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Recent Trends and Market Status for Sugar Alcohols (Polyols) - A Revolution in Sweetener Sector

Narendra Mohan[1], Anushka Agarwal[2]

[1]Director, National Sugar Institute, Kanpur, U.P., India – 208017

[2]Research Scholar, National Sugar Institute, Kanpur, U.P., India – 208017

Abstract: ***Diabetes and epidemic obesity continue to influence dietary lifestyles of consumers across the globe as they witness transitions in the quality of food being served to them. Despite limited market for natural sweeteners, a spurt in preference to plant derived-alternative sweeteners is known. Sugar substitutes, such as non-nutritional artificial sweeteners, low calorie or zero calorie natural sweeteners that include sugar alcohols and plant derived non-saccharide sweeteners find their application in processing various types of foods and beverages including pharmaceutical sector too. The demand for low calorie foods containing polyols is expected to grow since the market is driven by increasing consumer awareness of diabetes, as well as weight management. There is a need to further explore the available technologies for the development of alternative sweeteners, especially sugar alcohols from biomass, which would not only help in minimizing the problem of disposing surplus biomass but would also function in line with the safety and health of consumers and also to food and beverage industries to get better market and price. The present work summarizes a literature review on current trends and future innovations of sugar alcohols for value additions.***

Keywords: Artificial sweetener, obesity, polyols, sugar alcohols, blood glucose.

1. Introduction

Sugar has been a part of the human diet for centuries but has recently been the target of considerable media attention, particularly in relation to weight and overall health. India's domestic sugar market is the largest market in the world in terms of volume. India, now being the largest sugar producing geography, remains to be the essential growth driver for world sugar, growing above the Asian and world's average growth consumption. Consumers now-a-days tend to overestimate the calorie content of sugars while failing to acknowledge that other carbohydrates and fats provide the same amount of calories or even more. Sugars are a group of sweet substances that are a source of fuel for the body and brain. The development of products containing low calorie sweeteners could therefore allow consumers to enjoy sweet foods and drinks with fewer calories.

Low calorie sweeteners are a group of food additives that provide a sweet taste with the hint of fewer calorie intake. They can broadly be divided into two categories – bulk sweeteners and intense sweeteners. Sugar is considered as a highly versatile ingredient, adding sweetness, texture, flavour, colour and preservative properties to many different foods and beverages. Bulk sweeteners are used when these functional characteristics are required. The primary group of bulk sweeteners are sugar alcohols (e.g. sorbitol, mannitol, xylitol). They provide 2.1 to 2.6 kcal/g (compared with 4 kcal/g for sucrose)[1].

Low calorie sweeteners find their application in different food and drink products, especially in the manufacture of low calorie foods and drinks. However, getting a product that not only taste's good but also retains its property throughout its shelf life is not an easy task. Replacement of sugar with other low calorie sweeteners in various food products offers various technical difficulties, as sugar has a number of functional characteristics in addition to providing sweet taste. Often, combinations of bulk and intense sweeteners are required to match the taste and texture of sugar-sweetened products. With complete knowledge of the technical characteristics and sweetness profile of different sweeteners, it is possible to produce lower calorie products that still taste good and provide more consumer choice. An increasing variety of polyol-containing foods is attracting the market shelves. Such products may have a role in weight management and diabetes.

Sugar alcohols occur naturally in a wide variety of fruits and vegetables, but are commercially produced from other carbohydrates such as sucrose, glucose, and starch. Along with adding a sweet taste, polyols perform a variety of functions such as adding bulk and texture, providing a cooling effect or taste, inhibiting the browning that occurs during heating and retaining moisture in foods. While polyols do not actually prevent browning, they do not cause browning either[2-3].Long-term benefits have not been established for sugar alcohols and further research is needed to document their health effects.

