SAÚDE E PESQUISA
e-ISSN 2176-9206

ORIGINAL ARTICLE

https://doi.org/10.17765/2176-9206.2026v19e13322

IDENTIFICATION OF CARBOHYDRATES IN INFANT FORMULAS AND THEIR CONTRIBUTION TO THE DEVELOPMENT OF DENTAL CARIES

IDENTIFICAÇÃO DE CARBOIDRATOS EM FÓRMULAS INFANTIS E SUA CONTRIBUIÇÃO PARA O DESENVOLVIMENTO DA CÁRIE DENTAL

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Received: 19 nov. 2024
Accepted: 24 feb. 2025

Editors-in-Chief: Dr. Leonardo Pestillo de Oliveira and Dr. Mateus Dias Antunes

ABSTRACT: The objective of this study was to identify the types of carbohydrates present in infant formulas available on the market and to evaluate their contribution to the development of dental caries. This was an observational and descriptive study in which different aspects of commercially available infant formulas were analyzed, including age range, brand, manufacturer, overall label composition, and types of carbohydrates present. A total of 16 types of infant formulas were identified, purchased from pharmacies and supermarkets, and among the 15 samples analyzed, 14 brands contained maltodextrins, while one brand contained starch in its composition, both of which are carbohydrates fermentable by bacteria in the dental biofilm. Infant formulas are widely available on the market and present a diversity of carbohydrates in their composition, and all carbohydrates identified in the evaluated formulas demonstrated cariogenic potential. In addition, the practice of adding sucrose to bottle preparations may further induce the formation of a cariogenic dental biofilm.

KEYWORDS: Breast-milk Substitutes, Dental Caries, Dietary Carbohydrates, Sucrose, Infant Formula.

RESUMO: O objetivo foi identificar os tipos de carboidratos presentes em fórmulas infantis disponíveis no mercado e avaliar sua contribuição para o desenvolvimento da cárie dental. Foi realizada uma pesquisa observacional e descritiva, na qual foram analisados diferentes aspectos das fórmulas infantis comercializadas, incluindo faixa etária, marca, fabricante, composição geral do rótulo e tipos de carboidratos presentes. Foram identificados 16 tipos de fórmulas infantis, adquiridas em farmácias e supermercados. Dentre as 15 amostras analisadas, 14 marcas continham maltodextrinas, enquanto em uma marca foi encontrado amido em sua composição, ambos carboidratos fermentáveis por bactérias do biofilme. As fórmulas infantis estão amplamente disponíveis no mercado e apresentam uma diversidade de carboidratos em sua composição. Todos os carboidratos encontrados nas fórmulas infantis avaliadas demonstram potencial cariogênico. Além disso, o hábito de adicionar sacarose à preparação da mamadeira pode induzir a formação de um biofilme dental cariogênico.

PALAVRAS-CHAVE: Carboidratos da Dieta. Cárie Dental. Fórmulas Infantis. Substitutos do Leite Humano. Sacarose.

INTRODUCTION

Breast milk is the primary source of essential nutrients for infants, and exclusive breastfeeding is recommended until 6 months of age, after which breastfeeding becomes a source of complementary nutrition and can be extended to 2 years of age.[1] Despite the importance of human milk and breastfeeding for child development and growth, there has been an increase in the use of infant formula as a substitute for breast milk to feed babies. However, these products are not recommended by the WHO, as they do not provide any nutritional benefits[2] and compete directly with the practice of breastfeeding.[3]

Infant formulas were developed as an alternative to breastfeeding to mimic the properties of breast milk. However, the components present in infant formulas differ from the composition of breast milk.[4] Infant milk formulas are composed of a variety of nutrients, including proteins, lipids, vitamins, and minerals.[5] However, unlike breast milk, which contains lactose as the main carbohydrate,[6] infant formulas contain a variety of carbohydrates, usually including lactose, maltodextrins, or a combination of these carbohydrates.[7]

While carbohydrates are used as a source of energy, the frequent intake of foods and beverages with high sugar content is associated with the risk of developing obesity, overweight, and type 2 diabetes.[8,9] In addition, the frequent use of sweetened baby bottles, especially at night, when saliva production is reduced, has been identified as a significant contributing factor to the development of dental caries.[10] However, despite the WHO's recommendation to limit the consumption of free sugars to a maximum of 10% of total energy intake,[11] the early introduction of sugars to infants remains a prevalent practice, although it is not advised.[12]

