

# The Contribution of Beer to Health

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For much of its long history, beer has been firmly associated with bread as a staple food. From the ancient Babylonians to the medieval peoples of Europe, people realised that beer contains components which, like bread, can support life. We now recognise these ingredients as nutrients such as protein and carbohydrates, together with essential B vitamins. Also up until quite recent times, even until the present day in some parts of the world, it has been recognised that the brewing and fermentation processes together make beer much safer to drink than some local water supplies! Not until the mid twentieth century did concerns both about toxicants in foods (epitomised by the discovery of nitrosamines) and alcohol consumption *per se*, lead to a general assumption that alcoholic beverages, including beer, could not possibly have a positive role in promoting health. More recently however, many epidemiological studies have led to the now widely accepted realisation that moderate alcohol consumption can actually protect against heart disease.

At the same time, an emerging body of research suggests that trace components in beer may have other additional protective effects against a range of diseases.

It is therefore timely to reconsider the whole question of beer and health and to review both the proven and the potential contributions which moderate beer consumption can make to health.

## Macronutrients in beer

A balanced diet demands an adequate amount of macronutrients, namely proteins, carbohydrates and fats. Beer actually provides a good balance of these macronutrients, since it contains both carbohydrates and proteins, derived from the malt. In this respect it differs from wine and other fruit-based drinks which contain carbohydrates, mainly as sugar, but little or no protein (Table 1). In terms of calories, the energy content of beer is similar to that of soft drinks (Figure 1).

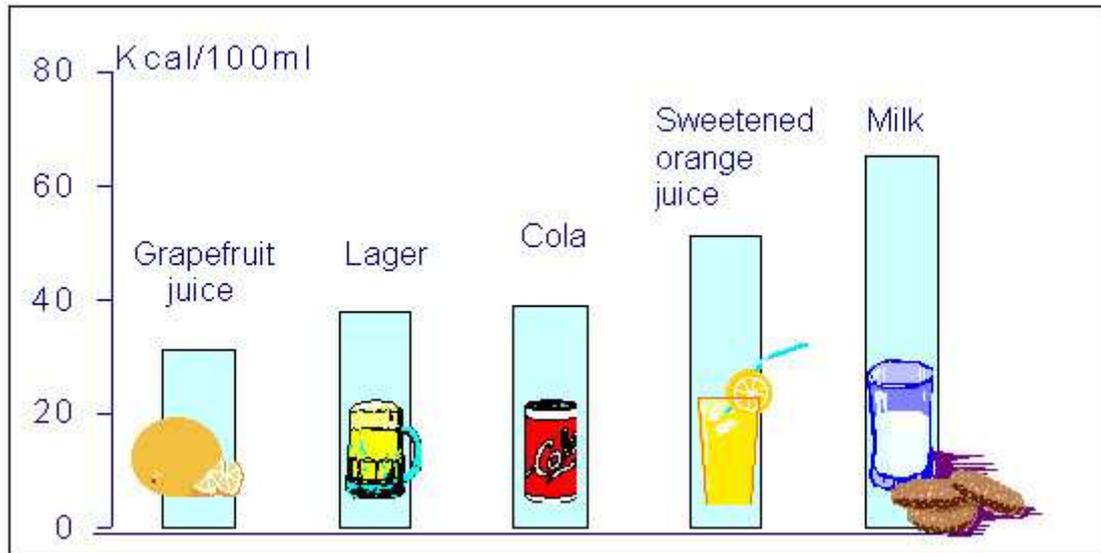
**Table 1. Major constituents of beer**

| Ingredient                               |            |  |  |  |  |
|--|------------|---|---|--|---|
|  |            | Beer  | Wine  | Milk   | Carbonated Soft Drinks  |
| Water                                    | (g/litre)  | 940   | 860   | 890  | 890   |
| Alcohol                                  | (g/litre)  | 30  | 10  | 0  | 0   |
| Total carbohydrates                      | (g/litre)  | 20  | 30  | 50   | 100   |
| - of which free sugars                   | (g/litre)  | <2  | 20  | 50   | 100   |
| Total proteins, peptides and amino acids | (g/litre)  | 5   | 0.2   | 30   | negligible  |
| Lipids                                   | (g/litre)  | negligible  | negligible  | 35   | 0   |
| Minerals                                 | (g/litre)  | 2.5   | 2   | 3  | 0.25  |
| Vitamins and other                       | (mg/litre) | 22  | 3   | 20   | 0   |
| Fibre                                    | (g/litre)  | 1 -6  | negligible  | negligible   | negligible  |
| Phenolic                                 | (mg/litre) | 20 - 600  | 200 - 2000  | 0  | 0   |

