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# bierNews SPECIAL

*Was sie schon immer über Bier wissen sollten !*

## Beer and Health
# International Symposium !

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der österreichischen Brauwirtschaft
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*Dear Readers!*

Beer is good for you – to drink and to talk about. Moderate beer consumption has a health-promoting effect. This brochure is a compilation of papers presented by a number of renowned scientists dealing with the medical effects of beer consumption.

Beer is the most popular drink in Austria, a beer-drinking country of long-standing tradition. About 400 different types of beer are brewed and drunk in Austria. Hence, it is only logical that experts and scientists should meet in the capital of beer-loving Austria to discuss the most recent findings of medicine. Prof. Dr. Antonio Gasbarrini, Dr. Caroline Walker, Dr. Norbert Frank, Univ.Prof. Dr. Wolfgang Koenig, Dr. Reinhold Lopatka, Prof. Dr. Jonathan Powell, Univ.Prof. Dr. Ing. Werner Back, and Univ.Prof. Dr. Manfred Walzl, physicians and scientists representing different disciplines, all agree that beer, if consumed with moderation, can have a wide range of positive effects on human health. In their opinion, the issue of beer and health is yet to be explored fully; at the same time, they agree that many of the well established research results have not yet received the degree of publicity they deserve. Throughout Europe, scientists are therefore making an increased effort to present the outcome of their research to a broader public.


We take pride in having been able to bring together such a distinguished panel of experts for a first meeting in Vienna and consider it our task to contribute towards promoting this exchange of ideas now and in the future.

*Austrian Brewers Association*

*Austrian Society for Nutrition – Southern Section*

## CONTENTS

Prof. Dr. Manfred Walzl (Neurological Hospital Graz)

# Beer – A New Challenge for Medicine?

Like no other foodstuff, beer has experienced a profound image change in recent years. A natural product, thousands of years old, has begun to attract great interest as a subject of medical research (to date, over 3,000 publications have appeared on the subject of beer). Thus, beer may turn out to be a (scientific) challenge for medicine.

The above said is in no way related to the alcohol content of beer. In fact, even low-alcohol beer and non-alcoholic beer have a health-promoting effect.

Since the introduction of the 0.5‰ alcohol limit for drivers of motor vehicles in Austria, the impact of beer consumption on the ability to drive has been widely debated. As a matter of fact, people are not aware of how much beer they may consume over a certain period of time without violating the law on impaired driving. The objective of our study was to compare Märzen beer with an alcohol content of 5.5% with low-alcohol beer (3.0%).

*Material and method:*

132 persons (81 men, 51 women, body mass and body fat index taken into consideration) had to consume half a litre of beer each within a period of 20 minutes after 24 hours of alcohol abstinence and six hours of food abstinence. After a ten-minute break, their breath alcohol concentration was measured by means of the breathalyser used by the Federal Police in the City of Graz. The test consisted of a total of three consecutive cycles, which meant that one and a half litres of beer were consumed within 80 minutes. The same test was repeated two weeks later with low-alcohol beer. Six months after that, the test subjects underwent a repeat test – again after 24 hours of alcohol abstinence, but following consumption of 180 grams of „Wiener Schnitzel“ and 150 grams of potato salad immediately prior to beer consumption.

*Results:*

After consumption of 0.5 litre of beer with a 5.5% alcohol content, the average breath alcohol concentration was 0.27 ± 0.03 ‰; after consumption of 1 litre of beer, the concentration was 0.69 ± 0.05 ‰. The corresponding values for low-alcohol beer were significantly lower at 0.09 ± 0.007, 0.19 ± 0.04, and 0.28 ± 0.04 ‰, respectively ($p<0.02$ for all values). Following standardised food intake, all values were reduced by 38.6 ± 2.2 % ($p<0.001$) on average.

*Summary:*

The results clearly show that consumption of 0.5 litre of beer results in a breath alcohol concentration well below the 0.5 ‰ limit. Low-alcohol beer, even if consumed in maximum quantities, never resulted in a breath alcohol concentration close to 0.5‰ in our study; on average, the maximum values reached were 44% below that limit.

Moreover, we were able to show that food intake reduces the concentration of alcohol in breath.

Moderate but regular consumption of beer has a wide range of positive effects on the human organism. Here are a few examples:

Studies in Finland and Italy confirmed that beer consumption substantially reduces the risk of developing renal calculi. A group of scientists at the National Health Institute in Helsinki carried out a five-year study involving 27,000 Finns aged 50 to 69, none of them suffering from renal calculi at the beginning of the study; however, more than 300 of the test subjects developed renal calculi after some time. The participants of the study were smokers who had been involved in a pulmonary screening programme.

A comprehensive analysis arrived at the following conclusion: consumption of half a litre of beer per day reduces the risk of developing renal calculi by 40%. In fact, a group of physicians from Milan even recommends „beer as a cost-effective measure of preventing renal calculi“.

And on top of that: beer makes you look beautiful. At least, this is what women in ancient Egypt thought. They „used beer foam to make their skin look fresh and clear“, as Pliny remarked more than 2000 years ago. Why is that so ? Because of the vitamins and minerals contained in beer.

Most importantly, the phosphoric acid contained in beer, an important component of cell growth, is essential for a healthy skin. Moreover, the human body needs potassium and magnesium (one litre of beer meets 45% of the daily re-

**Univ.Prof. Dr. Manfred Walzl**

Manfred Walzl worked as a science journalist and studied medicine at the University of Graz. Post-graduate training as a general practitioner and a specialist of neurology and psychiatry. Post-doctoral thesis in neurology in 1994. University professor since 2000. Scientific research on the prevention and development of arteriosclerosis, with a special emphasis on the role of nutrition. Dr. Walzl is President of the Austrian Society for Nutrition (Southern Section), Fellow of the American College of Angiology, Fellow of the Royal Society of Medicine in London, and Member of the Health Council of the Land of Styria. To date, Dr. Walzl's scientific work comprises 626 publications and lectures. Dr. Walzl is Head of the Joint Special Unit of the Graz Neurological Hospital.

quirement) to support muscle and nerve function. Sodium, a potential cause of hypertension, is only present in minimum quantities in beer. Another Italian study notes that development of a „beer belly“ is not due to excessive consumption of beer, but rather to a genetic deficiency in the blood-pressure regulating system, which increases the probability of a person growing a belly by about 200%.

Research on beer is currently being conducted all over the world by numerous groups of scientists approaching the subject from different angles. Most probably, the number of publications on beer and health will increase sharply in the near future.

