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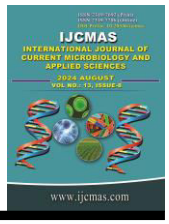

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Recent Studies of Maltodextrins Usage in Indonesia

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A B S T R A C T

Indonesia has increasingly integrated maltodextrin, a non-sweet soluble powder derived from starch hydrolysis that is favored for its neutral color, taste, and cost-effectiveness, into its food industry owing to its history of utilizing starch-rich crops such as sago and cassava. This review examines the production processes, chemical properties, and applications of maltodextrin, particularly as an encapsulating agent in food products. This review discusses enzymatic hydrolysis and the significance of degree of polymerization (DP) in determining the functional characteristics of maltodextrin. The encapsulation capabilities of maltodextrin were highlighted, demonstrating its effectiveness in enhancing the stability, solubility, and bioavailability of active ingredients, nutrients, and flavors. Case studies have illustrated the role of maltodextrin in improving the shelf life and functionality of essential oils, probiotics, and other bioactive compounds, thereby demonstrating its protective and stabilizing properties. Additionally, this review explores regulatory measures governing maltodextrin usage in Indonesia to ensure safe and effective incorporation into products. Although maltodextrin offers many benefits, challenges, such as health concerns, environmental impacts, and economic factors, have also been addressed. Understanding and mitigating these challenges indicate a promising future for maltodextrin in Indonesia, fostering continued innovation and advancement across various industries.

Introduction

Indonesia has a long history of utilizing starch-rich crops such as sago and cassava as traditional staple foods (Laga *et al.,* 2018). Maltodextrin (MD) is a non-sweet soluble powder derived from the hydrolysis of starch (Rao *et al.,* 2020). It is widely used as a food ingredient in Indonesia because of its neutral color, taste, and relatively low cost (Rao *et al.,* 2020). Indonesia relies heavily on rice as its major staple food, although tubers and other starch-based foods are also consumed (Moko *et al.,* 2022). The high availability of renewable carbohydrate resources makes maltodextrin an invaluable ingredient in various industries. It is derived from a diverse range of starch-containing materials through production processes involving chemical, physical, and biochemical reactions (Gunawan *et al.,* 2017). With increasing demand for processed foods, the food industry has sought to expand the use of these local resources, including MD production (Laga *et al.,* 2018; Rao *et al.,* 2020). Maltodextrin offers numerous advantages in food applications, including improved consistency, viscosity, mild texture, and stability (Laga *et al.,* 2018). Encapsulation is the process of coating or embedding

active ingredients, nutrients, flavors, or other substances within a protective material to create small uniform particles or capsules (Silva *et al.,* 2014).

This technique is widely used in the food industry to enhance the stability, solubility, and bioavailability of various compounds. Owing to its unique properties, maltodextrin has emerged as a popular encapsulating agent in Indonesia, particularly in the development of innovative food products (Rao *et al.,* 2020). This review explores the current use and study of maltodextrins as an encapsulating agent or filler for treating Indonesia. Understanding these aspects is essential for industry professionals to optimize the application and quality of maltodextrin. In addition, this review examines the regulatory measures governing its use, ensuring its safe and effective incorporation into various products and formulations (Zhang and Wang, 2021). By exploring the unique characteristics of different maltodextrin variants, professionals can harness their potential across diverse industries while adhering to necessary regulations.

The methodology used in this article is a literature review. This approach involves studying various theories and concepts, identifying variables related to the context of the literature topic being examined. The literature review focuses on various encapsulation methods and the characteristics of microcapsules based on maltodextrin as a coating material, as documented in scientific journals. The search for relevant journals was conducted using search applications such as Google Scholar and Publish or Perish 8, with keywords including "maltodextrin," "maltodextrin encapsulation," "encapsulation products," and "encapsulation methods." The retrieved journals were tabulated and categorized based on the type of encapsulation method and encapsulation products.