**Sources:**

*McCance and Widdowson's Composition of Foods, 4th edition, HMSO, London, 1978.*

*D.E. Briggs, J.S. Hough, R.Stevens and T.W. Young, "Malting and Brewing Science", Volume 2, Chapman & Hall, London, reprinted 1986.*



**Figure 1. Typical calorific values of beverages**

### Fat and fibre

In the more affluent parts of the world, such as Western Europe and North America, over-supply of certain foods is often more of a health risk than under-supply. Consequently, the latest health advice is to reduce consumption of fat and sugar. An added benefit of beer, therefore, is that most of the carbohydrate is in the form of complex carbohydrates - dextrins - with very little present as free sugars. And, contrary to popular perception, the amount of fat in beer is negligible! Also, perhaps more surprisingly for maltsters and brewers, beer does contain significant amounts of dietary fibre (defined as non-starch polysaccharides). This should not come as a surprise, though, if we remember that beer is made from whole grain cereals, that means that it includes the bran fraction which is often lost when, for example, wheat is milled to make flour for white bread. Fibre is thought to help protect against heart disease and some cancers by reducing blood cholesterol and may possibly also reduce the absorption of toxins through the gut. A litre of beer can contain up to 6g of soluble fibre (1), which is a third of the recommended daily intake. That is almost as much total fibre as a portion of high-fibre breakfast cereal (although in a soluble rather than insoluble form) and many would say, a lot tastier!

This is a sensitive subject though - while those of us keen to improve the healthy image of beer would like to increase the amount of fibre, brewers are ever mindful of the downside, in terms of poor run-offs in the brewhouse, or glucan hazes in finished products. But these problems are only likely to be associated with the large, highly viscous beta-glucans. We still have a lot to learn about relationship between size of the fibre molecules and the potential health effects, and the relative effectiveness of soluble versus insoluble fibre. There may yet be scope to raise the amount of small to medium size molecules without any detrimental effects on processing efficiency.

## Vitamins

**Table 2. B Vitamins in malt and their importance**

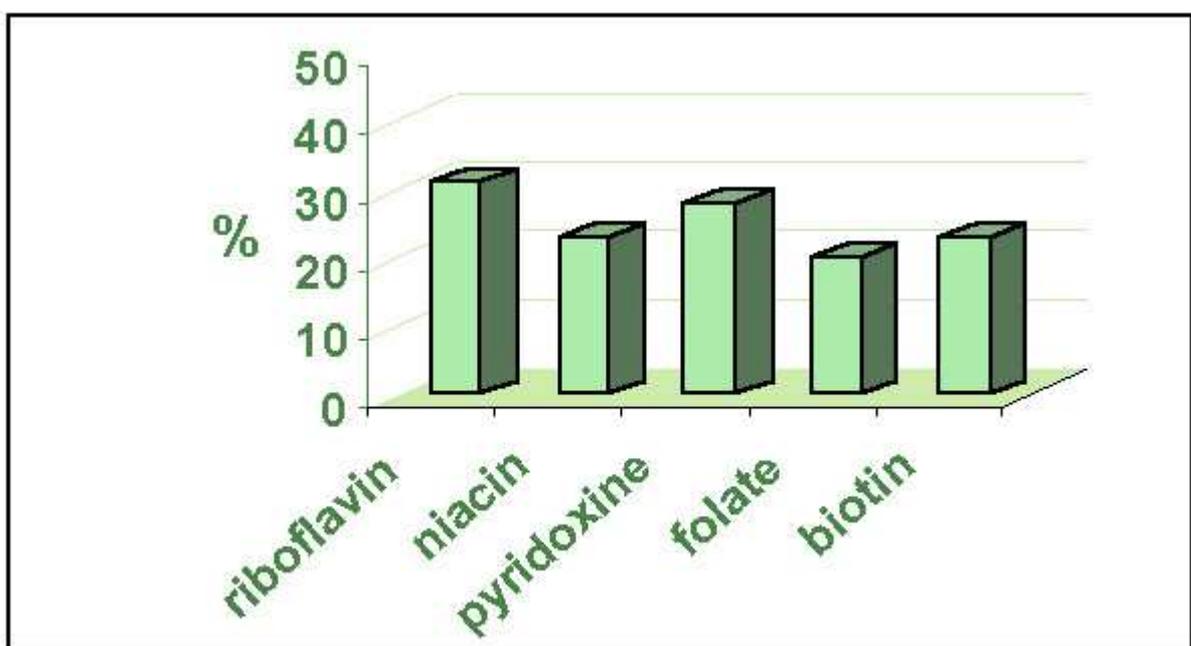
| <b>Vitamin</b> | <b>Main biological function(s)</b>                            | <b>Deficiency disorder</b>  |
|----------------|---|---|
| Thiamine       | coenzyme in energy metabolism                                 | beriberi  |
| Riboflavin     | coenzyme in redox reactions                                   | dermatitis  |
| Niacin         | coenzyme for dehydrogenase enzymes in respiratory chain       | pellagra  |
| Pyridoxine     | coenzyme in protein metabolism                                | Muscle weakness; nervous disorders; reduced resistance to infection   |
| Folate         | coenzyme for transfer of single carbon units in DNA synthesis | megaloblastic anaemia; congenital neural tube defects; antioxidant; possible protection against cardiovascular disease and some cancers |
| Biotin         | coenzyme in energy metabolism                                 | dermatitis  |
| Pantothenic    | acid coenzyme in fat synthesis, eg in membranes               | muscular weakness; neural disorders   |

