



Supermarket Challenge: the fungi in your shopping basket!

Fungi are an ideal food because they have a fairly high content of protein (typically 20 to 30% crude protein as a percentage of dry weight) and contain all the amino acids which are essential to human health - and several of the vitamins, too. Fungi are easily digested and also provide a good source of dietary fibre. Possibly most important of all, though, is that they are virtually free of cholesterol. Fungi just don't use cholesterol to the extent that animals do (fungi use a different sterol which doesn't accumulate in humans). Consequently, fungal foods compare very favourably with meats on health grounds as well as on grounds of nutritional value.

Mushrooms

Mushrooms are the most valuable horticultural crop sold in the UK; and, world-wide, mushroom cultivation is the next-biggest biotechnology industry after alcohol production. Mushrooms are available 365 days a year. The white *Agaricus bisporus* mushroom accounts for 95% of the total British market. The remaining 5% is shared between the cultivated brown/chestnut/portabello mushrooms (which are different varieties of *Agaricus bisporus*) and the so-called "exotics" like the cultivated oyster mushroom, shiitake (Chinese mushroom), blewit, enoki, horse mushroom, and hon-shimeji.

Try the Mushroom Bureau website <http://www.mushroom-uk.com>

Bread

Bread structure depends on the gooey-gluey properties of the wheat gluten protein. Mix wheat flour with water, yeast, salt, sugar and some fat and the dough will stick to anything - it's the gluten that does the sticking. Put the dough in a warm place for at least an hour, ideally two, and the yeast produces carbon dioxide and alcohol. The carbon dioxide gas is trapped into bubbles by the gluten and as more and more bubbles are formed in the dough they make it 'rise'. After this fermentation period the dough is cooked, the alcohol evaporates (shame!) and the bubbly structure of the dough is turned into the open structure of bread. Try this website for information about bread: <http://www.fabflour.co.uk/>

Beers and Ales

Beers and ales are also products of the fermentation of sugars from cereal grains by the yeast called *Saccharomyces cerevisiae*. All ales, beers and lagers are made from malted barley mashed into hot water and boiled with hops to add bitter flavours to the beer. The yeasts used for making ales tend to form froth and grow on the top of the mix. Lager yeasts do their fermenting at the bottom of the tank and they belong to the related *Saccharomyces carlsbergensis*.

<http://www.brewingtechniques.com/>

Wines

Wine yeasts are an elliptically-shaped variant of *Saccharomyces cerevisiae*. The classic wine grape has the scientific name *Vitis vinifera*. The important cultivars include Sauvignon (red Bordeaux); Pinot Noir (the main red Burgundy grape); Riesling and Silvaner (for German white wines); Barbera and Freisa (northern Italian wines); and Palomero, the main sherry grape. The whole of the black grape is crushed to make red wine; it's the grape skin pigment that makes it red. Black or white grapes can be used to make white wines but only the pressed juice is used and extraction of skin pigments is avoided.

<http://www.wines-411.com/> | <http://www.vinopolis.co.uk/> | <http://www.wine-pages.com/>

Cheese

Cheese production relies on the action of enzymes which coagulate the proteins in milk, forming solid curds (from which the cheese is made) and liquid whey. Traditional cheese-making uses animal enzymes, but now around 80% of cheesemaking uses non-animal coagulants, especially enzymes from moulds like *Aspergillus* spp. and *Mucor miehei*, so most industrial cheese production still depends on enzymes from filamentous fungi for the coagulation step. [Some other industrial uses for fungal enzymes include proteinases and lipases from *Aspergillus oryzae* used in detergents and proteinases used in hide processing in the tanning industry. The global value of enzymes from filamentous fermentations is in the region of US\$ one billion.]

Mould ripening is a traditional method of flavouring cheeses which has been in use for at least two thousand years. Blue cheeses, like Roquefort, Gorgonzola, Stilton, Danish Blue, Blue Cheshire, use *Penicillium roquefortii* which is inoculated into the cheese. During storage at controlled temperature and humidity the fungus grows throughout the cheese, producing the major flavour and odour compounds. Camembert and Brie are ripened by *Penicillium camembertii*, which changes the texture of the cheese rather than its flavour. This fungus grows on the surface of the cheese producing enzymes which digest the cheese to a softer consistency from the outside towards the centre.

<http://www.cheese.com/>

Marmite

The basic raw material used in the manufacture of *Marmite* spread is spent brewer's yeast. For many years this by-product of the brewing process was seen as a nuisance rather than a potentially valuable food. Towards the end of the nineteenth century the German chemist, Liebig found that this yeast could be made into a concentrated food product which resembled meat extract in appearance, smell and colour, though it was vegetarian. In 1902, the Marmite Food Company Ltd, later changed to Marmite Limited was formed. This company perfected a form of yeast extract for popular consumption, originally in a rented disused malthouse in Burton-on-Trent. It's been spreading ever since!

<http://www.marmite.com/>

Quorn

Mycoprotein is the name for a food product made from a strain of the filamentous fungus *Fusarium venenatum*. The fungus is grown on food-grade glucose as the carbon source in a 45 m tall airlift fermenter used in continuous culture mode (i.e. medium is added continuously and mycelium + spent medium is harvested at a rate equal to the production of new hyphae). The fungus is processed to reduce nucleic acid content to about 1%, then harvested to give a raw product containing about 30% solids. Myco-protein typically contains 44% protein, 18% dietary fibre and only 13% fat (the values for beef are 68%, 0% and 30% respectively). The sole use for myco-protein at the moment is as the primary ingredient of the Quorn range of 'meat-alternative' products.

<http://www.quorn.com/>

Fizzy drinks

Apart from alcohol, the single most important chemical produced by fermentation is citric acid, more than 600,000 tonnes of which are produced (mostly by *Aspergillus niger* and *A. wentii*) each year to be used mainly in effervescent soft drinks. The standard production method is a fermentation of sugar beet or cane molasses or glucose syrup.

<http://ejbiotechnology.ucv.cl/content/vol5/issue3/full/3/index.html>

Soy sauce

In soy sauce production soybeans are soaked, cooked, mashed and fermented with two moulds called *Aspergillus oryzae* and *Aspergillus sojae*. Depending on the size of the factory, the soybeans may be fermented in fist-sized balls (the traditional method) or on trays. When the soybean substrate has become overgrown with the fungus the material is mixed with salt and water and the fermentation is completed in the brine. The brine fermentation takes six to nine months to complete, after which the soy sauce is pressure-filtered, pasteurized and bottled.

<http://www.japanweb.co.uk/listing/soy.htm>

Chocolate and coffee

Fermentations also play a role in the production of chocolate and coffee. In these cases the fermentation is responsible for the preparation of the bean, to separate it from the pod and mucilage in cocoa; or the cherry and mucilage in coffee. The fermentation of coffee is just to remove the mucilage so that coffee beans (two from each cherry) can be dried and further processed. In cocoa production the fermentation does breakdown the mucilage, but in addition the fermentation is absolutely essential for flavour development.

<http://www.exploratorium.edu/chocolate/> | <http://www.realcoffee.co.uk/> | <http://www.nationalgeographic.com/coffee/>

VISIT the BMS website at <http://www.britmycolsoc.org.uk>
and <http://www.fungi4schools.org/>