The data tabulation includes encapsulation methods, encapsulation products, and the characteristics of the resulting encapsulations. The methods and characteristics of microcapsules from various core encapsulation materials were compared and discussed. Additionally, the challenges and prospects for developing maltodextrin encapsulation as a coating or filling material are presented in this literature review.

Production Process of Maltodextrin

Maltodextrins are typically produced by the partial hydrolysis of starch, which can be derived from a variety of sources such as corn, wheat, potato, and tapioca (Abdalla *et al.,* 2021; Laga *et al.,* 2018). Hydrolysis can be performed using enzymes, acids, or a combination of both (Marchal, 1999). The enzyme-catalysed production of maltodextrin involves the use of specific enzymes such as alpha-amylase, which cleaves the glycosidic bonds of starch molecules, resulting in the formation of shorter glucose chains with varying degrees of polymerization (DP) (Marchal, 1999). The degree of polymerization (DP) of maltodextrin is a crucial factor determining its physicochemical properties and functional characteristics (Abdalla *et al.,* 2021).

The production of maltodextrin with a specific degree of polymerization, such as maltoheptaose (DP7), has gained significant attention owing to its diverse applications in the food, cosmetic, and pharmaceutical industries (Abdalla *et al.,* 2021). Maltodextrins are a group of polysaccharides with varying molecular weights that are classified based on their average degree of polymerization (DP). Notably, the DP value may not accurately predict the performance of maltodextrins (MD) in technical applications (Saavedra-Leos *et al.,* 2015). This is because the chemical composition of MD depends on the type and conditions of hydrolysis, leading to contrasting physical properties, even among MDs with similar DP values (Chronakis, 1998). Although the degree of polymerization may be a better indicator of MD performance, the direct relationship between the DP and DE values indicates that most studies still use the DE value as a parameter to evaluate the MD molecular weight. In this study, DE was used to facilitate understanding and make it more convenient to paraphrase the results of other studies.

Maltodextrins are produced through enzymatic hydrolysis of starch, which involves several stages. First, starch is liquefied using heat, acids, or enzymes to break down large starch molecules into smaller ones (Abdalla *et al.,* 2021). The liquefied starch is then further hydrolysed using enzymes to produce maltodextrins with varying DP, ranging from 3 to 20 glucose units (Abdalla *et al.,* 2021). The maltodextrin solution was then dried to produce the final powdered product (Rao *et al.,* 2020). Characterization of the maltodextrin produced during the hydrolysis process ensures that it meets the desired specifications for its intended application.

The Chemistry of Maltodextrin

Maltodextrins are polysaccharides derived from starch and are commonly used as encapsulating agents due to

their film-forming properties and ability to protect core materials from environmental factors. However, the context provided here does not specifically address the use of maltodins as encapsulating agents in Indonesia. However, it is known that maltodextrins have been employed in various encapsulation processes, including the encapsulation of olive leaf extracts, as reported by Medfai *et al.,* (2023), where they were used in combination with other agents such as pectin and gum arabic to enhance the encapsulation efficiency and product yield. Interestingly, although the use of maltodextrins in Indonesia has not been explicitly mentioned, the global trend in encapsulation technologies, including the use of maltodextrins, is on the rise owing to their protective qualities and ability to improve the stability of encapsulated substances. Given the increasing global trend and versatility of maltodextrins for encapsulation, it is plausible that their use as encapsulating agents could be applicable in Indonesia's food and pharmaceutical industries, similar to other regions. In summary, although the specific application of maltodextrins as encapsulating agents in Indonesia is not detailed in published papers, the general properties and uses of maltodextrins in encapsulation processes are well documented. Maltodextrins, as part of a hybrid coating material, have been shown to improve the encapsulation efficiency and stability of bioactive compounds, which could be beneficial for various industries in Indonesia, mirroring global trends in encapsulation technology (Medfai *et al.,* 2023). Maltodextrins are glucose chains that are typically generated through starch hydrolysis (Abdalla *et al.,* 2021).