Today, the diets of beer-drinkers are rarely lacking in macro-nutrients, and there is considerably more interest in trace components, such as antioxidants, which are thought to play a crucial role in keeping our bodies healthy and protecting us against disease. The vitamins are probably the best recognised of these micro-nutrients. The B vitamins are a group of structurally diverse compounds involved in basic cellular biochemistry, often as essential co-factors for enzyme reactions. Thus deficiency of these vitamins can affect a range of tissues and organs, such as blood, skin and bone (Table 2). Since one vitamin can affect the absorption or effectiveness of another, foods which are multi-vitamin sources are particularly useful. Whole cereal grains such as barley are good sources of the B vitamins thiamine, riboflavin, niacin, B6 (pyridoxine), folate, pantothenic acid and biotin.

Recent interest has focussed on folate, which is now thought to have a role in protecting against cardiovascular disease and some cancers. Intake of folate in the general population is often sub-optimal and beer is regarded as a significant source (2) . Research is currently underway in the EU to establish the clinical effects of this vitamin and to determine its bioavailability from beer and other important dietary sources.

The vitamins are mostly localised in the living tissues of the grain, the embryo and aleurone (bran), and thus are often lost when wheat is milled to form white flour for baking. Malt, however, is of course made from whole grain, and thus retains all the vitamin content of the raw barley. Indeed, the malting process itself, since it involves sprouting and growth of the embryo, results in an increase in many of the B vitamins, including folate and niacin. The B vitamins are largely soluble in water and relatively heat stable, and thus mainly survive the brewing process and persist through to the beer (Figure 2). An exception is thiamine, which is largely taken up by the yeast, leaving low levels in the beer. On the other hand, yeast can provide some vitamins. Almost half of the riboflavin present in the beer is derived from the yeast.

As Figure 2 shows, on average a litre of beer (that is, 3 to 4 units of alcohol, the current recommendation for daily moderate alcohol consumption) can provide 20 to 30% of most of the B vitamins.



