KAPITEL 2 / *CHAPTER 2* [2]
THE GLYCEMICAL INDEX AS A MEASUREMENT OF THE QUALITY OF CONFECTIONERY PRODUCTS IN THE XXI CENTURY

DOI: 10.30890/2709-2313.2024-32-00-022

Introduction

Relevance of the Topic. In the 21st century, the confectionery industry is facing new challenges related to the rising incidence of diabetes and obesity among the population [1]. Traditional confectionery products containing high amounts of sugars and rapidly digestible carbohydrates contribute to elevated blood glucose levels and negatively impact metabolic health [2]. In this context, the glycemic index (GI) becomes an important tool for evaluating the quality of food products and their effects on the human body [3].

The glycemic index, first introduced by Jenkins and colleagues in 1981 [4], characterizes the rate and extent of the increase in blood glucose levels after consuming a product. High-GI products lead to a rapid spike in glucose, whereas low-GI products provide a slower and more stable energy supply [5]. Considering the GI in the development of confectionery products can be an effective approach to reducing the risk of metabolic diseases and improving the quality of life for consumers [6].

Despite the growing number of studies in dietetics and food science, the use of the glycemic index as a quality criterion in the confectionery industry remains insufficiently explored [7]. Most manufacturers still focus on traditional quality indicators, such as organoleptic properties and shelf life, without considering the metabolic impact of their products [8].

Aim of the Study: To determine the role of the glycemic index as a measure of quality for confectionery products in the 21st century and to develop recommendations for its implementation in production.

[2] ***Authors:*** *Kovalenko Ihor Svyatoslavovych*

2.1. Theoretical Foundations of the Glycemic Index and Its Significance in the Food Industry.

The glycemic index (GI) was introduced in 1981 by David Jenkins to classify carbohydrate-containing foods based on their impact on blood glucose levels [9]. Prior to this, foods were evaluated based on their content of simple and complex carbohydrates, which did not always reflect their actual glycemic effect. It was found that complex carbohydrates can have a high GI, while simple sugars can have a low GI [9], which changed the approach to carbohydrate assessment and facilitated the development of GI tables.

The GI reflects the speed at which blood glucose levels rise after consuming a product compared to a standard [10]. High-GI foods cause a rapid increase in glucose and insulin levels, which can lead to metabolic disturbances. Low-GI foods provide a gradual increase in glucose, which is more beneficial for the body [11].

Determining the GI is carried out by measuring the glycemic response in healthy volunteers after consuming 50 grams of carbohydrates from the test product [12]. Blood glucose levels are measured while fasting and at intervals after consumption, a glycemic curve is constructed, and the GI is calculated by comparing the area under the curve of the test product with that of the standard.

High-GI foods are associated with an increased risk of developing type 2 diabetes [13], cardiovascular diseases, and obesity. Low-GI diets help in controlling blood glucose levels and reducing weight [14].

Confectionery products typically have a high GI due to their high sugar content, which limits their consumption for individuals with metabolic diseases [15]. Incorporating the GI in the development of such products allows for the creation of products with improved properties. The use of alternative sweeteners and dietary fibers can lower the GI and make products more appealing to health-conscious consumers [16].

2.2. Analysis of the Confectionery Market in the 21st Century.

In the 21st century, the confectionery industry remains one of the most dynamic sectors of the food industry. Population growth and changes in lifestyle contribute to the increasing consumption of confectionery products. The global confectionery market reaches billion-dollar turnovers and continues to grow [17].

Main Industry Trends:

• Product Innovations: Manufacturers are introducing new flavors and shapes to meet consumer demands [18].

• Rising Demand for Healthy Products: Consumers increasingly value the quality and health benefits of products [19].

Traditional Quality Criteria for Confectionery Products

The quality of confectionery products is traditionally assessed based on:

• Organoleptic Properties: Taste, aroma, texture, and appearance.

• Chemical Composition: Content of sugars, fats, proteins [20].

• Physico-Chemical Indicators: Moisture, acidity.

• Shelf Life: Resistance to spoilage.

However, these criteria do not take into account the metabolic impact of products on the human body, which becomes important due to the increasing prevalence of nutrition-related diseases.

Impact of Confectionery Products on Consumer Health

Elevated Sugar Content and Its Consequences. Confectionery products contain high amounts of added sugars, leading to a high glycemic index [21]. Excessive consumption of such products is associated with:

• Risk of Developing Type 2 Diabetes: Rapid increase in glucose promotes insulin resistance.

• Obesity: High-calorie products contribute to excessive body weight [22].

• Cardiovascular Diseases: Elevated cholesterol levels.

