

PHYSIOLOGICAL FUNCTION OF ISOMALTOSE OLIGOMERIC AND ITS APPLICATION IN FEED INDUSTRY

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The present review article highlights the results of modern research on the development and use of phytogetic additives in the feeding of farm animals and poultry. Particular attention is paid to the analysis of the effectiveness of phytogetic additives as an alternative to antibiotics aimed at improving animal health, increasing their productivity and improving the quality of meat raw materials. The materials of the article serve as a basis for an analytical synthesis of modern approaches to solving the problem of reducing the use of antibiotics in livestock and poultry farming, which is important for ensuring food safety and preserving ecological balance. Today, isomaltose oligosaccharide is a promising green feed additive that can replace antibiotics due to its unique biological properties. As a feed additive, isomaltulose can promote the growth of bifidobacteria in the intestinal tract, inhibit the growth of *Escherichia coli*, which, according to our research, has a positive effect on improving the functioning of the intestine and improving its internal bacterial environment, while improving animal health. Isomaltose also helps to strengthen the immune system of animals by stimulating the growth of beneficial microflora in the intestines. It supports the health of the digestive system, reducing the risk of developing infectious diseases. In addition, this additive is environmentally friendly and does not cause antibiotic resistance, making it safe for both animals and consumers of their products. In addition, the use of isomaltose is aimed at reducing the use of chemicals in livestock farming, ensuring improved product quality and safety for the end consumer. The introduction of isomaltose into livestock production is an important step towards the sustainable development of the poultry industry. The use of isomaltose as a feed additive in poultry production meets modern environmental standards and helps to improve product quality without harming the environment. This article also focuses on the physiological function of isomaltulose, its unique properties and prospects for use in the feed industry. The article discusses its impact on metabolism, its ability to provide animals with energy for a long time, and its role in maintaining a healthy intestinal microflora. Special emphasis is placed on the possibility of using isomaltulose as an effective ingredient for the creation of high-quality and safe feed that meets modern standards in animal husbandry.

Key words: isomaltose oligomeric, physiological function, feed industry, antibiotics, feed additive.

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Isomaltooligosaccharide (IMO), also known as branched oligosaccharide, isomaltose oligosaccharide, isomaltose oligosaccharide, refers to a type of oligosaccharide with monosaccharide number ranging from 2 to 6 formed by the combination of glucose group with α -1, 6 glycosidic bond (Gormley A. et al., 2024). Its main components are isomaltose, panose, isomaltotriose and isomaltotetraose, etc. (Ya-Jun Li et al., 2009). The following figure shows the molecular structure of the main components of isomaltose.

Because of its unique physiological function, isomaltose oligosaccharide has become an important food and feed,

which can be widely used in various health and nutrition products and food industry. Isomaltose has the function of proliferating bifidobacterium and inhibiting harmful bacteria, so it has a broad prospect as a feed additive (Tathiana Souza Martins Meyer et al., 2015; Tymczynsyn E.E. et al., 2014).

Materials and Methods. The main methodological method used in writing the article was the research of modern domestic and foreign scientists who are actively involved in studying alternative ways of using antibiotics in feeding farm animals and popularizing the use of plant feed additives.

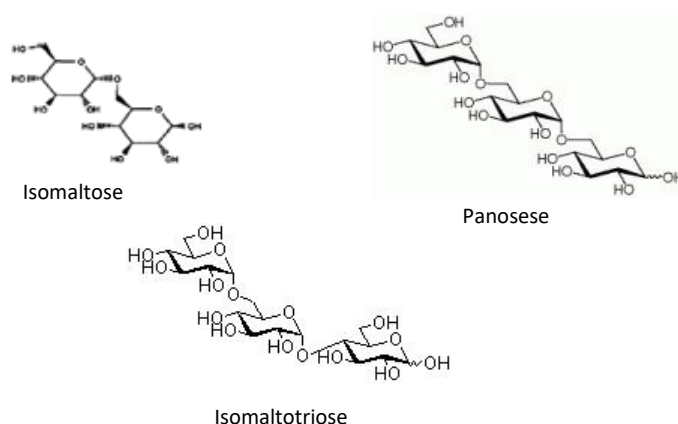


Fig. 1. Molecular structure of the main components of isomaltose

During the study, classical methods were used, such as generalization of results, analysis, comparison, abstract-logical approach, economic-statistical analysis of results.