**Figure 2. Approximate percentage of the daily recommended dose of B vitamins in a litre of beer.**

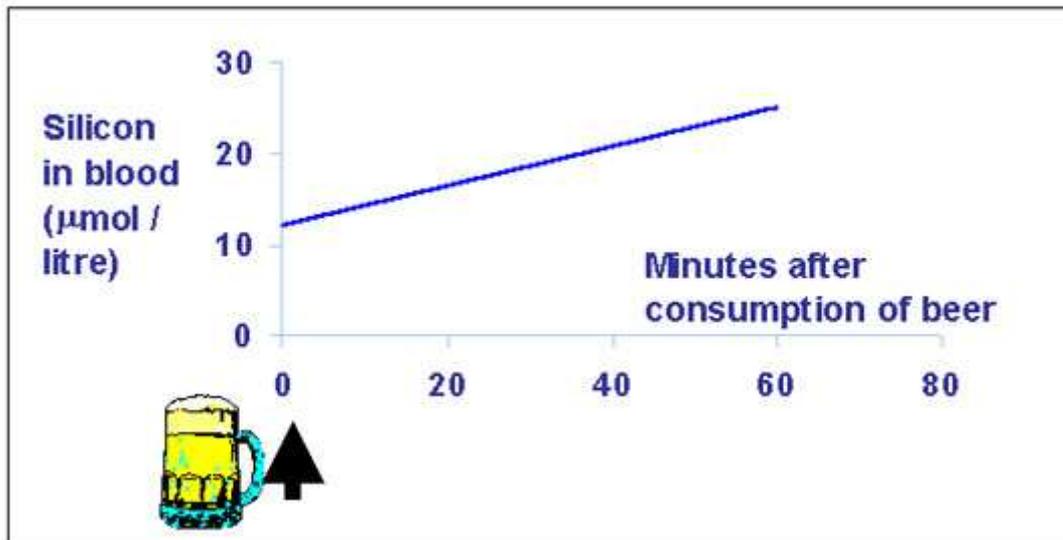
## Minerals

Beer is also a good source of several important minerals (Table 4). Some of these, for example calcium, are derived mainly from the water and will therefore vary according to the beer type and where it is made. The pale ales typical of Burton-on-Trent in the UK are very high in calcium, while the Pilsen-style lagers are made from softer water and contain much less salts. Some of the minerals in beer, however, come from the malt, and these tend to be less variable. Potassium is perhaps the most important of these. Potassium is the main ion in plant cells (as opposed to sodium in animal cells) and thus foods like beer which are made from plants tend to be high in potassium and low in sodium. Typically, beer contains four or five times as much potassium as sodium. This is good news for the beer drinker, since modern diets, which are often rich in meat and processed foods, frequently contain too much sodium as salt and too little potassium, a ratio that is not good for our blood pressure.

**Table 4. Typical mineral content of beer**

| Mineral   | Typical levels in beer<br>mg/litre   | Recommended intake<br>mg/day |
|-----------|--------------------------------------|------------------------------|
| Potassium | 300 - 550                            | 3,100 - 3,500                |
| Sodium    | 72 - 88                              | < 1,600                      |
| Calcium   | 20 - 90 (lagers)90 - 160 (pale ales) | 700 - 1000                   |
| Magnesium | 63 - 100                             | 200 - 300                    |
| Silicon   | 30 - 50                              | -                            |
| Phosphate | 260 - 400                            | 550 - 775                    |

Beer is also rich in silicon. The association of this mineral with bone health in humans is only now becoming apparent, although its importance in animal diets has been recognised for some time. Silicon is one of the most abundant elements on the planet, so it is surprising that it should ever be lacking in the diet. However, most of the silicon around us, in rocks or in the soil, is solid silicon dioxide, which is unreactive and poorly absorbed by the body. Even although silicon is abundant in plant foods such as cereals as phytolithic silica, it is again in a form which is poorly absorbed. In liquids, however, the silicon can be hydrated to form orthosilicic acid, which is much more easily absorbed by the body (3). This form of silicon is abundant in many natural water supplies, but nowadays is often removed by the flocculants and other treatments used for purifying drinking water. Fortunately for the beer drinker, however, the brewing process very efficiently extracts the phytolithic silicon from malted barley and converts it to readily bioavailable orthosilicic acid. Studies (4) have shown that consumption of just two pints of beer can increase blood silicon levels by over 100% (Figure 3).



**Figure 3. Increase in blood silicon after consuming 2 pints of beer ( Data taken from Anderson (3) )**

Another element which is abundant in beer is magnesium. This comes from both the malt and the water, and is highest in the hard waters used to brew traditional Burton Pale Ales. Magnesium is essential for many aspects of healthy metabolism, including bones, as well as nerve and muscle function. Just one litre of beer can provide between a quarter and a half of the body's daily requirement. This is especially useful since an official UK survey in 1995 indicated that the average intake of magnesium was only 88% of recommended levels (5). The observation that moderate beer drinking can protect against kidney stones is thought to be partly due to its magnesium content (6).

