Isomalt in Breakfast Cereals, Granola Bars, and Muesli

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Sugar-free and sugar-reduced products are increasingly being recognized for their health benefits. In the confectionery sector, a wide range of sugar-free chewing gums and candies, as well as chocolates and baked goods, are available. With a high sugar content of about 10–20% (in some cases as high as 40%), breakfast cereals and corresponding products are good candidates for development of sugar-free or sugar-reduced variants.

So far only a limited number of no-sugar-added and reduced-sugar products have been introduced in the market. Because most of these products fail to meet consumer expectations for taste and texture, they usually quickly disappear from store shelves. Consumers are not willing to buy a healthier product if it lacks desired sensory properties. Good taste and texture, i.e., the enjoyment derived from consuming a product, are as important as nutritional value.

Many of these initial products simply contained less sugar or used ingredients such as fibers to replace some of the sugar. Merely reducing sugar content or replacing sugar with other ingredients that do not provide the basic properties of sugar, typically results in texture and flavor changes in products, however, and original product qualities are lost. The aim of our evaluations is to substitute isomalt for sugar in breakfast cereals and other cereal products to develop comparable products with respect to flavor, bite, bowl life, color, etc.

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Isomalt Properties in Cereal Products

Isomalt is a white, crystalline carbohydrate with low hygroscopicity that contains only half the calories of sugar, is odorless, and has a low glycemic effect. Because isomalt is derived from pure sugar, it has a smooth, sweet profile similar to that of sugar but with more scope for flavor development. Chemically, isomalt is a sugar alcohol (polyol). It is a mixture of two disaccharide alcohols: a gluco-mannitol and a gluco-sorbitol. Like other polyols, isomalt helps prevent dental caries and plaque formation; it does not, however, have the "cooling" effect of some polyols.

There are several important properties of isomalt to be considered when formulating cereal products. Isomalt provides fewer calories (2 cal/g) and lower glycemic response because it is only partially digested and so is less well absorbed than sucrose. It is a bulk sweetener that can be used to replace sucrose at a 1:1 ratio (by weight) and has low solubility, a sintering or melting range of 145–150°C, no Maillard reaction, very low hygroscopicity, and a sweetness intensity of 0.45–0.65 (sucrose = 1).

In addition to its physiological properties, isomalt is more stable than sucrose, so it can be heated without breaking down and can be used in baked products or those subjected to higher temperatures during processing. Because it absorbs little water, products containing isomalt absorb less moisture, which improves the shelf life and texture of stored cereal products.

A number of studies and trials have shown that isomalt can be used in a wide range of cereal products, including extruded cereals (e.g., balls, rings, pillows); coated breakfast cereals (e.g., frosted or crystallized, glazed or transparent appearance); cooked cereal products (e.g., corn flakes); and granola bars, cereal bars, and muesli clusters.

Regulatory Aspects

When creating new "sugar reduced," "no sugar added," "low glycemic," or "dietetic" cereal formulations, government regulations relating to the use of polyols and isomalt have to be considered. For example, in the United States the application of isomalt (up to 20%) as a sweetener or glazing (surface-finishing) agent in breakfast cereals is covered by the GRAS Affirmation Petition for isomalt. In this case, isomalt may be used in combinations with sugars and/or intense sweeteners (e.g., acesulfame K, aspartame, sucralose, neotame).

According to the EU Sweetener Directive (Directive 94/35/EC), isomalt may be used in "calorie reduced" (minimum 30%); "no sugar added"; and dietetic (e.g., in D, not harmonized within the European Union) cereal products. In addition, according to Miscellaneous Directive 95/2/EC, isomalt may be used for technological reasons (e.g., as a bulk ingredient, stabilizer, coating agent, anticaking agent, etc.). A sugar-related claim (e.g., "25% reduced sugar") seems to be possible, as long as the technological function of the isomalt is evident. If the polyol content of the product is 10% or higher, a warning label such as "excessive consumption may produce laxative effects" is required.

Because isomalt has a mild sweetness, the addition of intense sweeteners may be required in some formulations. According to the EU Sweetener Directive, intense sweeteners (acesulfame K, aspartame, cyclamate, saccharin, and neohesperidine, as well as sucralose and aspartame-acesulfame K salt [as of January 2005]) can be used in breakfast cereals containing a minimum of 15% fiber and 20% bran that are energy reduced or have no sugar added and in cereal-based desserts (e.g., bars) that are energy reduced or have no sugar added.

In the case of higher dosages, control of the serving size becomes increasingly important, which limits packaging sizes. If a warning label is not acceptable to customers, the isomalt content should be kept lower than 10%. Depending on the total sugar content of the original product to be modified, no-sugar-added or sugar-reduced (e.g., sugar reduced by 25 or 50%) versions can be developed.

Technological Aspects

Extruded Breakfast Cereals. In extruded cereals, sucrose can be replaced very easily with isomalt. Extruded cereals typically contain between 5 and 15% sucrose. No-sugar-added versions can be formulated by replacing all of the sucrose with isomalt. Isomalt is very similar to sucrose with respect to its production process characteristics and its effects on final product density and appearance.

Studies have shown that extruded cereals formulated with isomalt often have a crunchier texture and increased hardness compared with those formulated with sucrose. Furthermore, due to its low solubility, isomalt may help extend the crunchiness of breakfast cereal products when combined with milk (extended bowl life).