Prof. Dr. Antonio Gasbarrini (Catholic University of Rome)

# Review of the History of Beer and its Historical Medicinal Properties

First record of fermentation is about 6.000 years old and it is related to the old civilisation of Sumerians in Mesopotamia. In all ancient societies, the brewing of beer was the esclusive domain of women brewsters. Of course detailed explanation is not available, but it seems that brewing has been discovered by chance when a piece of bread became wet and later started to ferment. The first technique to store and prepare beer was based on the use of baked bread. The resulting beer was unfiltered and therefore cloudy.

Afterwards, the beer was exported and distributed by Babylonians (who brew 20 different types of beer) to Egyptians, which improved the taste by adding some dates. In the Egyptian society beer was the staple drink of the poor (wages were sometimes paid in beer), it was a drink of the rich and wealthly, and a drink offered to the gods and placed in the tombs of the dead.

In ancient Greece Hippocrates used beer as a remedy to facilitate diuresis and the drink was also considered to act against fever.

During Roman Empire, wine was the most common drink, even if beer, considered as barbarian drink, continued to be brewed in those areas where vine was difficult to grow and in particular in the ancient Germany.

During Middle Ages, brewing was demanded mostly to monasteries. In that period the beer markedly improved its taste and was used instead of meals during the period of fasting by monks. It was in Brabant monasteries that hops were used for the first time as basic ingredient. The usage of hops allowed to flavour and add a natural preservative to the beer. A further step was made by the introduction of mixture of herbs in order to obtain a special and dedicated taste. The herbs balance became a sort of patent, allowing a brewer to have its own peculiar taste.

After Reformation, the monopoly of monks ended and brewing was under the responsibility of commercial brewers. In 1516 Wilhelm IV, Duke of Bavaria, proclaimed the German Beer Purity law, stating that only pure water, barley and hops could be used to brew beer. As a result, quality of beer was markedly improved and distribution and export started on large basis. In 14th century Bremen was the most important centre for production and distribution, while Hamburg took a relevant place in the 15th century.

In the 17th English brewers create beer designed to withstand the long sea voyage to Britain's colonies in Asia. These strong, highly hopped ales become known as "India Pale Ales".

The main contributions to today's beer, in terms of production process and purity of taste, were due to J. Watt through the steam engine and C. von Linde who invented the artificial cooling. Finally in the 19th, on the basis of Paster's studies, C. Hansen isolated a single yeast cell. The resulting yeast propagation method allowed to improve the fermenting quality.

As far as beer medical properties are concerned, the beneficial effects were detected since the early civilisations. In particular, the mood-altering properties were considered as supernatural and intoxication was thought to be divine. Behind these aspects, the beer su-

**Prof. Antonio Gasbarrini**

Doctor Antonio Gasbarrini was born in Bologna the October 11th, 1963. Laurea summa cum laude in Medicine and Surgery at the University of Bologna, in 1988. Postgraduate Schools of Internal Medicine and Gastroenterology. From 1990 to 1993 he was a Clinical and Research Fellow in the Transplantation Department of the University of Pisttsburgh (USA). Assistant Professor of Internal Medicine in the Catholic University of Milan from 1995. He is a teacher in the Postgraduate School of Gastroenterology and Digestive Endoscopy at the Catholic University of Milan. Professor of Internal Medicine in the Catholic University of Milan from November 2000. Member of several National and International Scientific Society, is in the Editorial Boarder of several National and International Scientific Journals. Author of more than 600 papers: 217 of which as full papers on International Scientific Journals, 64 as lectures at National and International Meetings and 38 as monographs or treatises. He has an impact factor for his publication of 423.

rely increased health and longevity of ancient civilisation because of vitamins content and caloric income. Starting from Greeks, all medical books contains references to beer properties as diuretic, laxative and sedative drink. Moreover it was used in order to stimulate digestion and to treat anaemia and tuberculosis. Nowadays beer is appreciated for its antioxidant properties that could exert a protective role against heart diseases, under low doses.

Dr. Caroline Walker (Brewing Research International)

# Evaluation of Vitamins including Folates in Beer

Many people think of beer as just an enjoyable drink, but few realise that it actually contains vitamins. While this may seem strange to us, it would not be a surprise to those living a few generations ago. They would have known that beer was made from cereals and would have thought of it more as a liquid bread and a staple in the family's diet. These days we buy foods such as beer and cheese without really knowing how they are made, and this has changed our perception of which foods are healthy.

**Dr. Caroline Walker**

Dr Caroline Walker holds a degree and doctorate in Biochemistry from the University of Bristol. Her wide international research experience has included work in the UK, the USA and also in Denmark as a fellow at the Carlsberg Laboratories. She is currently Manager of the Health Programme at Brewing Research International, acting as a consultant on beer and health for the company's international membership. As well as leading research in this area, Caroline plays a key role in communication, and as a member of the British Guild of Beer Writers publishes articles on all aspects of health and brewing.

*So where are these vitamins coming from?*

The key issue here, is that the main ingredient in beer is barley. Most people accept that cereals have vitamins, but they don't make the logical leap to appreciate that cereal products such as beer must also contain vitamins. Many of these vitamins, in particular the B vitamins carry through into the bottle.

So what is the relevance of this to our every day diet? Surely we are well-nourished and are all getting enough vitamins anyway? On the whole, this is correct, but there are some vitamins that are likely to be lacking in the diet – and one of these happens to be folate (vitamin B9).

Folate has been recommended for a long time for pregnant women in order to protect against birth defects, and obviously beer drinking is not something that is recommended for pregnant women! However, folate intake is an issue for everyone. In the last decade, it's become clear that increasing folate intake may provide protection against cardiovascular disease and cancer. Cardiovascular disease kills about 40% of us in Western society, so this has to be taken seriously – in fact, increasing the folate intake of the population is now an important public health issue.

This presentation will summarise some of the latest research on beer and vitamins, and will discuss how these might offer possible health benefits to the beer drinker.

*Malting*

As mentioned above, beer is a cereal food with the major ingredient being barley which has been 'malted'. In principal, malting is a very simple process - seeds are soaked in water and allowed to sprout for a few days. As the seedling begins to germinate it makes vitamins. The figure shows how the folate levels rise in barley during this process. The overall result is a dried grain with a high vitamin content – the barley malt.