Results

1. Physicochemical properties and physiological functions of isomaltose oligomeric

1.1 Physical and chemical properties

Isomaltose is a non-digestible oligosaccharide, an indigestion food component, which can selectively promote the growth and reproduction of one or several kinds of bacteria in the colon (Xu, T. et al., 2022). There are two forms of isomaltose, one is syrup, colorless or light yellow transparent viscous liquid, the other is powdered sugar, an amorphous powder. The water activity of isomaltose is lower than that of sucrose and high maltose syrup, and bacteria cannot grow in the environment with low water activity, which indicates that isomaltose can better prevent the propagation of various microorganisms (XIAO J. et al., 2022). Its sweetness is 45%~50% of sucrose, which can be used to replace part of sucrose and reduce the sweetness of food. At the same time, it has the characteristics of low viscosity and is easy to operate in food and feed. Isomaltose has good stability and moisture retention, but it is not easy to ferment and can exert its own function and effect for a long time (Teruo Nakakuki, 2022; DING Bole, et al., 2020).

1.2 Physiological Functions

1.2.1 Promote significant proliferation of bifidobacterium

Isomaltose is the proliferation factor of bifidobacterium, a beneficial bacteria in the intestine, which can promote the multiplication of bifidobacterium in the intestine, thereby inhibiting the growth of a variety of pathogenic bacteria and reducing the generation of corrupting substances and toxins in the intestine (Xiaochun Yang, et al., 2023; Mazur-Kuśnerek M, et al., 2023). Bifidobacterium can also maintain the balance of intestinal flora, synthesize essential nutrients such as B vitamins and proteins, and promote the reasonable absorption of a variety of minerals and vitamins. It can improve the body immunity and prevent cancer and other diseases (Thitaram SN, et al., 2005).

1.2.2 Regulate intestinal flora and maintain intestinal health

Since isomaltose monosaccharide molecules bind to each other by α -1, 6-glycosidic bonds, whereas carbohydrate hydrolases secreted from the digestive tract of animals can only hydrolyze α -1, 4-glycosidic bonds, isomaltose enters the posterior gut in an undegraded form and is used by microorganisms in it. However, different strains have different utilization of isomaltose. Beneficial bacteria, especially bifidobacterium, can proliferate with isomaltose as nutrient matrix, while harmful bacteria such as *Escherichia coli* and *Salmonella* cannot. In addition, bifidobacterium and other bacteria produce lactic acid and other acidic substances after using isomalt oligosaccharides, which decreases the intestinal PH value and inhibits the growth and reproduction of harmful bacteria such as *Escherichia coli*, thus enabling the formation of healthy bacterial lines in the intestinal tract of animals (Sandeep Kumar, et al., 2023).

1.2.3 Combined with adsorption of intestinal pathogens to reduce the occurrence of diseases

Studies in recent decades have shown that the binding of bacterial cell wall surface proteins to sugar residues of glycolipids or glycoproteins on the surface of intestinal mucosal epithelial cells promotes bacterial colonization and propagation on the intestinal wall, leading to disease. When a certain amount of isomaltose is present in the intestine, it will bind to bacteria, thereby reducing the opportunity for bacteria to bind to intestinal mucosal epithelial cells and hindering the growth and reproduction of bacteria in the intestinal wall. Sometimes, isomaltose can even replace the glycosylated part of intestinal mucosal epithelial cells that have been bound to bacteria and play the role of replacing intestinal pathogens (Mizubuchi H, et al., 2005; Zhang WF et al., 2003).

1.2.4 Promote the synthesis and absorption of nutrients

Isomaltose can promote the synthesis and absorption of nutrients, which is mainly achieved by promoting the proliferation of bifidobacterium. A large number of experiments have proved that bifidobacterium can promote the synthesis of amino acids, VB1, VB2, VB6, VK, niacin and folic acid, and promote the absorption of amino acids, Ca²⁺, Mg²⁺, Fe²⁺ and other nutrients. Therefore, this effect can also be achieved when animals eat isomaltose (Innamma N, et al., 2023).

1.2.5 Improve immune function

Isomaltose can improve the immune system in three ways. The first is promote the proliferation of beneficial bacteria in the intestine, especially bifidobacterium, and maintain the balance of intestinal flora. Isomaltose oligomeric can promote the proliferation of bifidobacterium in the intestinal tract and improve the immunity and health level of animals. A large number of animal experiments have shown that the intake of bifidobacterium live or dead bacteria can improve the body's antibody level and activate the phagocytosis activity of macrophages, which plays an important role in improving the body's anti-infection ability and preventing, inhibiting and killing the production of tumor cells (Hayakawa T., et al., 2016). Secondly, it has the characteristics of an immune adjuvant and antigen. Isomaltooligosaccharides can bind to certain toxins and viruses, and act as adjuvants of these antigens, which can slow down the absorption of antigens and increase the titer of antigens. In addition, isomaltooligosaccharides also have antigenic effects and can induce direct antibody responses (X. Wang, et al., 2016). And third way it's activate the body's humoral and cellular immunity. Some researchers have reported that isomaltooligosaccharides can increase the concentration of immunoglobulin and the number of B lymphocytes in intestinal and serum of animals, increase the release of cytokines, increase the concentration of interleukin, and enhance the activity of interferon, thus improving the humoral and cellular immune functions of animals (Fawen Dai, et al., 2024).