Consumer Habits and Behavior. Modern lifestyles stimulate the consumption of confectionery products. Insufficient awareness about the harms of excessive sugar

intake exacerbates the situation.

Trends Towards Healthy Eating. There is a growing awareness of the need for healthy eating. Demand for products with reduced sugar content and natural ingredients is increasing [23]. Manufacturers are responding to these changes by offering alternative products.

Challenges and Opportunities for the Confectionery Industry

Need for Innovation. To maintain competitiveness, manufacturers must implement new technologies and ingredients that allow reducing the glycemic index of products without compromising taste qualities [24].

Regulatory Aspects. Many countries are introducing restrictions on sugar content and requiring transparent product labeling. This encourages the industry to seek healthier alternatives.

Role of the Glycemic Index in Product Quality Assessment

Considering the glycemic index when assessing the quality of confectionery products can be an important step towards improving public health. It allows consumers to make informed choices and enables manufacturers to meet new market demands [25].

2.3. Glycemic Index as a Quality Criterion for Confectionery Products

Drawbacks of Existing Quality Criteria

Traditional quality criteria for confectionery products focus on organoleptic properties (taste, aroma, texture), physico-chemical indicators, and shelf life [26]. While these aspects are important for consumer perception, they do not consider the product's impact on metabolic health. Given the increasing incidence of type 2 diabetes and obesity [27], it is necessary to revise the approach to assessing the quality of food products, particularly confectionery products.

Glycemic Index as a Tool for Quality Assessment

The Concept of Glycemic Index: The glycemic index (GI) measures the ability of

carbohydrate-containing foods to raise blood glucose levels after consumption [28]. High-GI products cause a sharp increase in glucose levels, while low-GI products provide a more gradual and stable energy supply [28].

Advantages of Using GI as a Quality Criterion: Considering the GI in the evaluation of confectionery products offers several advantages:

- Consumer Health: Low-GI products help control blood glucose levels, reducing the risk of developing diabetes and cardiovascular diseases [29].
- Informed Choice: Information about the GI on labels helps consumers make informed product choices [30].
- Innovation in Production: Encourages manufacturers to adopt new technologies and ingredients to lower the GI [31].

Comparative Analysis of Confectionery Products with Different Glycemic Indexes

Traditional Confectionery Products: Most traditional confectionery products have a high GI due to their high sugar and refined flour content [32]. For example, biscuits and sweet cookies can have a GI above 70.

Low-GI Products: Using whole grain flour, low-GI sweeteners (stevia, erythritol), and adding dietary fibers can lower the GI of confectionery products [33]. These products have a GI below 55 and are healthier.

Technological Aspects of Lowering the Glycemic Index

Use of Alternative Ingredients:

- Low-GI Sweeteners: Stevia, erythritol have minimal impact on blood glucose levels [34].
- Whole Grain Flour: Contains more dietary fibers, which help reduce the product's GI [33].

Technological Methods:

- Changing Product Structure: Less processed ingredients can lower the GI.
- Adding Dietary Fibers: Inulin and pectin slow glucose absorption [34].

Labeling and Consumer Information

Providing information about the glycemic index on labels helps consumers make

informed choices. In some countries, labeling systems indicating the GI have already been implemented.

Economic and Marketing Advantages for Manufacturers

Producing low-GI confectionery products can become a competitive advantage. The growing demand for healthy products opens up new market segments.

Challenges in Implementing GI as a Quality Criterion:

- Technological Limitations: Adaptation of recipes and production processes.
- Economic Costs: Investments in the development of new products.
- Educational Aspects: Need for educating consumers and staff about the importance of GI.

Future Prospects

Considering the glycemic index as a quality criterion for confectionery products aligns with healthy eating trends and can contribute to improving public health.

2.4. Technological Approaches to Lowering the Glycemic Index in Confectionery Products

Use of Alternative Sweeteners: Replacing traditional sugars with low-glycemic index sweeteners is an effective way to lower the GI of confectionery products. These sweeteners include:

- Stevia: A natural sweetener derived from the *Stevia rebaudiana* plant, it has a glycemic index of zero and is 200-300 times sweeter than sucrose [35]. The use of stevia allows for maintaining a sweet taste without raising blood glucose levels.
- Erythritol: A sugar alcohol with low caloric content and a glycemic index close to zero [36]. Erythritol has 70% of the sweetness of sucrose and does not cause tooth decay.

Enrichment with Dietary Fibers: Adding dietary fibers to confectionery products slows down carbohydrate absorption, reducing the glycemic index of the product [37]. The following fibers are used:

• Inulin: A prebiotic fiber that promotes the growth of beneficial gut microbiota [38].