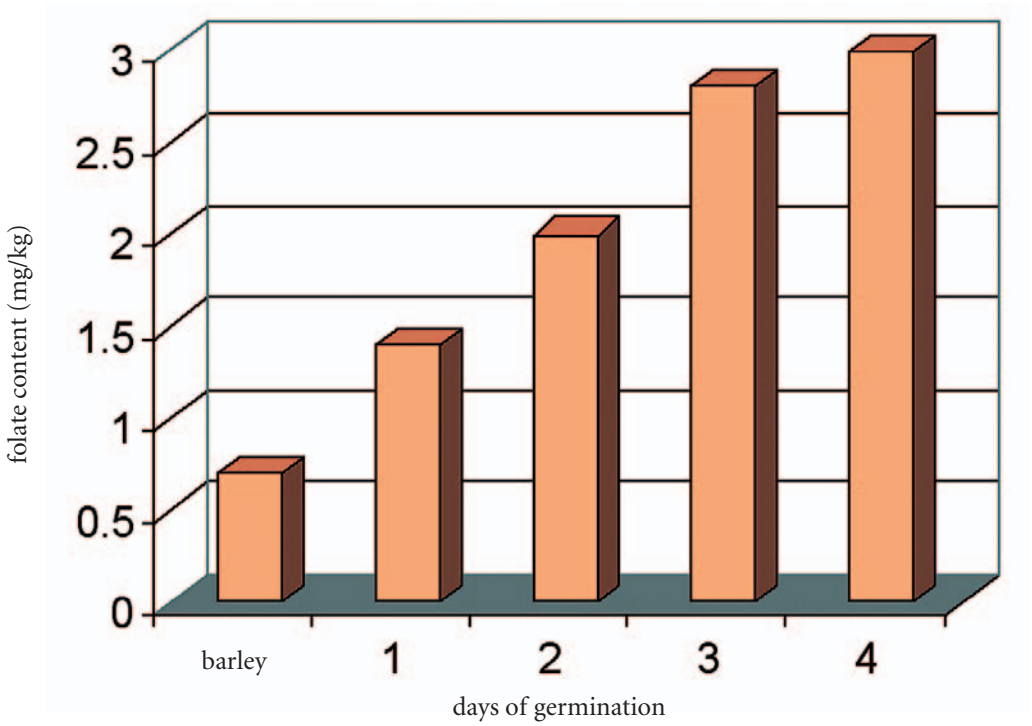
*Brewing*

It's worth stressing again that the main ingredient in beer is this high vitamin- containing malt. When making beer, the malt is milled into a flour, and then mixed with hot water. At this point all of the vitamins that can dissolve in water are released into the liquid. The result is therefore a broth which is enriched in these vitamins. The table below gives some typical values which may be found in beer.

*Folate in beer – a BRI/EU project*

Folates are found in fruit and vegetables, with the highest levels being found in dark green leafy vegetables. Unfortunately, we do not generally eat enough fruit and vegetables and the public are resistant to the idea of having another couple of portions a day! Therefore, nutritionists are focussing their attention on the nutritional value of some commonly consumed folate-containing foods, and this forms the basis of the EU project 'Folates, from food to functionality' which is being led by the Institute of Food Research at Norwich. Among the foods being looked at are rye breads, orange juice, fermented milk products, gazpacho and beer.

At BRI we are participating in this project by measuring the levels of folates in beer. We ha-




**The increase of folate levels during the germination of barley**

ve found that a litre of beer contains on average about 20-30% of the recommended daily intake of folate. To put this into context, some beers contain approximately the same amount of folate as:

- 100 g broccoli
- 0.5 kg tomatoes
- 0.25 kg potatoes
- 1.5 litres 2% milk

Those interested, can follow the progress of the EU folate project by visiting the web site at

http://www.ifr.bbsrc.ac.uk/folate/

*Absorption of vitamins from beer*

But can moderate consumption beer make a contribution to the vitamins in our diet? One problem that nutritionists must always consider is ability to absorb nutrients from food. Even although a food may contain quantities of a vitamin, it doesn't follow that we will be able to absorb it! This has been seen quite dramatically for vitamin A, which researchers have now shown is more readily absorbed from cooked carrots than raw ones – in other words soggy, boiled vegetables may in some cases be more nutritious than their raw counterparts.

**Average levels of vitamins in a litre of beer.**

| Vitamin | % daily intake/litre beer |
|---|---|
| B6 | 17 |
| Niacin | 13 |
| B2 (riboflavin) | 17 |
| Pantothenic acid | 8 |
| Biotin | 17 |
| Folate | 20-30 |

Currently, the indications are that we can absorb vitamins from beer. For example, in a study at the TNO Nutrition and Food Research Institute, in the Netherlands, a small group of volunteers were asked to drink either wine, beer, spirits or water with their evening meals over the course of three weeks. The researchers checked the volunteer's blood at the end of this time and found a major difference - the beer drinkers had bigger increases in the amount of vitamin B6 in their blood compared to those drinking any of the other beverages. This result may have been expected, in that beer was the only one of the beverages given to the volunteers which contained vitamin B6! However, it does suggest that we can absorb this vitamin from beer.

*Conclusions*

Vitamins in beer is not a joke, although the idea often gets a laugh! Culturally the knowledge that beer is made from highly nutritious malt has been lost to the general public and the perception of beer as simply an alcoholic drink with no nutritional value persists. Hopefully new research will restore the image of beer to one that earlier generations would find recognizable - namely as a beverage which, when consumed in moderation, may make a positive contribution to a balanced diet.

Dr. Norbert Frank (German Cancer Research Center Heidelberg)

# Is Hops beneficial to Health?

For most of us, hop is inseparably linked with beer – we can hardly image beer without hop. However, there was a time in history when beer was produced without the addition of hop. In fact, hop as a brewing additive was first used by Christian monks in the Middle Ages both to add flavour to the beer and as a preservative.

In popular medicine, hop is appreciated for its curative effect. In ancient times, Greeks, Romans and Arabs used hop to treat nervous disorders and biliary fever, to cleanse the blood, and to stimulate digestion. In Western Europe, Hildegard von Bingen (1098 – 1179) described hop as a psycho-active substance and a preservative. Paracelsus (1493 – 1541) recognised its soporific properties. Even today, hop-based preparations are used widely in popular medicine for a large number of indications. Roughly speaking, hop has the following effects:

- sedative,
- estrogenic,
- antibiotic,
- digestive,
- and antioxidant.

