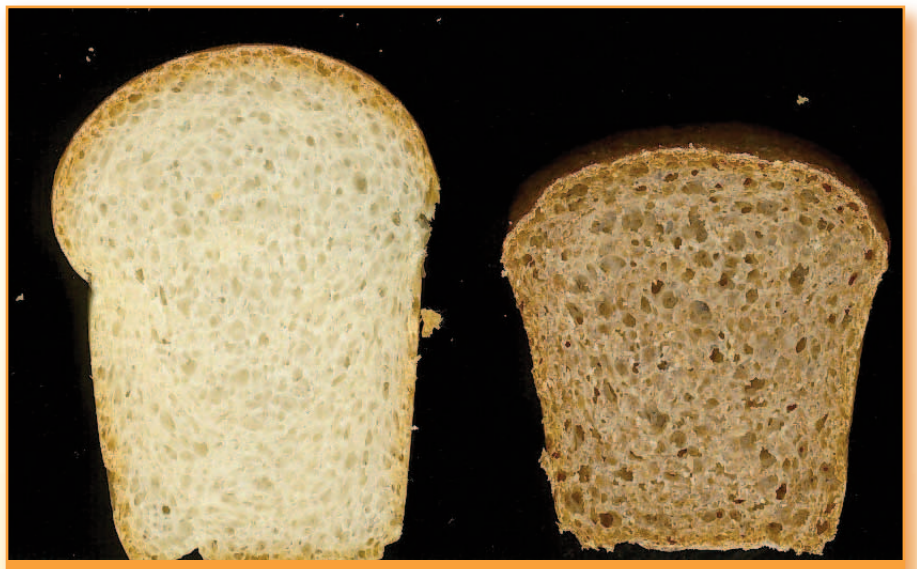
A mission for fibres

While the average western consumer eats too much fat, salt and sugar, the consumption level of fibres is nowhere near sufficient. In both Europe and the US, surveys have shown that consumers struggle to meet daily recommended fibre intake through natural dietary sources alone. Dietary guidelines recommend a minimum daily intake of dietary fibre (DF) of 25 g but actual consumption is much lower than that. For instance, in the US current intake of DF ranges between 12 and 16g per day.

These recommendations are based on the scientific evidence that fibres have a positive effect on human health. Some fibres enable optimum functioning of the stomach and intestines and, therefore, supple bowel movements. Other fibres offer protection against heart and vascular diseases, help reduce the cholesterol content or have a favourable effect on the glucose and insulin concentrations in the blood.



Some healthy fibres have a negative effect on the quality of the bread. Bread enriched with wheat fibre (right) has less volume, a harder structure, darker colour, specific odour and taste compared to white bread.

Availability of fibres

Fibres are carbohydrates that are not digested or absorbed in the human intestine. Moreover, several different classes of fibres have demonstrated one or more of the beneficial physiological effects mentioned above. Natural products that contain a high amount of these fibres are vegetables, fruit and wholegrain cereals. In addition, dietary fibres strongly associate with many other health-promoting components in grains, vegetables and fruit. As an example, it is known that the fibre-rich fractions of wheat kernels contain the majority of antioxidants, sterols, vitamins and minerals.

From a historical perspective, highly refined products show a strong association towards consumer liking, especially for children. Typically, in north-Western Europe white bread was regarded as a luxury in contrast to wholegrain bread. Similar observations were done in Asia where unpolished rice has a negative cultural association. This has all to do with evaluating a product in terms of sensory properties. The soft texture and neutral (sweet) taste of white bread and white rice is much more appreciated than the hard texture and more pronounced taste of wholegrain bread and unpolished rice.

The hypothetical, well-balanced, western diet based on products like grain, vegetable and fruit products, guarantees a sufficient intake of fibres as recommended by e.g. the Health Council. However, the average consumers nowadays do not meet these standards and consumption levels of vegetables, fruits and wholegrain products are simply too low for an adequate fibre intake.

