

# Summary

Hitherto neither an official Danish definition of the concept wholegrain nor rules/guidelines for the wholegrain content of foods claiming to be wholegrain foods existed. In addition, there has been no quantitative recommendation for wholegrain intake in Denmark, only a suggestion in the Dietary Guidelines (2005) to eat “coarse” foods, plus some overall considerations about the type of grain products one should choose.

Grains consist of three parts: endosperm, bran, and germ. Wholegrain is defined as intact and processed (dehulled, ground, cracked, flaked or the like) grains, where the components endosperm, bran and germ are present in the same proportions as in the intact grain. Studies show that the level of milling affects the way wholegrain is digested and metabolised, and the resulting nutritional and health effects. However, data does not support a limit for milling, where the positive effect on health is larger than the negative. Therefore, the current definition does not take level of milling into consideration.

The definition of wholegrain includes grain seeds from the following genera of the grass family *Gramineae*: barley (*Hordeum*), oat (*Avena*), wheat (*Triticum*), rye (*Secale*), rice (*Oryza*), millet (*Panicum*), maize (*Zea*; only as dried maize) and sorghum (*Sorghum*). The definition includes grain seeds from species, hybrids and cultivars from the above mentioned genera.

A distinction is made between wholegrain and wholegrain products. The concept “*wholegrain*” refers to the grain itself, whereas “*wholegrain products*” are foods containing a minimum amount of wholegrain. Wholegrain should contribute considerably to foods being labelled as wholegrain products, and the term wholegrain should only be used on the following foods and food groups: flour and grain (including rice); bread and crisp bread; breakfast cereals; pasta and noodles. Flour and grain must be 100% wholegrain. Foods containing other ingredients than wholegrains should contain more than 50% wholegrain in dry matter ( $\geq 51\%$ ). If a product is claimed to contain wholegrain (e.g. by using a label), the wholegrain content must be declared according to predetermined instructions (Quantitative Ingredient Declaration, QUID). A content of  $\geq 51\%$  of dry matter corresponds to a wholegrain content of at least 35% for bread, and at least 55% for crisp bread, breakfast cereals and dry pasta and noodles, according to QUID.

Basically grain seeds have the same anatomical structure, but important differences exist in chemical composition, which affects nutritional value and functional qualities. The outer cell layer of the endosperm (the aleuron layer) has thicker cell walls and a different chemical composition than the rest of the endosperm. For example, the aleuron cells have a higher content of dietary fibres and essential amino acids (e.g. lysine) than other parts of the grain. The aleuron layer also has the highest concentration of minerals, including a large amount of phytic acid-bound phosphorus and other nutrients. During milling the aleuron layer ends up in the bran fraction.

Grains are primarily carbohydrate sources with a high content of starch (concentrated in the endosperm) and dietary fibres (concentrated in the bran including the aleuron layer). Most of the vitamins and minerals are situated in the germ and bran fractions, as a number of phenolic and other bioactive compounds are. The extraction rate is very important for the content of nutrients and bioactive compounds in grain.

As a basis for a quantitative recommendation of wholegrain intake, a review of prospective population studies was undertaken. Quantitative studies, which had the intake of wholegrain

products measured (either as frequency or amount) against risk of disease, were included. The review included prospective studies of the association between wholegrain intake and risk markers for selected diseases influenced by dietary habits plus specific studies of the effect of the most important components in wholegrain on risk for these diseases. For most studies there is no information of the quantitative intake of wholegrain, but a reference to a number of portions of wholegrain products.

Many cohort studies have shown a significant inverse association between the intake of wholegrain (or wholegrain products) and risk of total heart disease, coronary heart disease and stroke. Wholegrain products could reduce risk factors for heart disease, mainly documented for the effect of oats on blood lipids and lipoproteins. The association is consistent, relatively strong (20-30% risk reduction), independent of other lifestyle factors, and biologically plausible. The focus has mainly been on wholegrain's contribution of dietary fibres, magnesium and potassium, and antioxidants (especially vitamin E), which have documented effects on insulin sensitivity, blood lipids and lipoproteins, and blood pressure. Having said this, none of the above single components can explain the overall association.

Several larger cohort studies show a relative convincing, inverse association between intake of wholegrain products and type-2 diabetes. It is mainly the content of dietary fibres and magnesium in wholegrain product that were suggested to give the possible protecting effect of wholegrain products.

The association between intake of wholegrain and the risk of being overweight is the result of several American cohort studies, of which only one study has results for breakfast cereal intake. All studies show inverse association between intake of wholegrain products and weight gain or risk of obesity. No randomised experiments have separately investigated the effect of increased intake of wholegrain products (e.g. compared to refined cereals) on body weight and weight change. The importance of wholegrain intake on weight regulation is considered a result of the content of dietary fibres in wholegrain, and the importance of dietary fibres for glucose metabolism and satiety.