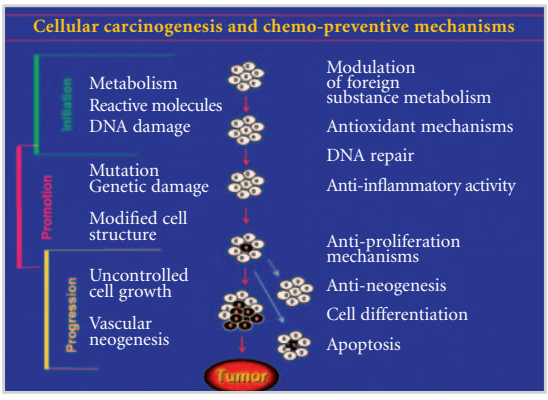
As with all other active substances, excessive dosages have toxic side effects, such as contact dermatitis and painful menstruation.

If a health benefit is to be derived from the positive properties of hop, the findings of traditional popular medicine must be subjected to a scientific revision. Above all, three questions need to be answered:

1. Which active substances are contained in hop and what are their biological effects?
2. Can these effects be optimised by modifying the substances, their composition and the mode of administration?
3. Which indications are these substances suited for? Are there any new fields of application?

Basically, the substances contained in hop have been investigated in the context of the brewing process. They include bitter acids (humulone, lupulone), essential oils (linalool, myrcene), mineral substances, flavenoids, chalcones (xanthohumole, prenylnaringenin), polyphenols, and catechines. Many of these substances are biologically active and known for their health-promoting effects, although it is difficult to relate these properties directly to the curative qualities postulated by popular medicine. To date, we do not know which of these substances account for the psycho-active or sedative properties of hop. This is due, among other things, to the absence of a proven and simple test model. The estrogenic or anti-estrogenic effects of hop are easier to demonstrate. 8-prenylnaringenin is one of the most effective phyto-estrogens. The antioxidant effect of many of the substances contained in hop is also well established. Given the fact that many diseases, such as cancer, arteriosclerosis, Alzheimer's disease and Parkinson's disease, are associated with oxidation processes, these substances are assumed to have a positive, preventive effect. This is to be illustrated by the example of xanthohumole in cases of cancer. The development of cancer is a multifactorial process involving numerous biochemical, genetic and cellular events. The steps leading to the development of a tumour are shown in a simplified pattern on the left side of the diagram. The events counteracting the carcinogenic events, i.e. having a preventive effect, are shown on the right side of the diagram. Substances that support the mechanisms on the right side are potentially chemo-preventive agents. A number of test systems have been developed in our laboratory to investigate the possibility of inhibiting and/or inducing the above mechanisms through plant-based substances. Among many others, substances contained in hop and beer were tested. In the course of this process, xanthohumole was identified as having a positive effect in almost all the steps shown above. Therefore, xanthohumole was further investigated in an organ-culture model, where its cancer-inhibiting effect was again demonstrated.

This leads us to conclude that hop has a health-promoting potential, the extent of which has not yet been fully recognised.




**Dr. Norbert Frank**

Norbert Frank was born on 1 June 1945 in Baden-Baden. He studied chemistry at the University of Basel and obtained his doctoral degree from the University of Freiburg. After his post-doctoral studies at the Institute of Organic Chemistry of the University of Heidelberg, he joined the scientific staff of the German Cancer Research Centre in Heidelberg, working in the "Metabolism of N-nitrosamines" Department. Visiting scientist at the National Cancer Center Research Institute, Tokyo, Japan; research fellow at the Foundation for Promotion of Cancer Research. From 1987 to 1994 member of the scientific staff of the "Molecular Toxicology" Department of the German Cancer Research Centre in Heidelberg. Since 1995, member of the scientific staff of the "Toxicology and Cancer Risk Factors" Department of the German Cancer Research Centre in Heidelberg. Research area: mechanisms of chemo-prevention of cancer. Dr. Frank is married and has four children.

Prof. Dr. med. Wolfgang Koenig (Medical University Clinic Ulm)

# Effect of Beer Consumption on Cardiovascular Diseases?

In recent years a range of prospective long-term epidemiological studies have shown that moderate alcohol consumption is associated with lower overall mortality and with reduced cardiac mortality and frequency of coronary heart disease. This connection is apparent both in populations that prefer wine as an alcoholic drink as well as in a predominantly beer-drinking population, as for example in Denmark (Hein et al. BMJ 1996;312:736-741) or the region of Augsburg in Germany (fig. 1; Keil et al. Epidemiology 1997;8:150-156). Despite the consistent connection in the literature, the mechanisms responsible for this positive effect of alcohol are currently only partly understood. It has long been known that moderate, chronic alcohol consumption increases the beneficial HDL cholesterol level, raises blood coagulation ability through the formation of higher concentrations of tissue plasminogen activators and reduces the coagulation-promoting blood proteins such as fibrinogen.

**Professor Dr. med. Wolfgang Koenig**

After taking a degree in medicine at the LMU in Munich, he was employed as a medicinal assistant at the Munich-Schwabing city hospital, then as an assistant doctor at the Höhenried clinic for cardio-vascular diseases of the Oberbayern LVA in Benried/Obb. He received his doctorate at the University of Heidelberg in 1980 and then became a scientific employee at the Institute for Work and Social Medicine, University of Heidelberg, and scientific worker at the MEDIS institute of the society for radiation and environmental research (GSF), Neuherberg. From 1983 to 1986, he was head of the MONICA heart-attack register of the World Health Organisation (WHO) at the Zentralklinikum in Augsburg. At the University of Ulm Medizinische Klinik since 1986. Currently assistant medical director of the department of internal medicine II, cardiology, Medizinische Universitätsklinik Ulm. Leader of the "preventative cardiology" working group and of the high blood-pressure clinic and the heart failure clinic. He is author and co-author of approximately 160 publications and more than 200 lectures in the fields of clinical cardiology, cardiovascular pharmacology, clinical epidemiology, cardiovascular epidemiology, hypertonology and haemorheology.

