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Trends in Food Science & Technology 35 (2014) 32–41

TRENDS IN FOOD SCIENCE & TECHNOLOGY

Review

Low glycemic index ingredients and modified starches in wheat based food processing: A review

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Most of the wheat products are known to have high glycemic index (GI). According to the World Health Organization prevalence of diabetes affected population is increasing worldwide, these populations can be benefitted by low GI foods. Furthermore, modification of starches promotes reduction of GI and improving the quality characteristics of the foods. Hence, the effects of low GI ingredients and modified starches on wheat based food systems have been reviewed. As low GI food prevents wide range of health disorders, these are forthcoming in new trend foods. There is a scope for development of wheat based food products with these modified low GI ingredients to improve the health of consumers.

Introduction

Cereal grains are the major source, which fulfills our requirements for dietary energy, protein and antioxidant substances (Ragaee *et al.*, 2006). These cereals are of monocotyledonous grains. The three major cereals like wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and rice (*Oryza sativa* L.) contribute for 90% of cereal grain production worldwide and provide two-third of energy requirement for humans through diet. These are also known as the foundation of human food supply (Cassman, 1999). The cereal group of plants has been very successful in contributing to mankind's food needs. This is indicated by cultivation of more than trillions of cereal plants worldwide, resulting in 2.2 billion tons of cereal grain harvest per year (Wrigley, 2010). Most important cereals of nutritional importance are wheat, rice and corn. All cereal species differ in their appearance at the macro and micro levels, so there is also difference in the composition of the grains. On the other hand, they all have uniformity in having a starch as the main source of stored energy. Along with the starch they all have an abundant source of stored proteins for new plant. These stores attract the predators which wish to take advantage from these stores (Wrigley, 2010). The worldwide cereal production in the year 2010 is given in Table 1.

Wheat evolved from wild grasses found growing in the Eastern Mediterranean and the Near East and Middle East areas. Wheat was probably domesticated around 10,000–15,000 BC. Starch and plant proteins represented a source of food easy to store without continuous care (Bozzini, 1988). Wheat is one of the oldest food crops grown by man, which has achieved a central role as a staple food for all the nations and cultures. This is because of its flour having unique property of forming a cohesive dough and thus to be made into leavened bread and many range of noodles, soups, pasta and other foods. Wheat contributes most of the nutrients to humans compared to other cereals. About 44% of protein and 40% of fat are provided by wheat compared to other cereal grain sources. This highlights the importance of wheat as food grain. Wheat grain develops proteins, starch, lipids and sugars that accumulate in the endosperm for the embryonic wheat plant. We take advantage of this valuable package of nutrients (Uthayakumaran & Wrigley, 2010).

Glycemic index

The glycemic index (GI) was introduced by Jenkins *et al.* in the early 1980s and is a concept for ranking of carbohydrate foods based on their effects on postprandial glycemia. *The GI is defined as the incremental blood glucose area following the test food, expressed as the percentage of the corresponding area following a carbohydrate equivalent load of a reference product*. With white bread as reference, GIs range from less than 20% to approximately

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http://dx.doi.org/10.1016/j.tifs.2013.10.007

Table 1. Worldwide cereal production (in 2010).

Grain	Worldwide production [million metric tons]
Maize	844
Rice	672
Wheat	651
Barley	123
Sorghum	56
Millet	29
Oats	20
Rye	12

Source: Food and Agricultural Organization

120%. The main cause for these large differences in GI is differences in the rate of digestion or absorption of carbohydrates and thus low GI foods release glucose at slower rates to the blood after digestion. The concept appears to rank foods similarly in diabetic and non-diabetic individuals, although originally the identification of foods of low GI character was considered mainly in diabetes. Low GI diet improves glycemic control and other health related risk factors like coronary heart disease. Low GI diet greatly benefits the diabetic population where the goal has been tight glycemic control to avoid health related complications (Jenkins *et al*., 2008).