### Anti-oxidants

The micro-nutrients which we hear most about nowadays are antioxidants. There is increasing evidence that some important chronic diseases such as cardiovascular disease, some cancers and even ageing, are partly caused by oxidative damage. Highly reactive forms of oxygen, such as hydroxyl, superoxide and peroxide radicals, can damage lipids and DNA. Anti-oxidants act by scavenging tissues for these oxygen species and reacting with them preferentially, thus protecting cellular components (7). A number of foods, particularly plant foods, contain natural anti-oxidants. The chemical structure of these varies. Many are phenolics and include simple *phenolic acids* (such as ferulic acid and chlorogenic acid), *flavonoids* (such as quercetin, which is common in many fruits and vegetables) and *polymeric flavonols* such as the anthocyanins (responsible for the red colour in fruits like strawberries) and proanthocyanidins (found in red grapes, wine and some barleys) (8). Repeated epidemiological studies suggest that populations which consume more fruit and vegetables tend to be longer-lived, and current advice from nutritionists is for people to consume at least five portions of such foods a day.

Beverages such as beer, wine and fruit juices are of course extracts of fruit, whether that fruit is grapes, barley or oranges, and thus will also contain water-soluble anti-oxidants. Both hops and malt contain polymeric proanthocyanidins similar to those found in red wine.

Malt also contains small phenolic acids like ferulic acid. Hops are rich not only in quercetin, which is common in many plants, but also in unique flavonoids such as xanthohumol. These compounds can have a number of beneficial effects.



Some studies -as yet confined to the test-tube- suggest that hop flavonoids can also protect against cancer, by inhibiting the growth of cancerous cells (9) and deactivating toxins (10). Other workers have shown that xanthohumol and hop alpha-acids can decrease the formation of pits in bone and thus may be able to protect against osteoporosis (11). Antibiotic properties, for example against the *Helicobacter* which are responsible for stomach ulcers, have also been demonstrated for beer and wine (12).

However, the actual concentration of a nutrient in a food is not the only factor - of equal importance is the ease with which it can be absorbed by the body, that is, its bioavailability. High molecular weight species, such as the polymeric proanthocyanidins, are less likely to be readily absorbed. Ferulic acid is widespread in cereals, but is linked via ester bonds to sugars in the plant cell walls (the fibre fraction). This tends to reduce its bioavailability, since the sugars must be removed before the ferulic acid can be absorbed, and mammalian cells do not possess the correct enzymes to do this. Ferulic acid in beer, however, is readily absorbed (13), and it is likely that this is due to malt esterases releasing the ferulic acid during mashing, thus making it more bioavailable. Indeed, in clinical studies, moderate consumption of beer has been found to significantly increase the antioxidant capacity of blood plasma (14).

But phenolics and flavonoids are not the only antioxidants to be found in beer. It is less frequently recognised that the melanoidin compounds formed during kilning, especially in speciality malts, also possess significant anti-oxidant properties (15).