Current scientific emphases:
- Hämostasis system and atherogenesis
- Inflammation, infection and atherogenesis/ atherosclerosis
- Clinical pharmacology of cardiovascular substances
- Clinical epidemiology
- Cardiovascular epidemiology

Professional societies
- Member of the German Society for Cardiology –- Cardiovascular Research
- Fellow of the European Society of Cardiology (FESC)
- Fellow of the American College of Cardiology (FACC)

Since the importance of a systemic, low-level inflammatory answer for atherogenesis and its clinical complications like myocardium infarction, stroke and peripheral arterial blockage disease has in the meantime been recognised, we studied the connection between alcohol consumption and systemic markers of the inflammation in various population groups. In a multivariable analysis of 2006 men and women between the ages of 18 and 88, who were representative of the former West Germany, we were able in a multivariable analysis to show a U-shaped connection between alcohol consumption and the concentration of the C-reactive protein (CRP), a sensitive marker for systemic inflammation, and a classical acute-phase protein (fig. 2). We found the lowest CRP concentrations with a daily intake of 20g to 40g of alcohol in men and 40g to 60g in women. These results were confirmed in three other population-related major studies (MONICA – Augsburg study in Germany; Glasgow – MONICA in Scotland, and MONICA–Lille in France). In a major control case-study, we investigated whether the type of alcoholic drink might have an influence on the risk of coronary heart disease (CHD) and also on possible mediators. Moderate alcohol consumption, regardless whether through the consumption of wine or beer, was associated with a clear reduction of coronary risk. At the same time, these people also showed a better blood-fat profile and a more balanced coagulation situation. Finally, in 478 healthy blood donors, not only did we see the above-mentioned U-shaped relationship between alcohol intake and various inflammatory proteins, but we were also able to demonstrate a comparable connection with other inflammation markers, such as, for example, the cytokine interleukin IL-6 or the adhesion molecule ICAM-1 (intercellular adhesion molecule).

The alcohol dehydrogenase (ADH) is the main enzyme responsible for the metabolism of alcohol. In a prospective American study it was shown that a polymorphism of ADH 3 can delay the ethanol metabolism. Further, they found in this study that people who drank moderate quantities of alcohol and were homozygous for the y2y2 allele of ADH 3 displayed a particularly reduced risk of myocardium infarction. We therefore investigated whether there was an interaction between the ADH 3 genotypes and the effect of alcohol consumption on inflammation markers. In 3,650 men and women randomly recruited from the general population we determined the CRP with a highly sensitive assay and analysed the ADH 3 genotypes using high-throughput procedures (MALDI – TOF). All three genotypes showed a U-shaped connection with alcohol consumption. The people who were homozygous for

the y2y2 allele, however, showed the lowest concentrations. As mentioned above, this group is characterised by the fact that they break down alcohol significantly more slowly.

In summary it can be taken as certain that moderate consumption of alcohol is associated with a reduced inflammatory response. This connection has been shown in various population groups with quite different drinking habits. Only heavy drinkers represent an exception here. This drinking behaviour is associated with significantly excessive morbidity and mortality. The major part of the anti-inflammatory effect can be ascribed to the ethanol. New studies, however, have shown that the concentration of various polyphenols can modify this effect by approximately 30%. One may thus conclude that the anti-inflammatory characteristics of moderate alcohol consumption represent a possible mechanism explaining the reduced cardiovascular morbidity and mortality and the lower overall mortality in these people in comparison to non-drinkers. Finally, however, one must bear in mind that despite the favourable effects of alcohol described here, it should be fundamentally taken into account that alcohol influences health and sickness in a very complex way.

## Dr. Reinhold Lopatka (Member of the Austrian Parliament)

# Beer and Sports "From the Life of a Marathon Runner"

Food is an essential part of life for all of us, not just for top athletes. Our energy household must be in balance, and the body needs an adequate supply of liquids, vitamins and minerals.

Professional athletes and amateurs agree that beer and sports go together very well. In a representative survey conducted by the Munich University of Technology (Prof. Dr. Piendl), 92% of the 360 top athletes questioned stated that beer was their preferred drink before and after a period of physical exercise. 63% like to drink beer the night before the competition in order to sleep well, 41% appreciate its relaxing effect. One out of two athletes regards beer as the ideal thirst-quencher – a most remarkable result in an age of power- and energy-enhancing drinks! Above all, however, people who regularly engage in sports appreciate beer for its purity and its refreshing effect.

Thanks to its high water content (with a relatively low percentage of alcohol) and an equally high content of minerals (potassium, magnesium, etc) and vitamins, beer serves as an isotonic replacement for the liquid lost during physical exercise; at the same time, its readily available carbohydrates supply the body with the necessary energy.

Moreover, according to Antonelli and Romano, two Italian experts in sports medicine, the consumption of 1 litre of beer per day enhances the performance and concentration of athletes, increases their speed of reaction, and helps them build muscle strength. American cardiologist Sheehan found that beer is ideally suited to replace the liquid and energy lost through long-term physical exercise (marathon running, jogging, cross-country skiing). According to French physician Gulpin, beer even has the potential to increase pulmonary activity, which in turn results in a higher energy uptake. From a marathon runner's point of view, the physiological properties of (non-alcoholic) beer are as follows:

- alcohol content low to zero
- high water content
- isotonic effect
- rich in carbohydrates
- low calorie content
- readily available sugar
- all important amino acids
- no fat and cholesterol
- rich in potassium, magnesium and other trace elements
- all vitamins of the B group
- almost no sodium
- fibre content to stimulate digestion
- no chemical additives

The alcohol content of beer is a matter of special importance for a marathon runner. Naturally, low-alcohol beer is to be recommended, its alcohol content being 40 – 50% lower than that of "regular" beer. Studies (by Walzl et al. in Graz) have shown that the blood alcohol level after consumption of beer with half the alcohol content of regular beer is much lower than expected – not even one third of the level reached after consumption of regular beer in most test subjects. This phenomenon can be explained in terms of nutritional physiology: the higher the amount of water and extract in which alcohol is „embedded", the lower the quantity of alcohol ente-

**Dr. Reinhold Lopatka**

Born in 1960 in Vorau. 1978 to 1982, degree in theology and law at the Karl-Franzens University, Graz. 1978 to 1984, freelance at the Südost-Tagespost daily newspaper and at Modell Steiermark. 1982 to 1986, assistant at the Faculty of Law. 1983 to 1991, regional chair of the Styrian youth wing of the Austrian People's Party [Christian Democrats (ÖVP)]. Member of the Styrian provincial assembly since 1986. 1989 to 1992, member of the board of governors of the Styrian regional health insurance. 1992 to 1993, chair of the Styrian welfare organisation. 1993 to 2001, secretary of the Styrian People's Party (ÖVP). 2000 to 2003, Party leader of the Styrian ÖVP. Since 2003, member of the national parliament and general secretary of the ÖVP. During the last 10 years Lopatka participated in 37 marathon races (among others the Mount Everest-, Sahara-, 25. New York- and 100. Boston-Marathon). On April 27 2003 he won the Members of Parliament world champion-ship in Breslau (Poland).

ring the blood stream and the lower the blood alcohol concentration.