The food and beverage market is responding to this with fibre supplements or by means of fibre enriched products for the consumer. Current supermarket trends reveal fibre enriched yoghurt, muesli, bread, dairy and fruit drinks that all claim to contain specific fibres that have a positive impact on health. Of all these food items, bread is well known to contain fibres, thus it is a natural and appropriate carrier of these healthy components.

Addition of fibres to foods can give all kinds of problems with respect to processing, product quality and shelf life/stability. For instance, when fibres are added to bread the baking volume is reduced, the dough becomes sticky, kneading time is longer and the colour deviates. Thus many sensory qualities are lacking to maintain a high attractiveness for consumers. As a result of that, when developing fibre-rich products, attributes like taste, texture, colour and the perceptibility of "particles" have to be studied in much detail.

Multi-functional research

TNO has been studying fibres in relation to health for quite a number of years now. By improving the traditional 'Englyst' method for

HEALTHGRAIN

TNO is co-initiator of the EU HEALTHGRAIN project (2005-2010).

Grains contain various types of food fibre and a series of vitamins, minerals and anti-oxidants. The aim of the project is to study the health effects of these substances in great detail. The research focuses on the investigation of differences in grain species, effects of processing of grains and consumer studies of food products to lay the basis for a broader range of attractive, healthy grain products. The two key bread grains are wheat and rye.

Recent results show that the fibre and bioactive substance content in wheat and rye varieties can vary strongly. Both state of the art in-vitro research and in vivo studies using animals reveal that aleurone, the innermost fibre layer in grain kernels, which is closely associated with vitamins, minerals and bioactive substances, has the biggest health-related effects.

Within Healthgrain, TNO performs in-vitro research and food studies relating the role of fibre fractions to the structure of bread products. In addition, TNO coordinates the technology transfer to industry along with communication to food experts and consumers.

In the context of this project TNO works closely with 12 industrial companies, the Dutch Agriculture Commodity Board and the universities of Wageningen and Maastricht.

TNO has much to offer in helping you develop attractive and healthy fibre-rich products.

TNO is an internationally prominent expertise centre for food fibres. In a platform covering multidisciplinary projects, the following disciplines work closely together:

- Valorisation & separation technology: extraction of valuable fibre and fibre-related components
- Carbohydrate technology: development, characterisation and analysis of new functional fibres
- Ingredient and product technology: the use of fibres in food matrices based on fibre functionality and interactions with other ingredients in the matrix
- Health effects of fibres: desk studies of physiological effects, in-vitro and in-vivo studies, gastro-intestinal models, complex flora analysis, human volunteer studies, analyses like anti-oxidant capacity
- Legislation & claim support

analysing starchy foods an optimized method to predict the Glycaemic Index (G.I.) of foods was developed some time ago. This method allows the assessment of food products for both fast and slow digestible carbohydrates and evaluation several other kinds of dietary fibres. This Glycaemic TNO Index (GtI) method is a fast yet simple and reliable alternative to expensive human studies.

In addition to fibre analysis and characterization, research of physiological health effects and complex flora analysis are in the forefront of research nowadays. Moreover, TNO also focuses on the development of new functional fibres. The application of fibres in complex food matrices by studying its interactions with other ingredients (see text box) is yet another activity. This is done using food model systems for products like bread, yoghurt and drinks. These TNO food model systems are not only used for the fibre enrichment of products but also for fat reduction programmes where fibres can be used as an alternative to replace fat.

Fibre enrichment of bread and bakery products is currently the subject of considerable interest at TNO. This resulted in a modern science infrastructure with dedicated texture measurements including a state-of-the-art application bakery. Moreover, the participation in the EU HEALTHGRAIN (see text box) project amplifies expertises in this area and TNO can certainly be considered as an authority in this knowledge area. In the HEALTHGRAIN project, TNO is performing in-vitro food research into the properties of the healthy ingredients of wholegrain products as well as the role of fibre fractions in the structure of bread products.