The degree of polymerization (DP) is a crucial parameter that reflects the average number of glucose units in each maltodextrin molecule, providing valuable insights into its molecular structure and functional properties (Abdalla *et al.,* 2021). Studies have highlighted the significant influence of the saccharide composition on the physical and biological characteristics of maltodextrins, such as hygroscopicity, fermentability, viscosity, sweetness, stability, and gelation.

DE is a measure of the amount of reducing sugars present in a sugar product and is expressed as a percentage of the total dry substance. Different DE in maltodextrin provide different behavioral characteristics in solution, such as viscosity, molecular conformation, and stability. Maltodextrins with lower DE (0.5-10) tend to have randomly coiled molecular structures, while those with higher DE (10-20) exhibit more stretched conformations (Takeiti *et al.,* 2010). Maltodextrins are glucose chains that are typically generated through starch hydrolysis (Abdalla *et al.,* 2021).

Usage of maltodextrin in Indonesia

Maltodextrin is widely used in Indonesia as an encapsulating agent and filler in powdered products, making it a valuable ingredient in the food and beverage industries. Its versatility extends beyond the food industry, with widespread applications in the pharmaceutical and healthcare sectors (Raja *et al.,* 1989). Its neutral taste, low cost, and ease of handling make it a popular excipient in various pharmaceutical formulations. It is also valued for its ability to enhance the stability and solubility of active ingredients in drug delivery systems. In the food technology additives, such as flavoring agents, natural colorants, antioxidants, preservatives, and functional ingredients, such as probiotics and anthocyanin, are crucial for food production (Wahyuni *et al.,* 2022; Novianti *et al.,* 2020; Wening *et al.,* 2022). However, many of these additives are susceptible to environmental stresses such as oxygen, enzymes, light, temperature, pH, and metal ions, which can lead to volatilization, degradation, oxidation, discoloration, or other changes that impair their function.

Furthermore, some additives may be water-insoluble, making their integration into food products challenging, whereas others may possess beneficial physiological properties but have poor flavours (Nguyen *et al.,* 2022). Maltodextrin (MD) has shown to be a highly effective encapsulating agent to tackle the limitations of food additives.

Active components such as vitamins prebiotics, omega-3 and omega-6 fatty acids, essential oils, and volatile compounds often lose stability when exposed to heat, acid, oxygen, and light, impeding their commercialization (Saloko *et al.,* 2021; Sucianti *et al.,* 2020; Wenang *et al.,* 2022). MD encapsulation enhances stability, thereby addressing this issue (Necla *et al.,* 2021). Moreover, maltodextrin improves the solubility of hydrophobic compounds, thereby allowing their incorporation into water-based food systems.

Table.1 Recent encapsulation study in Indonesia

Product	Core	Encapsulator	Methods	Reference
Flavor Powder	Lemi extract	Maltodextrin and Carragenan	Oven drying	Gonardi *et al.*, 2022
Dye Powder	Pandanus tectorius extract	Maltodextrin and Arabic Gum	Thin Layer drying	Wartini & Ganda Putra, 2018
Dye powder	Ulva lactuca extract	Maltodextrin and Gelatin	Thin Layer drying	Fridayana *et al.*, 2018
Instant Drink	Powder of Terong Cepoka	Maltodextrin	Cabinet Dryer	Sakdiyah *et al.*, 2019
Food additives	Arenga Powder Sugar	Maltodextrin and Chitosan	Cabinet Dryer	Saloko *et al.*, 2021
Food additives	Moringa leaf Extract	Maltodextrin and Whey Protein Isolate	Spray Drying	(Sadiah *et al.*, 2022)
Flavor Powder	Polygonum minus Huds Extract	Maltodextrin and Tween 80	Foam Mat Drying	(Mayasari & Manalu, 2019)
Dye Powder	Manihot esculenta Crantz leaf extract	Maltodextrin and Magnesium Carbonat	Foam Mat Drying	(Wiyono *et al.*, 2023)
Probiotic	Lactobacillus fermentum	Maltodextrins	Spray drying	(Dista *et al.*, 2022)
Hidrolisat	Snakehead Fish (Channa striata) Hydrolysate	Maltodextrins	Coacervations	(Syukri *et al.*, 2022)
Dye Powder	Super Red Dragon Fruit (Hylocereus costaricensis)	maltodexstrins	Freeze drying	(Sucianti *et al.*, 2020b)
Flavor Powder	Bumbu genep	maltodextrins and tween 80	Thin Layer drying	(Cakswindryandani *et al.*, 2023)
Flavor Powder	Extract orange peel	maltodextrins and arabic gum	Thin Layer drying	(Angelina *et al.*, 2022)
Flavor Powder	Sugar cane sap	maltodextrins	Spray Drying	(Wening *et al.*, 2022)
Probiotic	Probiotic whey	maizena starch, maltodextrins	Cabinet Dryer	(Wahyuni *et al.*, 2022)