2. Recent advances in production of sugar alcohols

Sugar alcohols are neither sugars nor alcohols. They are carbohydrates with a chemical structure that partially resembles sugar and partially resembles alcohol, but they don't contain ethanol as alcoholic beverages do. They are incompletely absorbed and metabolized by the body and consequently contribute fewer calories. The polyols commonly used include sorbitol, mannitol, xylitol, maltitol, maltitol syrup, lactitol, erythritol, isomalt and hydrogenated starch hydrolysates. Recent technical advances have added

to the range of sugar alcohols available for food use and expanded the applications of these sugar replacers in diet and health-oriented foods. They have been found useful in sugar-free and reduced-sugar products, in foods intended for individuals with diabetes, and most recently in new products developed for carbohydrate controlled eating plans. Due to their health-promoting benefits as sugar substitutes, they are used in the food and pharmaceutical industries. In addition, some sugar alcohols such as xylitol and sorbitol have potential applications as building blocks for producing various value-added derivatives[3].

Most sugar alcohols are industrially produced by the catalytic hydrogenation of sugars under high pressure and temperature. However, current chemical processes require extreme conditions and costly chromatographic purification steps, which lead to low final product yields. Because of these drawbacks various research work is in route to establish cost effective techniques for production of such high value-added products with the aim of benefiting the consumers as well the industry. One such step towards advancement is the biotechnological production of sugar alcohols. Biotechnological production based on microbial fermentation offers safer and environmentally friendly processes. However, not all the fermentative processes are applicable for industrial scale manufacturing yet because of several issues, such as high production and purification costs, and low productivity. To make the biotechnological processes for sugar alcohol more competitive and economic, diversification ofvalue-added chemicals derived from sugar alcohols, improvementof applicability of inexpensive substrates,such as cellulosic hydrolyzates, and development of efficient bioconversion processes to produce higher-value derivatives of sugar alcohols will be necessary[4].

Alternatively, the heterogeneous catalytic production of sugar alcohols from renewable biomass provides a safe and sustainable approach. Hydrolysis, coupled with hydrogenation and hydrogenolysis has been proved to be more effective strategy for sugar alcohols production from biomass. Sugar alcohols, including sorbitol, mannitol, xylitol and erythritol are vital chemicals with wide applications. The applications of these sugar alcohols in food, pharmaceutical, cosmetics and polymer industries have been widely reported. Presently, sorbitol and mannitol can be synthesized through hydrogenation of fructose and glucose; xylitol and erythritol can be prepared by conversion of xylose and glucose, respectively. New strategies for the valorization of these sugar alcohols via one-pot heterogeneous catalytic conversion of biomassto sorbitol, mannitol, xylitol, erythritol and their applicationsis of great importance[5].

3. Sugar alcohols versus artificial sweeteners

Sweeteners may be used separately or in combination with other sweeteners, and the latter is becoming increasingly popular in recent years owing to technical, health and commercial advantages. The consumption of low-calorie foods by the worldwide population has dramatically increased, as well as health concerns associated with the consequent high intake of sweeteners both nutritive and non-nutritive.

Nutritive sweeteners include refined sugar, honey, high fructose, corn syrup, dextrose and sugar alcohols. There are eight non-nutritive sweeteners included in EU legislation that are allowed for use in food, i.e., acesulfame K (E950), aspartame (E951), cyclamic acid and its Na, Ca salts (E952), saccharin and its Na, K, Ca salts (E954), sucralose (E955), thaumatin (E957), neohesperidine DC (E959) and salt of aspartame–acesulfame K (E962).

One of the most important differences between artificial sugar substitutes and polyols is that the first ones contain zero calories, with the exception of aspartame that provides 4 kcal per gram but is consumed in very small amounts, contributing negligible energy. Sugar alcohols contain from 0.2 to 2.7 calories per gram, while common sugars supply 4 kcal/g.

Unlike artificial sweeteners, polyols can raise blood glucose but less than sugars, which is due to their incomplete absorption in human organism. However, particular sugar alcohols are metabolized differently and thus can exhibit various impacts on glucose levels in organism.

The sweetness of sugar alcohols varies from 25 to 100 % as compared with table sugar, whereas artificial sweeteners are 30 to even 13,000 times sweeter than sucrose. Thus, they can be used in small amounts to achieve desired sweetness in such products as beverages, ice cream chewing gum, chocolate, jams/jellies, yogurt and salad dressings. However, artificial intense sweeteners are used only for sweetening, whereas polyols can be used as anti-caking and glazing agents as well as stabilizers and thickeners. Similar to common sugars, they can be also used as bulking agents besides being excellent natural sweeteners. They also help food keep moisture, prevent browning when heated and add a cooling sensation to products. Some artificial sweeteners may leave an aftertaste, but mixing with particular polyols such as erythritol, isomalt or lactitol can result in a similar flavor to the one of table sugar [6-7].

