Phytate – a natural component in plant food

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Phytic acid is a bioactive compound widely distributed in plant foods. Due to its molecular structure, phytic acid has affinity to polyvalent cations, such as minerals and trace elements, and could in this way interfere with their intestinal absorption in man and animals. Most studies in humans have therefore concentrated on the effect of phytate on mineral absorption and deficiencies. Currently, scientific studies have indicated that dietary phytate may have beneficial properties, giving anticancer, antioxidative and anticalcification effects.

What is phytate?
Phytate, myo-inositol hexakisphosphate, is the salt of phytic acid and is widely distributed in all seeds and possibly all cells of plants. It serves as a storage of phosphorous and minerals and accounts for 60-90% of the phosphorous in the plant. Besides phytate, other inositol phosphates are present in the seeds, however to a much lower extent.

In cereals, phytate is located up to 80% in the aleurone layer, but is also found in the germ, while the endosperm is almost free of phytate.

During the germination of seeds, phytate is hydrolysed, and phosphorous along with minerals such as calcium, magnesium and iron are liberated, becoming available for germination and development of the seedlings.

Sources of phytate
The main sources of phytate in the daily diet are cereals and legumes, but also oil seeds and nuts. These foods are important in the human diet and represent 40% and 60% of the caloric intake for humans in developed and developing countries, respectively.
Cereals are rich in phytate containing approximately 1% phytic acid on dry matter basis (dmb) (from 0.06 to 2.2%). For wheat bran contents have been reported ranging up to 7.2% and for rice bran ranging up to 8.7% (dmb).

In legume seeds phytate predominately occurs in the protein bodies of the endosperm, ranging from 0.2 -2.9% (dmb).

In oil seeds such as sunflower seeds, soybeans, sesame seeds, linseeds and rape seeds the phytic acid content ranges from 1- 5.4% (dmb). In soy concentrates a content of 10.7% (dmb) has been reported.

In nuts, the fourth group of foods rich in phytate, such as hazelnuts, walnuts, almonds and cashew nuts, the phytic acid content varies from 0.1 – 9.4% the highest in almonds. There is a huge variation of phytate content in different raw and unprocessed foods, depending on botanical varieties, various climate conditions and different stages of seed maturation.

Intake of phytate

Controlled intervention studies of the mean intake of phytate or phytic acid in humans are very rare. The data given for the mean daily intake in humans in countries are therefore mainly derived from estimations from dietary surveys or from food balance data from all over the world. The dietary regime has an important impact on the total mean intake: from a low level (250-350 mg) in a Western diet low in phytate rich plant foods, a higher level (500-800 mg) on a Western style diet with higher intake of whole grain products and other phytate rich foods, to a high level (≥ 1000 mg) in diets rich in plant and phytate containing foods such as vegetarian diets.

In developing countries, with a high content of cereals and legumes in the commonly consumed diet, quite high levels of phytate up 2000 mg or more may be consumed daily.

The daily intake of phytate in humans shows strong differences between developing and industrialized countries, between urban and rural areas, between females and males, between young and old and between omnivores and vegetarians. These differences derived from differences in the foods consumed, different processing (see below) and preparation methods. Further, the estimated phytate intake also depends on the ability to correctly assess dietary intake and the quality of phytate data in the food composition tables used for calculations.

Influence of phytate on mineral absorption

Health authorities all over the world recommend increasing intake of whole grains and legumes for health reasons. Whole grain foods are valuable sources of dietary fiber, numerous bioactive compounds, vitamins, minerals and trace elements. A high content of phytate in these products has been considered a factor for limiting mineral bioavailability.

The inhibition of minerals may be counteracted by many food components such as organic acids, lactic acid, ascorbic acid and proteins. Minerals are also more available in fermentation food products, like e.g bread. In countries with well balanced diets the inhibitory effects of phytic acid are low and not a significant problem. With unbalanced diets or undernourishment the inhibitory effect of phytate may, however, lead to serious deficiencies, like in developing countries. Vulnerable groups in these countries but also in developed countries with inadequate intake of minerals and trace elements need to increase the total intake of these nutrients via the daily diet or increase the bioavailability.

Phytate can be degraded during food processing like soaking, germination, malting and fermentation under optimal conditions, as well as with addition of the enzyme phytase that will hydrolyze phytate. The soaking medium used depends upon the type of seed. At optimal conditions for the enzyme phytase (55°C, pH 4.5-5.0) phytate could be effectively reduced after 12-16 hours of soaking.

The acidity of the dough during breadmaking is of great importance for phytate degradation during scalding and sourdough fermentation. Sourdough fermentation (10% sourdough giving a pH between 4.4 and 5.0) has shown to reduce the phytate more effectively than yeast fermented bread. After 8 hours of fermentation at 37°C a reduction of 65% of the content of phytate may be obtained in regular dough, compared to 97% in a sourdough.

The degradation of phytate will result in an increased bioavailability of minerals and trace elements.

Beneficial properties of phytate

Dietary phytate has received much attention as an antinutrient, but more recent scientific studies support different beneficial properties of phytate in humans on several civilisation diseases: antioxidative effect, preventing pathological calcification, e.g. kidney stones and calcification in the heart vessels, cholesterol lowering effects and anticancer activity. If phytate through additional scientific studies continues to show these positive properties, the term "antinutrient" in connection with phytate will belong to the past. Today many societies have begun to classify phytate as a bioactive compound.

The actual demand to either improve bioavailability or to help prevent cancer, kidney stone formation, or other civilisation diseases, where phytate may have an impact, will decide whether or not phytate will have a positive role in our daily diet.

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