Finally, beer also appears to have a favourable influence on „marathon runner's haematuria", a condition sometimes developed by long-distance runners, as the small blood vessels of the bladder or – more rarely – the kidney tend to rupture under mechanical stress. Dark coloured urine is a symptom of such haemorrhage. To prevent this from occurring, marathon runners should never take any haemo-diluting drugs, which would increase the probability of a haemorrhage. Running with a slightly filled bladder appears to be an effective preventive measure. According to recent publications (e.g. Bassler et al.), consumption of liquid in the form of (non-alcoholic) beer is recommended for this purpose.

## Dr. Jonathan J. Powell (King's College London)

# Beer, Bones and Silicon

Silicon, as the orthosilicate ion $H Si(OH)_4 \leftrightarrow Si(OH)_3O$, appears to be essential. Its main function is in optimal bone and cartilage formation. The silicon content of beer is high and, at least in men, beer has been shown to be the highest contributor of silicon to the Western diet. Here the evidence for the importance of silicon in health is reviewed and the potential importance of beer as a dietary source of silicon is discussed.

*What is Silicon? Where is it found?*

Silicon is the second most abundant element on the earth after oxygen, making up 25.7% of the earth's crust by weight. On earth, it is mainly found as silicon oxides such as sand and quartz, or certain gems (e.g. amethyst, agate and opal) as well as being abundantly present in minerals such as the clays. Within the human body, and as noted above, silicon is mostly found as orthosilicic acid. This is formed when silicon oxides and the silicate minerals are gradually leached in water forming orthosilicic acid up to a level of ~50 mg/l but more commonly of 1-15 mg/l. This level of 50 mg/l is relatively important because higher concentrations tend to polymerise (forming poly-silicic acid) and are less available for absorption. It is notable that some beers are nearly saturated with orthosilicic acid achieving levels of up to 40 mg/l (Table 1).

**Dr. Jonathan J. Powell, FRSC, PhD**

Dr Jonathan Powell was appointed as Senior Lecturer in Nutrition at King's College London (KCL), in Feburary 2000. He is also an Honorary Senior Lecturer in Medicine at KCL's St. Thomas' Hospital campus where he heads up a research group in gastroenterology and nutrition. His major research interests are the biology and biochemistry of silicon, the gastrointestinal absorption of iron and the absorption and immune-potentiating activities of fine and ultrafine dietary particles. Diseases of interest are Crohn's disease and osteoporosis. His previous positions were visiting Assistant Professor, Dept. of Immunology and Rheumatology, University of California at Davis, California, USA from April 1998 and MRC fellow/Honorary Lecturer, Dept. of Gastrointestinal Research, Rayne Institute St Thomas Hospital, London from August1995.

Selected Recent Publications

Othosilicic acid stimulates collagen type 1 in human osteoblast-like cells in vitro. Reffitt D.M., Ogston N., Jugdaohsingh R., Cheung H.F.J., Evans B.A.J., Thompson R.P.H., Powell J.J., Hampson G.N. Bone. 2003 Feb;32(2):127-135

The role of dietary microparticles and calcium in apoptosis and IL-1b release of intestinal phagocytes. Evans S.M., Ashwood P., Warley A., Berisha F., Thompson R.P.H.. Powell J.J. Gastroenterology. 2002:123;1543-1553.

Analysis of Aluminosilicate Particles in Biological Matrices using Histochemistry and X-ray Microanalysis. Powell J.J. Analyst. 2002:127(6); 842 – 846.

Dietary silicon intake and bioavailability. Jugdaohsingh R, Anderson SHC, Tucker KL, Elliott H, Kiel DP, Thompson RPH, and Powell J.J. Am. J. Clin. Nutr. 2002;75:887-893.

Aluminium-Dependent Regulation of Intracellular Silicon in the Aquatic Invertebrate Lymnaea stagnalis Desouky M, Jugdaohsingh R, McCrohan CR, White KN, Powell JJ. Proc. Natl. Acad. Sci. 2002;99:3394-3399.

Efficacy of a low particle diet in a double blind randomised study in Crohn's disease. Lomer M.C.E., Harvey R.S.J., Evans S.M., Thompson R.P.H. and Powell J.J. Eur. J. Gastroenterol. Hepatol. 2001;13:101-106.

*Why is silicon important?*

During studies in the 1970's silicon was identified as an essential element (3) for mammals and higher plants. These studies confirmed that silicon is required for normal healthy growth and development, as well as the integrity of bone, cartilage, connective tissue, arteries, hair, nails, skin and mucous membranes. Silicon has also been shown to be involved in collagen formation, and possibly also gene expression. For example, diatoms from both fresh and sea water extract silica from the water and incorporate it into their cell walls; Some studies have revealed that silicon can affect gene expression in diatoms which may be an indicator for a comparable role in humans.

Much of the work from the author's group has concentrated on silicon absorption from the diet and its impact on bone formation.

*Silicon and Bone Formation*

The best documented function of silicon is its action on bone

development. Bone is made of apatite (calcium phosphate) crystals imbedded in a protein matrix containing collagen and glycosaminoglycans. Silicon appears to play a structural role in the development of glycosaminoglycans and their protein complexes during the initial stages of bone formation. It may also increase the rate of bone mineralisation and enhance calcium deposition in bone. Studies have shown that silicon increases the bone density and strength of the femur. Its deficiency has been shown to form weak and malformed bones of the arms, legs and head in animals.

Osteoporosis has been proposed as one situation associated with inadequate silicon intake or absorption. The results of a study carried out in 1993 on 8 women with osteoporosis, who were injected with a silicon compound showed that modest levels of silicon significantly increased the density of their femur, but did not affect the density of vertebral bone. An animal study was also conducted in rats; one group had their ovaries removed to mimic the post-menopausal state, another had a sham operation and a third group served as baseline controls. These groups were further subdivided into those receiving silicon supplementation and those that did not. Results showed that, as expected, the rats that had their ovaries removed experienced an increased rate of bone turnover. However, silicon significantly slowed the turnover and increased bone formation rates by 30% compared to controls.

**Table 1: Silicon Values in a Range of European Beers**

| | Mean±SD | Range |
|---|---|---|
| Lager | 22.1±8.26 | 11.65-39.37 |
| Bitter | 19.8±5.65 | 12.63-29.84 |
| Mild* | | 16.74-30.14 |
| Stout* | | 9.59-19.65 |

* Indicates too few samples for a meaningful average and standard deviation (SD)

In collaboration with Tufts and Harvard Universities, Boston, USA, we showed in an initial analysis that silicon intakes are positively associated with bone mineral density in men (Table 2).