A typical formulation for a ring-shaped (5–6 mm thick) extruded cereal might include 69.3% wheat flour; 15.0% oat flour; 12.0% bulk sweetener; 2.1% dark malt; 1.0% light malt; and 0.6% salt. Figure 1 shows a typical production process for ex-

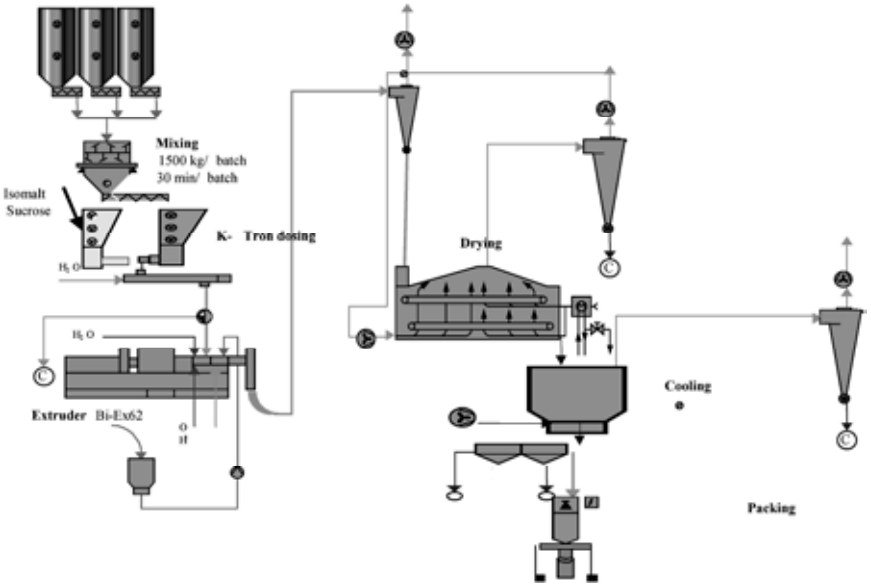

Fig. 1. Production flow chart for extruded breakfast cereals.

An advertisement appeared here
in the printed version of the journal.

truded cereals. The key production equipment is a cook extruder, a modern high-temperature short-time (HTST) process. The extrusion process includes steps such as continuous conveying, mixing, homogenizing and cooking (reacting), and mechanical and thermal energy dissipation for plastifying and modifying biopolymer feeds (e.g., flour, starches, etc.).

Fig. 2. Breakfast cereal products coated with glaze (top) or frosting (bottom) containing isomalt.

All ingredients are mixed in a suitable mixer and fed into the feeding system of the extruder line. In the extruder, the premix is further homogenized using water addition and then cooked using shear force, temperature, and pressure. Finally, the mass is expanded through a forming die at the end of the extruder, and depending on the die, balls, rings, or pillows are produced. The expanded product is then transferred through a drying oven and is cooled before being packaged.

Coated Breakfast Cereals. Cereal coatings are produced using coating equipment (e.g., coating pans or drums). Unlike the coating process for products such as chewing gum, only one coating cycle (application of engrossing syrup) is required for breakfast cereal products. When using glazing and frosting coatings containing isomalt rather than coatings containing sugar, adjustments must be made in the drying parameters (i.e., the drying temperatures of existing production lines must reduced).

Different isomalt variants can be used to produce glazing and frosting coatings. Some variants produce very shiny, stable glazes, whereas others produce frosted coatings with a white, crystallized appearance (Fig. 2). In general, isomalt's low solubility and hygroscopicity positively affect the shelf life of the final product. Information on process details and basic formulations for isomalt glazing and frosting coatings are available.

Cooked Cereal Products. Isomalt has been tested in cooked cereal (corn flake) production. In brief, corn grits are cooked in an isomalt-based syrup until the grits have absorbed sufficient moisture. After a predrying process, the cooked grits are formed into flakes using rollers that squeeze the cooked grits through a gap between two rollers. Finally, the flakes are toasted at high temperature for a short time (Fig. 3).

Fig. 3. Stages in processing of corn grits into flakes for breakfast cereals.

Because isomalt does not undergo Maillard reaction (browning), the color of the final product is slightly lighter and the toasted flavor is reduced compared with similar sugar-containing products. The physical properties of isomalt result in corn flakes with a very good shelf life and good crunch.

Soft or Crunchy Granola and Cereal Bars and Muesli Clusters. Isomalt can be used as a binder in crunchy or soft granola and cereal bars, as well as in breakfast cereals. For soft textures, combinations of isomalt and sweeteners such as maltitol syrup can be used: maltitol syrup's noncrystallizing and hygroscopic properties cause it to act as a humectant, while isomalt complements the formulation by improving the flavor profile and reducing stickiness.

For crunchy muesli bars or clusters, isomalt can be used as a single sugar replacer or in combination with inulin or oligofructose if a "fiber-enriched" claim is desired. The basic process produces a kind of candy mass, which is then blended with the muesli, granola, or cereal base. Other processes use a highly concentrated isomalt solution blended with a cereal or muesli base that is dried and formed into clusters or bars. Isomalt's very low hygroscopicity produces crunchy granola and cereal bars, as well as muesli clusters, that have an excellent shelf life and retain their crunch over time.

Summary

A wide range of sugar-free products formulated with isomalt is available, including hard and soft caramels, hard candies and cough drops, chewing gums, chocolates, fondants, marzipans, baked goods, preserves, ice creams, pressed mints and dragees, pharmaceutical products, and many others. The high sugar content of breakfast cereals and related products make them good candidates for development of sugar-free or sugar-reduced variants.

Trials have shown that isomalt can be used in a wide range of cereal products, including extruded and coated breakfast cereals, cooked cereal products, soft or crunchy granola and cereal bars, and muesli clusters. Isomalt provides a variety of benefits, including fewer calories and lower glycemic response than sucrose, low solubility, no Maillard reaction, very low hygroscopicity, and smooth, sweet profile similar to that of sucrose. It is also more stable than sucrose and can be heated without breaking down under higher temperatures during processing. Because it absorbs little water, products containing isomalt absorb less moisture, which improves the shelf life and texture of stored cereal products.

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