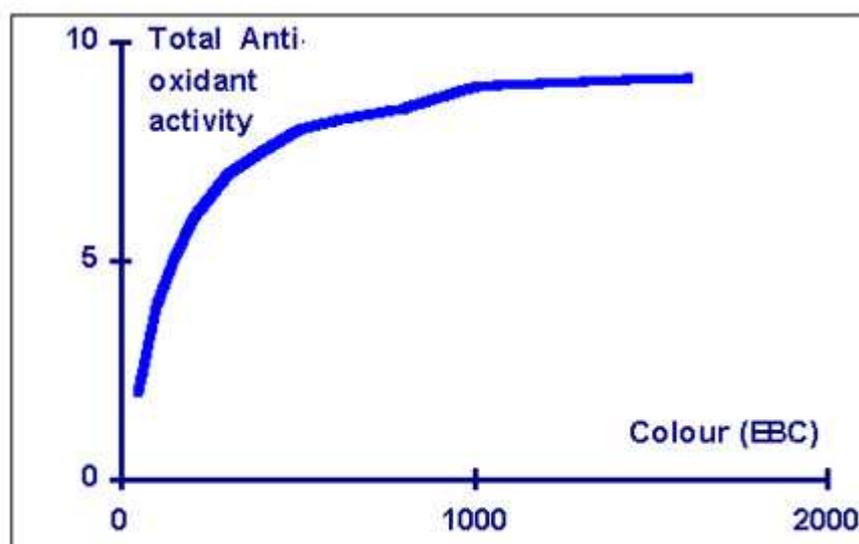


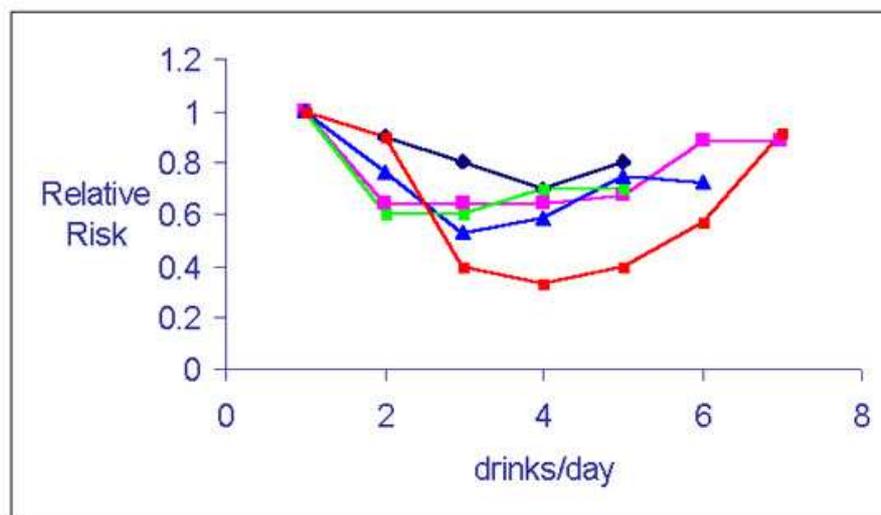
Figure 5. Total antioxidant activity in relation to malt colour. (Heasman & Hughes, 1998)

This has been confirmed recently by work at BRi, which showed that antioxidant activity in coloured malts increased up to a colour of about 400 °EBC (Figure 5). These speciality malts are used to give flavour and colour to beers, suggesting that dark beers could have more anti-oxidant properties than lighter ones.

### Alcohol

It must not be forgotten that alcohol itself makes a very significant contribution to good health, provided of course that it is consumed in moderation. There are now a large number of epidemiological studies which have examined the relationship between alcohol consumption, incidence of particular diseases and overall mortality. These studies have been in several countries, with different ages and ethnic groups, and using quite different study designs. The overwhelming majority show that moderate intake of any alcoholic beverage is associated with lower mortality overall, and especially with a very significantly lower incidence of heart disease (Figure 6).

"Moderate" is defined as anything between 1 and 5 or 6 drinks a day, depending upon the country, but is usually taken as 3-4 units of alcohol a day. These findings are supported by a number of clinical and biochemical studies to determine the actual means by which alcohol exerts its protective effects. It now appears certain that alcohol helps to shift the balance of lipoproteins in the blood, decreasing the Low Density ones (LDLP), which are more likely to form fatty plaques on the blood vessel walls, and increasing the proportion of protective High Density Lipoproteins (HDLP).



#### Key;

- Kiel et al, (Germany); *Epidemiology*, 1997, **8(2)**, 150-157
- Yuan et al, (China); *BMJ*, 1997, **314**, 18-23.
- Doll et al (UK); *BMJ*, 1994, **309**, 911-918.
- Kono et al (Japan); *Int. J. Epidemiology*, 1986, **15(4)**, 527-532.
- Thun, et al (USA); *N.Eng.J.Med.*, 1997, **337(24)**, 1705-1714.

Figure 6. Relative risk for coronary heart disease v alcohol intake.

At the same time alcohol decreases the concentration of blood clotting factors, making the blood less "sticky". Recently Rimm, of the Harvard School of Public Health, has reviewed more than forty published papers (16). From these, he estimated that consumption of 30g alcohol per day resulted, on average, in an 8.3% increase in HDLP, a 6.5% increase in the "good" apolipoprotein A1, and modest reductions in fibrinogen and other clotting factors. Overall, Rimm estimated, this was equivalent to a reduction of 25% in the risk of coronary heart disease.

Equally, we must not neglect the importance moderate consumption of alcohol, whether as beer, wine or spirits, has on a person's general sense of well-being. The relationship between such subjective parameters and physical health is far from understood. Nevertheless, a number of studies now indicate that individuals who drink one or two drinks a day tend to remain more alert in their old age (17). Other positive effects of moderate drinking on brain function have also been observed -, for example, a lower risk of developing Alzheimer's disease (18), (19).

### Summary

In summary, then, we can see that beer is well placed to make a very positive contribution to health, provided that, like all alcoholic drinks, it is consumed in moderation. Actually, because beer typically contains only 4-5% alcohol, it is ideally placed as a drink of moderation! A couple of drinks of beer a day can make a significant contribution to mineral balance, vitamin intake and antioxidants and at the same time provide enough alcohol to protect against heart disease but not too much.

It tastes good too!

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