In the cosmetics sector, maltodextrin serves as a film-forming agent, stabiliser, and thickener in various personal care products. Additionally, maltodextrin functions as a humectant, increasing the water content of the skin and hair, resulting in improved hydration and softness (Santana & Meireles, 2014).

Current Drawbacks of Maltodextrin

Although the potential of maltodextrin in Indonesia is significant, several drawbacks and issues need to be addressed to fully harness its benefits. One of the main challenges is limited domestic production capacity, which necessitates heavy reliance on imports to meet the growing demand for maltodextrin in the country. This dependency not only makes the supply chain vulnerable to global market fluctuations but also increases costs, making maltodextrin less accessible to local businesses. There is also a pressing need to increase public awareness and education regarding the benefits of maltodextrin, particularly highlighting its role as a healthier alternative to wheat flour. Many consumers and industries are not fully aware of the versatility of MD and its potential applications in the food and pharmaceutical sectors. Efforts should be made to disseminate information about its health benefits, such as its lower glycemic index compared to traditional carbohydrates, which can be beneficial for patients with diabetes and for those looking to manage their blood sugar levels. Affordability and accessibility are critical factors. Maltodextrin needs to be more affordable and accessible to a wider range of consumers, including small and medium enterprises in the food and pharmaceutical sectors. High costs can be a barrier for these smaller businesses, preventing them from adopting maltodextrin as an ingredient in their products. Encouraging the local production of maltodextrin by providing incentives and support to manufacturers can help reduce dependence on imports. Governments and stakeholders can play pivotal roles by offering tax breaks, subsidies, and technical assistance to local producers. This not only boosts domestic production but also creates jobs and stimulates economic growth. Additionally, coordinated efforts by the government and stakeholders to raise awareness of the advantages of maltodextrin are essential. Highlighting its versatility, health benefits, and potential to replace wheat flour in various applications can drive its demand and acceptance. Public campaigns, educational programs, and industry collaboration can be effective in achieving this goal. By addressing these challenges through strategic initiatives and supportive policies, Indonesia can better leverage the potential of maltodextrin, ensuring that it becomes a valuable resource for the country's food and pharmaceutical industries.

This article presents a thorough examination of the uses, advantages, and recent studies of maltodextrin in Indonesia. Maltodextrin, a versatile and valuable ingredient, has a wide array of applications in the food, pharmaceutical, and cosmetic industries in Indonesia. Its capacity to improve the stability, solubility, and performance of various additives and active ingredients makes it an indispensable component in numerous products. Nevertheless, the country confronts several obstacles, such as reliance on imports, limited public awareness, and affordability challenges. To fully exploit the potential of maltodextrin in Indonesia, a collaborative approach involving multiple stakeholders is necessary.

Author Contributions

Ardhinata Antares: Investigation, formal analysis, writing—original draft. Luh Putu Wrasiati: Validation, methodology, writing—reviewing. Ni Made Wartini:—Formal analysis, writing—review and editing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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