The effect of wholegrain intake on risk of cancer development is described in a few studies on individual types of cancer. The results are not aligned. For colon and rectal cancer an association cannot be established. Furthermore, there is no association in risk of cancer in stomach or uterus. On the other hand, a tendency for increased risk of breast cancer was shown with high wholegrain intake. For total cancer risk in upper respiratory tract and stomach-digestive tract an inverse association to intake of wholegrain products was shown, while there was only a tendency for inverse association between wholegrain intake and total cancer. The majority of studies concern the contribution of dietary fibres (especially colon cancer), folate and, to a certain extent, vitamin B<sub>6</sub> and magnesium from wholegrain. Also the possible effect of lignans has gained scientific interest.

Presently, it is not possible to verify specific compounds in the grain seeds as being responsible for the effects of disease risk. It is most likely that it is the combination of chemical compounds found in wholegrain that are important for disease risk. It should be noted that the chemical compounds in wholegrain are highly correlated, and thus it is impossible to separate the effect of individual compounds. The association to disease risk is shown from the lowest to the highest intakes of wholegrain products.

Most studies consisted of American cohorts and only few studies included Scandinavian cohorts. Cultural differences exist in dietary habits, and especially in choice of wholegrain products, between the US and Scandinavia. The typical intake in the US is less than 1 portion (16-28 g) of

wholegrain per day, while in Scandinavia it is 2-3 portions (35-55 g) per day. At present there is insufficient scientific evidence to argue that one species is necessarily healthier than another.

Wholegrain and wholegrain products can, similar to other foods, contain unwanted chemical compounds from several different sources. Contaminations include a broad spectrum of organic and inorganic compounds like environmental pollutions, production aids and compounds produced unintended during food production. Besides, grains and grain products can also be contaminated with pathological bacteria, and finally grain seeds can contain natural toxins. However, the continuous control of contaminants and unwanted chemical compounds show that the content in grain and grain products is at a very low level in Denmark, and in general below existing threshold values. Thus no health concerns should be necessary in connection to an increased and diversified use of bread and other cereals including wholegrain products.

It is concluded that the scientific documentation is sufficient to recommend a wholegrain intake in Denmark of 4 portions per day, equal to minimum 75 g *wholegrain*/10 MJ under Danish conditions. The recommendation for wholegrain intake agrees with the dietary guideline advising an intake of 500 g potatoes, rice, pasta, bread and grains per day, and can be considered a specification of the existing dietary advice. The recommendation should not just focus on intake of wholegrain, but on how wholegrain products can be part of a healthy diet, and emphasis should be placed on a varied intake of wholegrain products. The recommendation shall be seen as a minimum recommendation for persons with a energy intake of approximately 10 MJ/day, equal to an average Danish diet. For persons with an energy intake of less than 10MJ/day the wholegrain recommendation shall be reduced in percentage terms equal to the energy intake, and similarly increased for persons with an energy intake of more than 10MJ/day. Correcting for a lower energy intake, it means the recommendation for small children age 4-10 years (mainly girls) and for light eating larger children and women will be approximately 20-50% lower, corresponding to a recommended intake of 40-60 g wholegrain per day. It is important to note that the recommendation refers to *wholegrain*, which can be implemented as different types of *wholegrain products* with variable wholegrain content.

Calculations of a Dane's wholegrain intake from data from The Danish National Survey of Dietary Habits and Physical Activity 2000-2004 show, that Danes eat approximately half the recommended amount of wholegrain, and only 6% of the population have a dietary wholegrain density of 75 g/10 MJ. The typical content (median content) is around 30 g/10 MJ per day. The dietary wholegrain content is highest among the youngest and the eldest age groups and lowest among young people, particularly those aged 14-24 years. The majority of persons living up to the wholegrain recommendation eat the recommended amount of bread and grain products. Rye bread is the single largest contributor to the wholegrain intake for both Danish children and adults. Next comes oats (including porridge). Coarse wheat bread contributes less to the wholegrain intake.

Due to the high wholegrain content of rye bread, lunch contributes with about half the wholegrain intake for both children and adults. Next comes breakfast, followed by dinner and snacks. Breakfast and dinner present the greatest potential for increase in wholegrain intake. It is estimated that there is a potential for increased wholegrain intake through increased wholegrain content of fast food and pita bread, sandwiches, flutes and buns.

According to The Danish National Survey of Dietary Habits and Physical Activity 2000-2004, the diet of persons living up to the wholegrain recommendation has a more optimal nutrition profile in accordance with Nordic Nutrition Recommendations than the diet of those who do not live up to the recommendation. Thus, those living up to the wholegrain recommendation, have a diet with a more favourable macronutrient composition, have an intake of dietary fibres at the recommended level,

plus a higher intake of a number of vitamins and minerals. Since those living up to the wholegrain recommendation, simultaneously have a higher intake of vegetables (children) or fruit (adults), it seems that a high wholegrain intake is, in general, part of a healthier diet. The calculations of wholegrain intake of Danes show that an effort to increase the intake should be primarily targeted towards the whole population.