• Beta-Glucans: Soluble fibers from oats and barley that lower blood glucose and cholesterol levels [39].

Use of Whole Grain Ingredients: Replacing refined flour with whole grain flour increases fiber content and lowers the GI of products [40]. Whole grain ingredients retain the grain's outer layer, which is rich in vitamins, minerals, and antioxidants.

Addition of Proteins and Healthy Fats: Proteins and fats slow down the digestion of carbohydrates, reducing the glycemic index [41]:

• Protein Additives: Whey protein, soy protein.

• Healthy Fats: Nuts, seeds, cold-pressed oils.

Technological Processing Methods:

Reduction of Milling Degree: Less processed ingredients have a lower GI as they require more time for digestion [40]. Using coarsely milled flour or whole grains slows down carbohydrate absorption.

Control of Thermal Processing: Prolonged thermal processing can increase the GI of products due to starch gelatinization [41]. Optimizing baking temperature and time helps preserve carbohydrate structure.

Use of Enzymes and Starch Modification: The application of enzymes, such as amylases, modifies starch, making it less accessible for quick digestion. This helps to lower the glycemic index of the final product.

Combining Ingredients: Combining different approaches—using alternative sweeteners, dietary fibers, proteins, and fats—allows for the creation of low-GI confectionery products without compromising taste.

2.5. Prospects and Recommendations for the Use of the Glycemic Index in the Confectionery Industry

Prospects for Implementing the Glycemic Index in the Confectionery Industry:

Given the growing consumer focus on healthy eating and blood sugar control, the use of the glycemic index (GI) as a quality measure for confectionery products has significant potential for the industry's development [42]. Consumers are increasingly seeking products that not only satisfy their taste preferences but also promote a healthy lifestyle.

The implementation of the GI can become a key factor in the development of new products that meet modern market demands. Furthermore, it can help differentiate products and create competitive advantages for manufacturers [43].

Recommendations for Confectionery Manufacturers

- Development of Low-GI Products: Manufacturers are recommended to invest in the research and development of confectionery products with reduced GI. This may include using alternative sweeteners, enriching products with dietary fibers and proteins, as well as optimizing technological processes [44].
- Labeling and Consumer Information: Transparent labeling of products with their glycemic index will help consumers make informed choices. Manufacturers should provide accessible and understandable information about the benefits of low-GI products [45].
- Education and Staff Training: Training technologists and marketers on the importance of the GI and ways to lower it will facilitate the successful introduction of new products to the market.

Recommendations for Regulatory Bodies

- Development of Standards and Regulations: Regulatory bodies are recommended to develop standards and methods for determining the glycemic index of food products. This will ensure a unified approach and increase consumer trust in labeling [46].
- Support for Research and Innovation: Government support for scientific research in lowering the GI of confectionery products can promote innovation and the implementation of new technologies.
- Public Education Programs: Conducting educational campaigns about the importance of the glycemic index and its impact on health will help raise public

awareness and stimulate demand for healthier products.

Collaboration Between Scientists, Manufacturers, and Regulators

Effective implementation of the glycemic index in the confectionery industry requires close collaboration between scientific institutions, manufacturers, and regulatory bodies. Joint projects, experience sharing, and knowledge exchange will contribute to the development of the industry and improve public health.

Prospects for Consumers

The introduction of low-GI products to the market will provide consumers with a wider range of healthy alternatives. This may help reduce the risk of developing metabolic diseases and improve overall quality of life.

Conclusions

The study has shown that the glycemic index (GI) is an important quality measure for confectionery products in the 21st century. Traditional sweets, high in sugars and refined carbohydrates, raise blood glucose levels, which can lead to metabolic diseases such as type 2 diabetes and obesity.

Using the GI as a quality criterion allows for an objective assessment of a product's impact on health. Low-GI products promote a gradual release of energy and reduce the risk of metabolic disorders. Technological approaches, such as the use of alternative sweeteners, enrichment with dietary fibers, and the use of whole grain ingredients, effectively lower the GI of confectionery products.

The implementation of the GI as a quality measure opens new opportunities for manufacturers by meeting the growing demand for healthy food products and increasing consumer loyalty. This aligns with modern trends towards healthy eating and informed consumption.

It is recommended that manufacturers invest in the development of low-GI products and implement innovative technologies. Regulatory bodies should develop standards for determining the glycemic index and support research in this area. The

scientific community is encouraged to continue studying the impact of the GI on health and collaborate with the industry.

Incorporating the glycemic index into the confectionery industry is an important step towards improving public health and advancing the industry. Joint efforts from all stakeholders can lead to the creation of healthier and safer food products, which will help reduce the prevalence of metabolic diseases.