More recently we have shown that this also appears to be true for pre-menopausal women but not post-menopausal women, which is consistent with a role for silicon in bone formation. Post menopausally, bone mineral density is driven by resorptive process so one may expect little effect of silicon which mainly affects bone formation. Whether silicon also has any affect in preventing bone resorption, as suggested in rat studies, needs to be addressed in further work.

*Silicon and Arterial Health*

Silicon may also be important for the maintenance of the strength and integrity of the tunica intima of arterial tissue, disruption of which can lead to the formation of atherosclerotic lesions in animals. Silicon levels have been shown to be significantly decreased in arterial walls of atherosclerotic patients, just prior to plaque development. Studies carried out in rabbits fed on a high cholesterol diet have shown regression of atheroma lesions after intervention using silicon supplementation. 24% of rabbits that were supplemented with silicon developed atherosclerosis, compared to 77% of the controls. However the majority of the rabbits given silicon had healthy, smooth, shiny, elastic arteries despite the unhealthy diet. There were no differences in cholesterol or triglyceride levels in rabbits from either group.

*The Mechanism of Action of Silicon*

It remains a puzzle as to why orthosilicic acid has any biological action. Some studies have suggested that, under the correct conditions, $Si(OH)_4$ deprotonates (i.e. forming the soluble, silicate anion) and can then form Si-O-C bonds. However, strong evidence for these in biological, and certainly in mammalian, systems, remains elusive. Whether silicon could then have a structural role in, for example, bringing together the different protein chains in collagen is also under consideration. Others have suggested that silicon acts to stabilise radical formation, essential in certain enzyme systems, while a number of groups have proposed the idea that soluble silicic acid is the natural 'antidote' to aluminium toxicity. Although, under certain circumstances, this latter scenario certainly occurs it is unlikely to be the only biological effect of silicon.

*Silicon Absorption and Excretion*

As noted above silicon is absorbed as the soluble, monomeric orthosilicic acid. It can be ingested in this form or broken down from dietary, plant-based phytolithic silicon (see below – food sources of silicon).

Quantitative information on the rates of uptake and elimination of orthosilicic acid in humans is limited. Studies have shown that plasma silicon concentrations are higher in patients with impaired kidney function than in normal healthy individuals. This suggests that renal excretion of silicon is a vital control mechanism in silicon homeostasis. Indeed, total daily silicon elimination in healthy adults has been shown to be 20-30 mg, with renal clearance of plasma silicon to be high, at 70-80% (16-18). Work involving the ingestion of orthosilicic acid has shown that over 50% of the absorbed silicic acid was eliminated within 8 hours. Consistent with these findings a study conducted on rats found plasma silicon levels to fall by a factor of 10 within 4 hours, with approximately 80% of the administered silicon recovered in the urine within the same time. Some organ retention, especially in the kidney, liver and lung, however, was observed. In 1998 a study using isotopic 32Si was carried out on a single human subject to determine silicic acid uptake and elimination. It showed that 36% of the ingested dose was absorbed and eliminated within 48 hours. It is not known whether any silicon was retained over a longer period of time, but the kinetics implied any further release of silicon after 48 hours

was either relatively small or very slow. Of the absorbed silicon, the majority (approximately 90%) was excreted with a half-life of 2.7 hours, and the remaining 10% with a half-life of 11.3 hours. This again confirms that following rapid absorption of plasma silicic acid from the gastrointestinal tract, it is highly efficiently filtered by the kidneys, with minimal re-absorption.

**Table 2. Silicon Intake and BMD**
**Cross-sectional difference in BMD per unit difference in logarithm of silicon intake**

| | BMD (g/cm2) | | | |
|---|---|---|---|---|
| | **Femoral Neck** | **Trochanter** | **Ward's Area** | **Total Hip** |
| **Male** | 0.022** | 0.024** | 0.015 | 0.021* |
| **Female** | 0.017 | 0.004 | 0.020 | 0.009 |

* p<0.05 ** p<0.01
Tucker et al (American Society for Bone Mineral Research Oct 2001)

Taken together, all of these studies show that urinary silicon is a good proxy for absorption of silicon from the gastrointestinal tract. Thus this measure has been used by our group and others to assess silicon absorption from different foods and fluids. It is thought that silicic acid disperses through the entire extra-cellular fluid volume, and the rapid exchange between extra-cellular fluid and plasma would account for the rapid removal of 90% of the silicic acid. The remaining 10% is thought to be incorporated intra-cellularly, and hence is less mobile. It is the biological role of this '10%' that we are interested in finding out more about.

*Daily Intakes of Silicon*

It has been estimated that the average daily intake of silicon ranges from 20 to 50 mg/day in humans, and anything from 0 to >50% of this is absorbed depending on the diet ingested (see below). An average intake of 30 mg/day makes silicon one of the major minerals in the diet behind sodium, potassium, calcium and magnesium (zinc and iron intakes, for example, are about 10-15 mg/day). Elderly people and women ingest less than younger people and men. Animal based diets have a much lower silicon content compared to plant based diets. Water has traditionally been a likely source of bioavailable orthosilicic acid but the modern practice of purifying waters (e.g. aluminium flocculation for tap water) has reduced our exposure to water-borne silicon. Many manufactured soft drinks also use partially purified water, again reducing our fluid-based exposure to orthosilicic acid. Silicon, as orthosilicic acid, is safe when ingested, and shows only very limited interaction with other minerals.

*Food Sources of Silicon*

Silicon is widely available in food. It is present as polymeric/phytolithic silica in plants which can then be hydrolysed to orthosilicic acid in the gastrointestinal tract before absorption. Good sources of silicon include unrefined wheat, oats and rice, bananas and beans. The processing and refining of foods reduces the silicon content of foods by up to 99%. The bioavailability of silicon from different food types is very variable. It is present in a highly bioavailable form (49 ± 34%; range: 10-100%) in grain and grain products, but is found in a less bioavailable form (21 ± 29%; range 0-40%) in many fruits and vegetables. Bananas, for example, are high in silicon but appear to deliver it inefficiently for absorption. Fluids are ,generally, the best vehicles for delivery of bioavailable silicon.