2. Application of isomaltose in feed industry

Isomaltose as feed additive is superior to antibiotics and probiotics. Antibiotics kill good bacteria as well as bad ones, in addition, its long-term use of bacteria to drug

resistance and drug residues and the impact on the quality of animal products is also a serious problem. Probiotics are bioactive preparations made from living microorganisms, derived from cultures of commensal microorganisms of animal organisms or their fermented products. As a feed additive, it is easily affected by environmental conditions (temperature, moisture, pH, etc.), and its live bacteria preparation is easily inactivated during production and transportation. In the process of feed processing (such as high-temperature pelleting) and through the action of animal stomach acid, most of the live bacteria are killed (Wang XX, et al., 2016), and live bacteria preparation has a specific microecological environment. The eugenic effect of probiotics in the digestive tract of animals makes viable bacterial preparations unable to effectively colonize the posterior segment of the intestine, which seriously affects the use effect of probiotics (Ma Y., et al., 2021). Because of its non-digestibility, isomaltooligosaccharide can only be selected for absorption by beneficial bacteria and promote their proliferation. At the same time, its

characteristics of good compatibility, stability and meeting the requirements of processing technology have attracted increasing attention as feed additives (H. REHMAN, et al., 2009).

Conclusions. Isomaltose is a kind of functional oligosaccharide with the largest demand in the world. Over the years, the research on its functional characteristics and production methods has been carried out in depth. But there are also some problems, such as isomaltooligosaccharide regulating animal is unclear, the mechanism of lipid metabolism in the industrialized production of alpha turned glucose glycosides enzyme conversion rate can reach 40% ~ 50%, and the use of immobilized enzyme in the production or immobilized cells to achieve continuous production of enterprise is not much, separation and purification technology remains to be optimized. Therefore, there will be more research and breakthroughs on improving the conversion rate of enzyme, optimizing the separation and purification technology, and how to achieve continuous large-scale production and reduce the production cost.

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Фізіологічна функція олігомерної ізомальтози та її застосування в кормовій промисловості

У представлений оглядовій статті висвітлено результати сучасних досліджень, присвячених розробці та застосуванню фітогенних добавок у годівлі сільськогосподарських тварин та птиці. Особливу увагу приділено аналізу ефективності фітогенних добавок як альтернативи антибіотикам, спрямованим на зміцнення здоров'я тварин, підвищення їх продуктивності та поліпшення якості м'ясної сировини. Матеріали статті слугують основою для аналітичного узагальнення сучасних підходів до вирішення проблеми зменшення використання антибіотиків у тваринництві та птахівництві, що має важливе значення для забезпечення безпеки харчових продуктів і збереження екологічної рівноваги. На сьогодні олігосахарид ізомальтози є перспективною зеленою кормовою добавкою, здатною замінити антибіотики завдяки своїм унікальним біологічним властивостям. Ізомальтулоза як кормова добавка може сприяти зростанню біфідобактерій у кишковому тракті, пригнічувати розмноження «*Escherichia coli*», що, згідно з нашими дослідженнями, позитивно впливає на покращення роботи кишківника та поліпшує його внутрішнє бактеріальне середовище, при цьому відзначається зміцнення здоров'я тварин. Також, ізомальтоза сприяє зміцненню імунної системи тварин, стимулюючи ріст корисної мікрофлори в кишківнику. Вона підтримує здоров'я травної системи, знижуючи ризик розвитку інфекційних захворювань. Крім того, ця добавка є екологічно чистою та не спричиняє формування резистентності до антибіотиків, що робить її безпечною як для тварин, так і для споживачів їхньої продукції. Крім того, використання ізомальтози спрямованим на зменшення використання хімічних препаратів у тваринництві, забезпечуючи підвищення якості продукції та безпеку для кінцевого споживача. Впровадження ізомальтози у тваринництво є важливим кроком до сталого розвитку галузі птахівництва. Застосування ізомальтози як кормової добавки при вирощуванні птиці відповідає сучасним екологічним стандартам та сприяє підвищенню якості продукції без шкоди для навколишнього середовища. Також у даній статті основну увагу приділено фізіологічній функції ізомальтулози, її унікальним властивостям та перспективам використання в комбікормовій промисловості. Розглядаються її вплив на обмін речовин, здатність забезпечувати тварин енергією протягом тривалого часу, а також роль у підтриманні здорової мікрофлори кишківника. Окремо акцентується на можливості використання ізомальтулози як ефективною складовою для створення високоякісних і безпечних кормів, що відповідають сучасним стандартам у тваринництві.

Ключові слова: олігомер ізомальтози, фізіологічна функція, комбікормова промисловість, антибіотики, кормові добавки.