

Egg Yolk Immunoglobulins Used as Additives in Meat Quality

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Abstract

The quality of food and feed is more and more in the first place of research, being tightly related to the health state of humans and animals. Due to these features, antibiotics used in animals are no longer agreed to be used, and natural supplements are encouraged to be used to increase the meat's nutritional quality. One of the natural immunoglobulins used as a replacement for antibiotics is egg yolk immunoglobulin Y (IgY), which is added in diet supplementation for feeding animals. The combination of probiotics and other substances with an immunological role, especially some natural immunoglobulins - such as IgY, has multiple advantages. Thus, it can be increased meat production, improve the immunological status of animals which decreases the stress effects, improve infection resistance, increase the quality of carcasses - which implicitly also leads to economic growth, and also obtaining animal products without the addition of antibiotics or growth stimulants, or even obtaining organic products. There are several cost-effective methods to extract natural immunoglobulin IgY from egg yolk: using dextran blue, polyethylene glycol, chloroform, and cryo-ethanol treatment followed by precipitation with ammonium sulfate. In this paper, we will present some features regarding the methods of extracting IgY immunoglobulins from the egg yolk, the way of using these immunoglobulins in animal breeding and improvement technologies, as well as the biotechnological advantages that derive from the use of this natural product.

Keywords: Egg yolk immunoglobulins, meet quality

1. Introduction

Egg yolk immunoglobulins, also known as immunoglobulins Y (IgY), are antibodies found in the yolks of chicken eggs. These antibodies play a crucial role in providing passive immunity to young birds before their own immune systems fully develop. IgY can be extracted from egg yolks and utilized for various applications, primarily in the fields of health and research [1]. They have been investigated for their potential therapeutic applications due to their ability to target specific pathogens and antigens.

While IgY-based products have been explored in human and veterinary medicine, their application as additives in meat quality enhancement is not a conventional or well-documented practice up to 2021. The food industry typically focuses on more established methods and additives for improving meat quality, such as flavour enhancers, preservatives, and texture modifiers.

In last recent years, the researches focus on food and feed quality has intensified due to its profound impact on both human and animal health [2]. Thus, over-utilization of antibiotics in animal production has become under scrutiny due to concerns about antimicrobial resistance and potential effects on consumers [3]. As a result, there is a growing interest in exploring natural alternatives to antibiotics that can enhance meat

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quality while maintaining animal optimal health. One of such promising good option is egg yolk immunoglobulin Y (IgY), which offers for now a safe and effective solution for improving both animal health and meat nutritional quality.

1.1. Antibiotics in animal production and the need for alternatives:

The use of antibiotics in animal production has historically been common to promote growth and prevent diseases. However, the emergence of antimicrobial resistance has raised significant concerns about its impact on human health. Regulatory authorities worldwide are imposing stricter regulations on antibiotic use in animals, prompting the search for alternative solutions [3, 4].

1.2. Egg yolk immunoglobulin Y (IgY) related with animals:

IgY is an antibody found in the yolks of chicken eggs. It serves as a primary source of passive immunity for young birds, protecting them from pathogens until their own immune systems mature. IgY has gained attention for its potential therapeutic applications, including its use in animal feed to enhance meat quality [5].

1.3. Mechanism of action and benefits of IgY in animal feed:

Pathogen Inhibition: IgY antibodies can specifically target pathogens, including bacteria, viruses, and parasites. This can help reduce the prevalence of diseases in animals, leading to improved overall health.

Immune System Support: IgY can modulate the immune response, promoting a balanced immune system and reducing the need for antibiotics to manage infections.

Nutrient Absorption: IgY has been suggested to enhance nutrient absorption and utilization, potentially leading to improved growth rates and meat quality [6, 7].

1.4. Replacement of antibiotics with IgY in animal diets:

By incorporating IgY into animal diets, there is a possibility to reduce or eliminate the need for antibiotics, contributing to the reduction of antimicrobial resistance [3, 6, 8].

1.5. Safety and Sustainability: IgY is a natural component of egg yolks and is considered safe for consumption, both for humans and animals. Its use aligns with the trend toward more sustainable and also environmentally friendly animal production practices.

1.6. Impact on meat quality and nutritional value:

Improved Growth Performance: Studies have suggested that IgY supplementation in animal diets can enhance growth rates, leading to larger and healthier animals for meat production.

