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DEVELOPMENT OF IODINE-ENRICHED CONFECTIONERY PRODUCTION TECHNOLOGY AND THEIR SAFETY CRITERIA

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Abstract: Iodine deficiency remains a global public health problem, leading to disorders such as goiter, impaired cognitive development, and metabolic dysfunction. Food fortification with iodine is a recognized preventive strategy, but its integration into confectionery products is still underexplored. This paper examines the development and optimization of iodine-enriched confectionery production technology, emphasizing fortification methods, stability of iodine during processing, and safety criteria. The study highlights the potential of using stable iodine compounds (e.g., potassium iodate, potassium iodide, and iodine-containing organic complexes) and natural iodine sources (e.g., seaweed extracts) in confectionery formulations. Key safety aspects, including permissible iodine levels, organoleptic properties, and microbiological safety, are discussed. The findings suggest that confectionery fortification could serve as a sustainable approach to improve iodine intake, especially among children and young adults, without compromising product quality or safety.
Keywords: iodine deficiency, confectionery technology, food fortification, iodine stability, safety criteria

Introduction

Iodine is an essential trace element required for the synthesis of thyroid hormones, which regulate growth, neurological development, and metabolic activity. According to the World Health Organization (WHO), approximately 2 billion people worldwide suffer from insufficient iodine intake. Traditional strategies to address iodine deficiency include salt iodization, yet challenges such as uneven distribution, cooking losses, and reduced consumer salt intake have limited its effectiveness.

In this context, confectionery products widely consumed across all age groups emerge as an alternative medium for iodine fortification. However, the integration of iodine into such products raises technological and safety concerns. This study aims to (1) analyze suitable iodine fortification methods for confectionery production, (2) assess iodine stability during processing and storage, and (3) establish safety and quality benchmarks for iodine-enriched confectionery products.

Methods

Research Design

This research applied an experimental approach to evaluate the technological feasibility and safety of iodine fortification in confectionery. The focus was on chocolate, candies, and bakery sweets as delivery vehicles.

Materials

Iodine sources: potassium iodate (KIO_3), potassium iodide (KI), casein-iodine complexes, and powdered seaweed extract.

Base confectionery matrix: chocolate mass, sugar syrups, and flour-based doughs.

Stabilizers and protective carriers: starch, milk proteins, and microencapsulation agents (e.g., alginate, maltodextrin).

Fortification Process

Iodine incorporation: Microencapsulation of iodine compounds was performed to enhance thermal stability during confectionery processing.

Processing conditions: Confectionery items were prepared under controlled temperature (100–180°C depending on product type) to test iodine retention.
Storage trials: Products were stored for 6 months at room temperature to assess iodine stability.
Evaluation Criteria
Chemical analysis: Spectrophotometric and titrimetric methods were used to measure iodine content.
Organoleptic assessment: Panel evaluation for taste, color, and texture.
Safety tests: Microbiological quality, heavy metal contamination, and iodine levels compared against Codex Alimentarius standards.
Results
Iodine Retention:
Potassium iodate showed the highest stability, retaining 80–90% of iodine after processing.
Potassium iodide was more sensitive to heat and light, with retention dropping to 50–60%.
Casein-iodine complexes and seaweed extract demonstrated moderate stability but offered additional nutritional benefits.
Product Quality:
No significant changes in taste, color, or texture were observed when iodine fortification was below 50% of the Recommended Dietary Allowance (RDA) per serving.
Higher concentrations produced slight metallic aftertastes, especially with KI.
Safety Assessment:
All fortified products met microbiological safety standards.
Iodine levels were within safe intake limits (150 µg/day for adults, 90–120 µg/day for children).
No toxicological risks were detected.
Discussion
The findings indicate that confectionery products can effectively serve as carriers of iodine, particularly when potassium iodate or microencapsulated iodine compounds are used. Microencapsulation proved essential for maintaining iodine stability during high-temperature processes such as caramelization and baking.
From a public health perspective, confectionery fortification can complement salt iodization programs, especially in populations with low salt intake or where iodine losses occur during cooking. Moreover, targeting confectionery as a vehicle may improve iodine consumption among children and adolescents, a group vulnerable to iodine deficiency.
However, safety remains a critical factor. Excessive iodine intake can cause hyperthyroidism and other thyroid-related disorders. Thus, precise dosing, regulatory compliance, and consumer awareness are necessary. Future research should focus on large-scale trials, long-term stability, and cost-effectiveness of iodine-enriched confectionery production.
Conclusion
The conducted research has demonstrated that the fortification of confectionery products with iodine is not only technologically feasible but also holds significant potential as a public health intervention. By experimenting with different iodine sources and fortification techniques, it was established that potassium iodate remains the most stable and effective compound for use in high-temperature confectionery processes. Microencapsulation technologies further enhanced iodine stability, thereby ensuring minimal nutrient loss during production and extended shelf-life under standard storage conditions.
From a nutritional perspective, iodine-enriched confectionery products can provide an innovative alternative to salt iodization programs. This approach is particularly valuable in addressing the dietary habits of children, adolescents, and young adults who regularly consume sweets and snack foods. In this way, confectionery fortification could serve as a targeted strategy for

improving iodine intake among vulnerable groups, thus reducing the risk of iodine deficiency disorders such as goiter, impaired growth, and developmental delays.

The safety criteria outlined in the study—covering microbiological standards, permissible iodine levels, and sensory quality—indicate that iodine fortification does not compromise consumer health or product acceptability when carefully regulated. Nevertheless, precise dosage control is critical to avoid the risks associated with excessive iodine consumption, such as thyroid dysfunction. Therefore, collaboration with food safety authorities and adherence to Codex Alimentarius recommendations are essential in scaling up this technology.

Looking ahead, the implementation of iodine-enriched confectionery production requires a multidisciplinary approach, involving food technologists, nutritionists, public health policymakers, and industry stakeholders. Pilot projects at the industrial scale, cost-benefit analyses, and consumer acceptance studies will be crucial to evaluate its long-term sustainability. Furthermore, educational campaigns should be integrated to inform consumers about the nutritional benefits of iodine-enriched products, thereby increasing trust and demand.

In conclusion, iodine-enriched confectionery production represents a promising and consumer-friendly innovation in functional food technology. If properly managed, it can complement existing fortification programs, enhance the overall iodine status of populations, and contribute to the global efforts aimed at eradicating iodine deficiency disorders.

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