Sugar alcohols have been also associated with few side effects when eaten in excess, which include bloating, abdominal pain and diarrhea. However, in reasonable amounts, artificial sweeteners and polyols might be helpful in diabetes and weight control, but tooth decay prevention can be only associated to the latter consumption. Besides that, sugar alcohols exhibit many health protection roles.

All in all, both groups of sweeteners can be useful in diabetes management and are good option for people on low-carbohydrate diet. The highest polyol intake can be associated with consumption of confectionery products, fish/meat product and miscellaneous foods. Overconsumption of polyols can be only of concern in view of digestive comfort, while artificial sweeteners must be always estimated with respect to the maximum amounts allowed, which are considered safe for human consumption. Therefore, it might be worth using sugar alcohols in food products marketed to patients with diabetes and individuals considering energy restricted diets more frequently but bearing in mind their gastrointestinal effects. However, optimal diet should be based on fresh unprocessed foods with the minimal amounts of food additives, and then the

sugar replacers such as sugar alcohols or even artificial sweeteners will not have a significant role in the daily diet.

4. Market up-front of Sugar Alcohols

Global consumption of polyols sweeteners or sugar alcohols is predicted to be 1.6 million metric tons and is projected to reach 1.9 million metric tons by 2022 at a CAGR of 3.4%. Asia-Pacific is the leading global consumer of polyols, dominating the global market for polyols with a share of about 47%. Food regulatory bodies in different countries are acting as proponents for the growing use of sugar alcohols. In addition, scientific studies have dubbed sugar alcohols as nutritive sweeteners, which can not only regulate the metabolism of a diabetic person, but also lower the blood sugar responses. According to a recently published forecast study, the global sugar alcohol market is pegged to expand at a sluggish pace, registering an estimated 2.1% CAGR during the forecast period, 2017-2026[8]. The report further assesses that by the end of this period, the global market for sugar alcohols will reach a value of nearly US$ 1.4 Bn. With challenges in supply chain and raw material procurement, global sugar alcohol production is likely to face impediments in the near future. The reports have revealed that majority of sugar alcohols will be used in the production of beverages. In 2017, more than US$ 240 Mn worth of sugar alcohols was sold for their beverage applications. This has served as an indicator for manufacturers, who are likely to focus on improving the application purview of their products. Companies namely, Tate & Lyle PLC, MacAndrews & Forbes Incorporated, DuPont, Niutang Chemical Ltd., Ajinomoto Co., Inc., Cargill, Incorporated, Symrise AG, Archer Daniels Midland Company, Associated British Foods PLC, Nestlé S.A., Ingredion Incorporated, Wilmar International Limited, American Sugar Refining, Inc., and Roquette Frères are expected to actively instrument the global production of sugar alcohols through 2026.

5. Conclusion

Sustainable growth and consistent demand for zero or low-calorie alternative sweeteners by the global market are mainly attributable to public consciousness about health impact of artificial sugar substitutes. Biomass derived sugar alcohols (e.g. xylitol, arabitol) find numerous uses in oral hygiene, pharmaceutical industries and food containing sugar alcohols (polyols)- are appearing on supermarket shelves. These products may have a role in weight management and in diabetic eating plans. Due to increasing epidemic of obesity and diabetes, it is important to educate consumers to make reasonable and healthy food choices. Unfortunately, people crave sweetness, and thus, sugar substitutes have drawn attention of consumers as well as producers and dieticians. Sugars alcohol is believed to be good sugar substitute for people with diabetes plus they do not contribute to dental caries. Asia-Pacific is the leading global consumer of polyols, dominating the global market for polyols with a share of about 47%. With such market hold, approval for usage of sugar alcohols as sugar substitutes in food products by the regulatory agencies can initiate major trends for food and beverage industries to get better market, stability and price.

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