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# Nutritional properties of carbohydrates in cereal grains: state of the art and perspectives

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Cereal grains, in their various forms, are the dominant staple foods worldwide and have an important impact on nutrition and health. The challenge is to select ingredients and processing techniques that result in cereal foods with beneficial nutritional properties.

Carbohydrates are the most prominent component of cereal grains. Starch, containing alpha 1-4 linked glucose, is mostly digested and absorbed in the small intestine. The non-starch polysaccharides (NSP) are a heterogeneous grouping, which pass into the colon where they can be fermented to varying extents. In cereal grains the main types are cellulose and arabinoxylans, with soluble beta-glucans present in oats and barley. The NSP have a structural role in the plant cell wall, which can slow carbohydrate release, and is particularly associated with the bran and germ fraction that contain most vitamins, minerals and phytonutrients. Although these structural properties may be disrupted by milling, NSP remains a good marker for the associated micronutrients, and this is an important attribute of the beneficial naturally fibre-rich cereal foods. These unique properties cannot be replicated by resistant starch (RS) or other preparations of non-digestible carbohydrates.

The glycaemic index has highlighted the fact that many cereal products are rapidly digested, whereas there is evidence that a more sustained carbohydrate release is more desirable. However, foods can have a low GI due to high fat or fructose contents, indicating a need for a more direct measure of slow release carbohydrates. In conjunction with human studies we have developed in vitro measures that describe the bioavailability of carbohydrates from the food matrix. The Rapidly (RAG) and Slowly (SAG) Available Glucose measures describe the likely rate of release, and RS describes the amount likely to escape digestion in the small intestine. Typically RS represents 2-3 % of the starch component in cereal foods. Intact whole grains are rich in slow release carbohydrates (20-45%SAG), as are many pasta products (20-45%SAG) due to their dense food matrix. The majority of breads and bakery products are rapidly digested (0-10%SAG), as are breakfast cereals (0-5%SAG), due to the ready disruption of the food matrix and the gelatinised starch in these products. In contrast some biscuits are slowly digested (15-30%SAG), as starch remains in the ungelatinised form due to the low moisture baking conditions.

These bioavailability measures compliment the glycaemic index, and together with the overall classification and measurement scheme (Englyst & Englyst, 2005) provide investigative tools with which to further explore the concept of 'carbohydrate quality'.

#### Reference

Englyst KN, Englyst HN (2005) Carbohydrate Bioavailability. *Brit J Nutr*,94,1-11