Development of a healthy and functional food fibre

An example of comprehensive research being carried out within TNO is the development and purification of a new food fibre. It has being tested in terms of prebiotic properties and technological functionality. The name of this fibre is Reuteran, after the lactic-acid bacteria Lactobacillus reuterii, which enables production of this glucan with a highly specific structure. The glucose building blocks of Reuteran have both α-1.4 and 1.6 linkages making the molecule strongly branched and thus difficult to digest in the mouth, stomach and small intestine. Reuteran is, however, fully fermented in the large intestine and be considered a food fibre with prebiotic properties. It also appears to promote satiety. Since Reuteran has a strong gelling effect in combination with proteins at a low pH, consumption of a product that contains both ingredients will gel in the stomach (where pH is low) and thus induce a satiating effect. This effect has been demonstrated by TNO both using in-vitro tools and in-vivo assessment studies using human volunteers.

The special structure of Reuteran creates specific functional properties when added to a food matrix. Where most food fibres have a negative effect on the quality of the bread, Reuteran was shown to give a positive effect. Various parameters have been measured using a model system for bread. Reuteran improves, for instance, the volume of the bread and the crumb softness, and also helps to retain this softness better during storage. The addition of Reuteran not only increases the fibre content and product quality retention but also allows reduction of additives.

In the TNO application bakery it is possible to bake bread at various scales, from a model system and mini-roll to an entire loaf with a complete list of ingredients. Using a small scale can accelerate the screening of ingredients and reduce the cost of raw materials.

TNO has also investigated the effect of adding Reuteran to yoghurt. The aim of this was twofold: fibre enrichment and substitution of the stabiliser maltodextrin by the cheaper Reuteran. Maltodextrin is often added to immobilise the water phase in the food product and thus prevent syneresis. Using Reuteran instead of maltodextrin creates a more stable product. The improvement in stability is the consequence of better immobilisation of the water phase and an increase in the firmness of the product. Reuteran thus has a positive effect on these important product properties of several dairy products.

Screening for fibres with prebiotic properties

Another example of the exciting work going on at TNO is the development of the screening platform for prebiotic carbohydrates. Here, various technologies from different fields such as analytical chemistry, physiology, microbiology and molecular biology are intertwined. The approach consists of a fractionation step of an appropriate food matrix or any other natural source of dietary fibre. These fractions can be 'pre-digested' mimicking the stomach action. Subsequently, the functionality of the fractions is tested in an 'artificial micro-gut' system. Finally, these fractions can be characterized by modern analytical tools and the functional component(s) can be fully identified.

The heart of the screenings platform is the micro-gut, a multichannel system that allows both the cultivation and the stabilization of intestinal microbes. The chemical and physical conditions are mimicked here to provide the most natural environment for the microbial flora. The beauty of this is that intestinal floras of different groups can be investigated such as infants, people with allergies or elderly.

The next step after identifying functional fibres is the linkage to TNO's intestinal chip (I-Chip technology), an advanced micro array technique for the rapid identification and characterization of shifts in intestine flora.

The prebiotic screening platform was validated using a complex mixture of various fructose oligosaccharides (FOS-types of fibres). This mixture was fractionated on the basis of their degree of polymerization (chain length of the polymer). As expected, the un-fractionated FOS mixture clearly promoted one of the healthy microbes in the gut the group of bifido bacteria. However, using the screening platform, it could be demonstrated that relatively short FOS promoted different specified species of bifido bacteria than the longer chain FOS fibres.

Future for fibres?

The Health Council's recommendation for fibre intake focuses on fibre consumption through a mixed diet rather than on products enriched with fibres. However, given an unchanging consumption pattern, fibre enriched products could help boost fibre intake and thus benefit the consumer in the short term and even produce specific health effects if fibre is added in a deliberate way. Since the addition of fibres creates quality problems for many products, the model system developed by TNO can be used to simply and quickly screen fibres for the desired functionality. The combination of this with research into health effects is highly effective in speeding up new product development as well as reformulating existing products to meet dietary standards.

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TNO Quality of Life is a part of TNO; Europe's largest independent research institute for technological and strategic research and consultancy. By translating scientific knowledge into practice we optimise the innovative abilities of the industry and government. TNO is a research partner for various industries worldwide.

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