A study revealed that 94.3% of infants used baby bottles containing sugary foods during the first six months of life, and sugar was added in 86.2% of cases where the bottle was used to consume milk.[10] In addition to the evident role of sucrose in the development of dental caries through the formation of extracellular polysaccharides (ECPs) that promote a cariogenic dental biofilm,[13] the presence and combination of different carbohydrates in infant formulas may further enhance this cariogenicity.[14] Studies have evaluated the effect of different types of sugars on enamel demineralization and the composition of dental biofilm and have shown that formulas based on lactose, maltodextrin, or a combination of both have a cariogenic potential that is enhanced by the addition of sucrose to the bottle. [15-17]

The identification of carbohydrates in infant formulas has been the subject of extensive research in several countries because of its association with children's oral health and its impact on the development of dental caries.[18] Research conducted in Europe, North America, and Asia has shown that many of these formulas contain high levels of fermentable carbohydrates, which are often underreported on product labels, thereby compromising transparency for consumers.[18-20] Given this scenario, the implementation of more stringent regulations and preventive measures is imperative to mitigate the consequences of early sugar consumption. In addition, health promotion should encompass policies that promote breastfeeding and guide parents in choosing foods with a reduced cariogenic potential.

In this context, considering that the composition and consumption of processed foods directly influence children's eating habits, it is essential to know the nutritional content of breast milk substitutes since these products contain ingredients that can contribute to the development of caries in childhood. Therefore, the present study aimed to identify the types of carbohydrates in infant formulas and evaluate their contribution to the development of dental caries.

METHODOLOGY

This observational and descriptive study was conducted in Maceió, state of Alagoas, Brazil, in 2024, to deepen the understanding of infant formulas available on the market. To this end, a comprehensive data collection was carried out in person at pharmacies and supermarkets in the city.

The infant formulas were identified and cataloged considering the age range, the commercial brand, the manufacturing company, the general composition information on the labels, and the types of carbohydrates in their formulation. Photographic records of the packaging labels were obtained and analyzed for categorization and identification of the data. This process aimed to evaluate the profile of carbohydrates in infant formulas and investigate their cariogenic potential based on scientific evidence on the influence of these carbohydrates on the formation of dental biofilm and the development of dental caries in childhood. The following were considered as inclusion factors: infant formulas for infants (0-6 months), infant formulas for children (6-12 months), and follow-up infant formulas for children in early childhood (1-3 years of age). Conversely, infant formulas indicated for high-risk newborns and dairy compounds were excluded from the study.

RESULTS

A total of fifteen types of infant formulas were selected for evaluation based on a combination of inclusion and exclusion criteria. These formulas were obtained from retail locations, including pharmacies and supermarkets. The collected data were processed and analyzed to ascertain the composition of each formula. This analysis included an evaluation of the packaging and components present in each formula, as described in Table 1.

Table 1. Data obtained from the packaging of commercially available infant formulas.

COMMERCIAL BRANDS	MANUFACTURING COMPANY	MAIN CARBOHYDRATE
NAN SCIENCE PRO -EspessAR 0 to 12 months	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Nan Science pro H.a. 0 to 12 months	Nestlé deutschaland AG-fussener strasse,1 Biessenhofen-German company	LACTOSE AND MALTODEXTRIN
NAN SCIENCE PRO S.L. 0 to 12 months	Nestlé Nederland B.V Laan,110- Nunspeetindustria Dutch company	MALTODEXTRIN
NAN SCIENCE PRO -SOJA 0 to 12 months	Nestlé Infant nutrition, Arligton, VA 22209, USA Made in the United States	MALTODEXTRIN
Nestogeno ESPESSAR 0 to 12 months	Nestlé Brazil Ltda	STARCH AND LACTOSE
Nan supreme 2 6 to 12 months	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Aptamil profutura 2 6 to 12 months	Danone	LACTOSE AND MALTODEXTRIN
Nestogeno 2 6 to 12 months	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Neocate lcp 0 to 3 years	Danone	GLUCOSE SYRUP
Aptanutri premium 3 1 to 3 years	Danone	LACTOSE AND MALTODEXTRIN
Aptanutri pro futura 3 1 to 3 years	Danone	LACTOSE AND MALTODEXTRIN

COMMERCIAL BRANDS	MANUFACTURING COMPANY	MAIN CARBOHYDRATE
Nanlac supreme 1 to 3 years	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Ninho nutrigold From 1 year old	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Nestonutri 1 to 3 years	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN
Ninho fases 1+ 1 to 3 years	Nestlé Brazil Ltda	LACTOSE AND MALTODEXTRIN