*Silicon in Beer*

Silicon is present in high quantities in beer (Table 1). Using data from the Framingham Offspring Cohort study, it has been estimated that beer is the highest contributor of silicon intake in men, contributing 17.6% ± 23.7% of dietary silicon, and is within the top 10 major contributors of silicon intake for women. It should be noted that these data are from an older population with low to very low alcohol intakes compared, for example, to much of Europe. Indeed, Finnish and British studies have shown that men consume up to twice the amount of silicon compared to women which is mostly attributable to the men's high levels of beer consumption.

In addition to the amount of a nutrient contained in a food its bioavailability is also important. In beer, silicon is probably present as orthosilicic acid, which is the form that is readily bioavailable. Indeed, a study on calves showed that supplementation with orthosilicic acid was more effective than food at increasing silicon levels in the bloodstream and in increasing collagen synthesis. Thus beer may similarly be a readily bioavailable source of silicon. Consistent with this, one study has been carried out to investigate the bioavailability of silicon from beer and showed that plasma silicon concentrations were markedly increased an hour after beer ingestion and urinary silicon excretion markedly rose during 8-hours of collection. 42-72% (mean 56%) of silicon in beer was excreted within 8 hours of ingestion. This rapidity of absorption and excretion indicates that beer is a significant dietary source of readily available silicon.

*Source of Silicon in Beer*

The majority of silicon found in beer originates from the husk of the malted barley. Alt-

hough the silicon in barley is in the form of phytolythic silica, the hot mashing technique used in the manufacture of beer extracts orthosilicic acid from the insoluble silica. The second source of silicon is from finings, which some brewers add to beer in order to bind to and precipitate any particles in the liquid, for example yeast or proteins. One type of fining used, called isinglass or white finings, are the degradation products of the collagen of fish, which has a relatively high silicon content. It is unlikely, however, that finings or other additives contribute much to the silicon content of beer compared to that from mashing of the cereal. Another source of orthosilicic acid can simply be from the water used to produce beer. Collaborative work with Brewing Research International (BRI) in the UK will examine in clearer detail the exact sources of silicon in beer.

Univ. Prof. Dr. Ing. Werner Back (Technical University Munich)

# Beer and Health: Technical News

Beer is a high quality foodstuff. It is distinguished by purity, digestibility and a range of positive physiological characteristics. For beers brewed to the German purity standard there is additionally a clear definition of the ingredients.

Along with the selection of the raw materials, the purity of the beer is also ensured by the clearing processes during the preparation of the beer. The digestibility is a result of moderate alcohol, low levels of sulphur dioxide and acidity, and the absence of preservatives. Not least, beer is a healthy drink because of its high-quality ingredients. According to medical studies, the ingredients of beer have a protective effect on the vascular system. Furthermore, because of its characteristics as an anti-oxidant, beer can render free radicals harmless. The favourable ratio of water to ingredients, the low calorie content (fat-free when the sugar content is low), the high mineral content (more than 500 mg/l beer) and the favourable ratio of potassium and magnesium to sodium make beer an ideal thirst-quencher. With moderate, responsible beer drinking the alcohol even has positive effects on health. Thus it promotes blood-flow in the brain and coronary vessels and hinders the formation of deposits in the blood vessels. Substances that are negative from a health point of view, such as heavy metals, pesticides, mycotoxins, acrylamids and other harmful substances, are practically not detectable in beer. Pathogens also hardly occur in beer, owing to its selective characteristics (e.g. pH value 4.5, $CO_2$-, alcohol content, bitter hop constituents, polyphenols).

The brewing process begins with the crushing of the malt and the mixing of the meal with brewing water – the "mashing". In the mashing, malt-extract constituents are dissolved through physical and biochemical processes and broken down into lower-level molecular bonds. The subsequent purification separates the insoluble (spent grains) from the soluble (wort). In the following boiling of the wort, hops are added and there is a formation and evaporation of aroma constituents as well as the expulsion of high-molecule proteins. The constituents of the hops, such as the bitter acids and hop oils lend the beer the desired bitterness and the typical hop aroma. The hot wort runs through the whirlpool in which the boiling hazes are separated out by a "tea-cup effect" (hot-haze extraction). During the cooling of the wort, further hazes are separated out (chill-haze). The cooled wort is aerated, pitched with yeast and fermented. During fermentation, the formation of alcohol, $CO_2$, organic acids and bouquet constituents takes place. In the process there is an expulsion of protein, bitter hop constituents and polyphenols. The maturation of the beer provides the flavour conditioning and involves further separating-out processes. In the final filtration of the beer it becomes brilliant through the separating out of further haze constituents and yeast.

The beer's content of positive ingredients such as vitamins, polyphenols, minerals, and reducing agents can be increased through appropriate technological methods. This is particularly true for the high-value substance xanthohumol from the lupulin strobiles of the hop, which is normally only present in very small amounts in beer. With a special brewing process the content of this anti-carcinogen in beer can be increased from 10- to 30-fold. The essential differences to the usual brewing processes are:

**Univ. Prof. Dr. Ing. Werner Back**

After training as a "brewer and maltster", he became a qualified engineer (Munich-Weihenstephan Technical University, faculty of brewing and nutritional technology), then assistant at the Institute for Technical Microbiology and the Technology of Brewing. He received his doctorate in 1974 and since 1976 has been head of microbiology and quality control at Döhler, Darmstadt. Since 1985 he has been publicly appointed and sworn in as an expert witness on nutritional microbiology (IHK Darmstadt), and since 1992 has held the chair as Professor of Brewing Technology I at the Munich-Weihenstephan Technical University.

- brewing with higher original wort
- reduction of the boiling time for the wort
- addition of the hop product five minutes before the end of boiling
- rapid cooling of the wort to 80∞ by the addition of cold brewing water
- reduced yeast level
- reuse of the yeast
- careful beer filtration

Xanthohumol-enriched beers are characterised by a high sensory quality and a good stability of the head and the taste. The bio-availability and necessary in vivo studies on xanthohumol are the object of continuing research in cooperation with the German Cancer-Research Centre in Heidelberg as well as the Chair for Pharmacognosis and Analytical Phytochemistry in Saarbrücken. The joint project is sponsored by the scientific support fund of the German brewing industry. The aim is to enrich beer with the high-value substance xanthohumol in relevant concentrations in an economic way and under the terms of the German purity standard.

Beers produced according to "XAN technology" as well as "conventionally" produced beers can also make a contribution to a balanced and healthy diet. The implementation of new technological findings leading to the enrichment with nutritionally-physiologically valuable substances could enhance beer culture and raise the esteem in which beer is held.

**End of the english part.**