibility may be reduced due to their fibre content. Familiar algal proteins sold as supplements include Spirulina and Chlorella.

Mycoproteins are proteins derived from certain species of fungi e.g. Fusarium venenatum. They provide all the essential amino acids, are low in saturated fat, and have a high protein content. The fungus culture is added to a large fermentation tank with water, carbohydrates and a source of nitrogen, needed to make amino acids, such as ammonia gas (-NH_3) After a few weeks it can be dried and used as a meat substitute.

Microorganisms can also be engineered to secrete proteins e.g. fungi in precision fermentation tanks can produce whey protein to make an animal-free milk that is chemically and nutritionally comparable to cow's milk, but therefore unsuitable for those with milk allergies. The technology has been widely used in pharmaceutical (insulin) and brewing industries.

Pea protein is extracted from yellow or green split peas by removing the carbohydrates and fats. It contains all the essential amino acids and is used in many gluten-free products, as a protein supplement, as a meat replacer in its textured form, as well as to make plant-based beverages. Whole split peas are a good source of magnesium and folate, but products' nutritional composition varies widely between manufacturers.

Cultured meat and fish a re derived from animal cells and involve growing stem-cells in a suitable environment, so they multiply. This technology, while currently relatively expensive, holds great promise for minced meat products and start-ups are working on fish fillets. Challenges include the use of foetal bovine serum and other nutrients for meat, and minimal availability of nutritional information and legislation relating to cell-based and lab-grown meat.

How do they compare?

Protein sources	Typical protein g/100 g dry weight
TVP	50
Soya protein isolate	80
Insect protein	23-77*
Algal protein	50
Mycoprotein	12
Pea protein isolate powder	70

* Varies by species, sub-species, and developmental stages (larvae, pupae, adult)

What does the law say?

The protein content labelled on food packaging is usually measured by calculating the amount of nitrogen in the food and using a conversion factor. This is a good indicator when deciding how much is needed in one's diet, which is recommended to be about 50 g for a 2000 kcal diet (1 g of protein provides 4 kcal). In the UK, there is a legally allowed variance of ±20% for foods whose stated protein content is 10-40 g/100 g.

While many terms are used to sell and market meat and dairy alternatives, 'vegan' and 'plant-based' are not standardised in the UK and EU. It is optional for manufacturers to claim a product is vegan or vegetarian, but it is mandatory for them to list the contained ingredients and allergens (The Food Information Regulations 2014), so as not to mislead consumers (retained EU regulation 1169/2011).

References

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10. Mycoprotein image by Daniel Neville from Melbourne, Australia, CC BY 2.0 <https://creativecommons.org/licenses/by/2.0>, via Wikimedia Commons