DISCUSSION

According to the Codex Alimentarius (FAO/WHO), infant formulas are required to contain proteins, minerals, vitamins, and carbohydrates as obligatory components.[21] In the present study, infant formulas under analysis included the following carbohydrates: lactose, glucose syrup, starch, a mixture of lactose and maltodextrins, or maltodextrin alone in their composition. Lactose, the predominant carbohydrate in human and bovine milk, has been examined concerning its role in caries development. Studies have demonstrated that, despite its fermentation by bacteria in dental biofilms, lactose exhibits a reduced cariogenic potential when compared to other dietary carbohydrates.[22,23]

In addition to lactose, maltodextrins were identified in 14 of the 15 samples, and starch was identified in one brand. Regarding dental caries, starch is considered non-cariogenic for enamel[24,25] or slightly cariogenic for dentin. [26,27] However, starch hydrolysates, such as maltodextrin and glucose syrups, have been utilized by the food industry in infant formulas to increase caloric content or to influence properties such as reduced crystallization, augmented viscosity, consistency, stability, and volume. [14]

Studies have demonstrated that maltodextrins exhibit a reduced acidogenic potential in comparison to sucrose.[28,29] However, it is imperative to consider the synergistic effect of frequent ingestion and the accumulation of dental biofilm, which can result in enamel demineralization and the development of caries.[30,31] The cariogenic potential of maltodextrins in infant formulas has been documented[15,17], demonstrating that maltodextrin can be easily metabolized within the dental biofilm.

Besides the various carbohydrates present in infant formulas, sucrose has been incorporated into baby bottle preparations.[10] Studies[23,24,29] demonstrate that the combination of starch hydrolysates and sucrose can modify the matrix of the dental biofilm, rendering it more cariogenic. An in vitro study[15] evaluated the effect of infant formulas with and without added sucrose, concluding that infant formulas containing lactose, maltodextrins, or a mixture of these carbohydrates have cariogenic potential and that the addition of sucrose enhanced this potential, especially in maltodextrin-based formulas.

Consequently, the role of initial sugar consumption in children's oral health merits consideration. Dental caries, a prevalent disease affecting children's health and quality of life, is a notable concern.[33] Early exposure to sugars, as well as frequent consumption during the first year of life, can influence future experiences of caries in childhood.[34,35] Research has revealed a dose-response relationship between sugar intake and the development of caries, indicating that increased sugar consumption is associated with a higher likelihood of developing caries and more severe outcomes.[9,36]

The Dietary Guidelines for Brazilian Children Under 2 Years emphasize that sugar should not be introduced to children under 2 years of age, and no other type of sugar should be incorporated in food preparation.[1] The World Health Organization also advises limiting sugar consumption to 5% of total calorie intake as a measure to prevent tooth decay.[8] Additionally, the European Society for Paediatric

Gastroenterology, Hepatology and Nutrition (ESPGHAN) does not recommend the addition of sugars other than lactose in the quantities naturally present in milk.[37]

In light of this scenario, it is imperative to consider the reformulation of infant formulas with the objective of reducing the intake of fermentable carbohydrates by infants and young children. This is necessary to mitigate the risks of developing dental caries. The sustained growth of this market, propelled by effective marketing strategies and the absence of stringent regulations, has contributed to the widespread acceptance of these products. However, consumers often have a limited understanding of their composition and the implications for children's oral health.[38]

Furthermore, the widespread availability and promotion of infant formulas may compete with breastfeeding, reducing its prevalence and, consequently, the associated nutritional and oral health benefits.[2,8] Thus, the implementation of fiscal policies, product reformulation, and nutritional education initiatives may help to reduce the risks associated with excessive consumption of fermentable carbohydrates, thereby promoting healthier food choices for young children.

CONCLUSION

Infant formulas are widely available on the market and are composed of various carbohydrates, which may carry cariogenic potential. This can contribute to the development of dental caries in early childhood. Moreover, the addition of sucrose in the formulation of infant formulas further enhances this cariogenic risk. Therefore, guidance measures and public policies must be implemented to reduce the consumption of infant formula and mitigate the likelihood of developing dental caries. In addition, breastfeeding should be promoted as it is the safest and healthiest form of nourishment during the initial months of life and plays a key role in preventing both oral and nutritional complications.

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