GI of food products

GIs are now available for a considerable number of carbohydrate foods. Although there are indigenous traditional ingredients and products which are low GI, namely legumes, pasta, some rice, sourdough bread and burger-type products. It is also known that major sources of carbohydrates in a western diet are found to be in high GI range (≥70). Molecular weight of carbohydrate component has no relation to GI properties. High dietary fiber content is not a prerequisite for low GI properties and the naturally occurring levels of viscous fiber in common cereals have only a marginal impact on glycemia (Tharanathan & Mahadevamma, 2003). Whole meal cereal products thus produce GIs as high as those of white bread. Instead, dietary fiber as part of an intact botanical structure, as in barley and pumpernickel bread, may be effective in reducing glycemia (Liljeberg & Bjorck, 1994). For nutritional purposes, starches in foods may be classified into rapidly digestible starches, slowly digestible starches and resistant starches (Englyst, Kingman, & Cumming, 1992). All these are beneficial tools for deciding GI of various foods.

In Indian food context, most of the foods are considered to be low to medium GI except for the processed foods. Low GI (≤55) foods include whole wheat atta, parboiled rice, legumes and other beans. Medium GI (56–69) foods include rye, brown rice, oatmeal, popcorn, sweet corn and other minimally processed foods and high GI (≥70) foods include white bread, short grain rice, corn flakes, potato and other processed foods (www.resource-diabetic.in).

Study focusing on GI of commonly consumed Indian foods was carried out by Raghuram, Pasricha, Upadhyaya, and Krishnaswamy (1987, pp. 64–69). They found that none of the preparation showed low in GI except for the preparation containing green gram as pongal and pesarattu. This indicates that pulses have the potential to lower the GI of the foods. Another study conducted by Mani *et al*. (1990) on Indian traditional foods also revealed that when compared to rice, the combination of rice and peas yielded a low GI. Whereas, all other pulse combination also showed a significant reduction in GI compared to rice.

Wheat based food processing

Bakery industry in India has an important place as this is a widespread industrial sector. These bakery products are consumed by all the class of the population regardless of age and region, because of its low price and high nutrient value. With rapid growth and changing eating habits of the population, these bakery products are gaining popularity. The sector, typically, constitutes cakes, breads, biscuits and pasta & noodles (www.niir.org). India is the second largest producer of wheat in the world. Most of the wheat produced is suitable for bread making and essential for the bakery industry. This wheat is of soft to medium hard variety and with medium protein content. Increasingly, bread is finding popularity as item consumed in the breakfast in place of traditional chapattis (Khatkar, 2005). Bread production has thus been on the rise. Health conscious people now consume brown bread instead of white bread (Linda & Stanley, 2007, 54 pp). In India, we get bakery equipments and machineries suppliers catering to the needs of small and medium size plants (Edwards, 2007, 68 pp). Pasta and noodles are wheat based products that are formed from dough, but are not leavened. The processes by which they are formed are quite different, as per the types of flour used. The most common pasta types are macaroni and spaghetti. The consumption of pasta is very common in worldwide. US consumption is about 10 lb per person per year. Whereas, in Italy it is 5–10 times more of that amount. It is generally believed that the ideal raw material for pasta is *durum* semolina (Kruger, Matsuo, & Dick, 1996). Noodles are a type of pasta known to the Chinese about 5000 BC. This is generally made from flour, rather than semolina, consisting of salt in addition to flour and water. Dried noodles must contain less than 13% moisture. Noodles are thought to have originated in China and are still a popular food throughout Asia. As much as 40% of the wheat consumption in Asia is as noodles. Some noodle preparations involve eggs as one of the key ingredients. Oriental noodles contain no eggs (Kruger *et al*., 1996). Different types of oriental noodles and their process of preparations are schematically represented in Fig. 1.

Wheat flour is a unique material because a simple addition of water coupled with energy input through mixing enables the formation of dough that can be kneaded and stretched to