Enhanced Meat Quality: IgY's potential role in promoting nutrient absorption and immune health may result in meat with better texture, flavor, and nutritional composition.

Nutrient Enrichment: IgY can potentially enrich meat with bioactive compounds that offer health benefits to consumers [7].

1.7. Current Research and Future Directions:

Determining the optimal dosage of IgY for different animal species and production systems is crucial for achieving desired results.

Developing standardized protocols for IgY extraction, purification, and supplementation is important to ensure consistency and efficacy.

Communicating the benefits of IgY-enriched meat to consumers and addressing any potential concerns is essential for market acceptance.

Ongoing research is focusing on exploring various forms of IgY supplementation (raw, processed, encapsulated) to maximize its impact on animal health and meat quality [6, 8].

Investigating the underlying mechanisms through which IgY influences growth, immunity, and meat quality [9]. Exploring the potential transfer of IgY's benefits to human consumers through meat consumption.

2. Enhancing meat production and quality through synergistic effects of probiotics, immunoglobulins, and immunological substances

The global demand for high-quality and sustainable animal products has prompted the exploration of innovative strategies to improve animal health, production efficiency, and meat quality. To meet these challenges while also addressing concerns about antibiotic use and animal welfare, a novel approach has emerged. Among these strategies, the combination of probiotics,

immunoglobulins, and other immunological substances, such as IgY, holds great promise [9]. Our present review research explores how the synergistic effects of probiotics, immunoglobulins, and other immunological substances, together, are revolutionizing the meat production industry by boosting animal health, reducing the need for antibiotics, and improving the quality of meat products [7, 10]. This presentation aims to highlight the multiple advantages of this approach, including increased meat production, improved animal health, reduced stress effects, enhanced infection resistance, economic growth, and the production of antibiotic-free or organic animal products.

2.1. The role of probiotics and immunological substances:

Probiotics: Probiotics are live microorganisms that confer health benefits when administered in adequate amounts. They improve gut health, nutrient absorption, and immune response by modulating the gut microbiota.

Immunological Substances: Natural immunoglobulins, like IgY, are antibodies that offer passive immunity and immune regulation. They can target pathogens, enhance immune function, and support overall health [2].

2.2. Synergistic benefits of combining probiotics and immunological substances:

Enhanced Gut Health: Probiotics optimize gut microbiota composition, while immunological substances reinforce the immune response. This synergistic effect promotes gut integrity and nutrient utilization.

Stress Reduction: The combination reduces stress-related effects on animals' digestive systems and immune function, resulting in better overall health and welfare.

Improved Disease Resistance: Probiotics and immunoglobulins work together to enhance the body's defence mechanisms, making animals more resistant to infections and diseases [2-5].

2.3. Meat production enhancement and quality improvement:

Increased Growth Rates: The improved gut health and nutrient absorption achieved by this combination can lead to enhanced growth rates and larger animals, contributing to increased meat production.

Carcass Quality: Animals with optimized immune systems and gut health often exhibit better carcass

quality, including improved meat texture, flavour, and nutritional composition [10].

Economic Growth: Enhanced growth rates and better carcass quality directly translate into economic growth for producers.

2.4. Reduction of antibiotic use and growth stimulants:

Antibiotic-Free Production: By bolstering animals' immune systems and overall health, the combination reduces the need for antibiotics, leading to antibiotic-free meat production [11].

Sustainable Practices: A decreased reliance on antibiotics aligns with sustainable animal production practices and contributes to reducing antibiotic resistance [12].

2.5. Organic and premium product potential:

Organic Certification: The use of probiotics and immunological substances can contribute to organic certification criteria by promoting natural health and minimizing synthetic interventions.

Premium Products: Meat products produced through this approach can be marketed as premium, health-conscious options, appealing to consumers seeking high-quality, sustainable choices.

2.6. Research and Practical Implementation:

Optimal Formulations: Research is ongoing to determine the best combination of probiotics, immunoglobulins, and other immunological substances for different animal species and production systems [1].

Dosage and Application: Defining optimal dosages and application methods ensures consistent results in terms of growth, health, and meat quality improvements.

2.7. Challenges and Considerations:

Animals' responses to probiotics and immunological substances can vary, necessitating tailored approaches for different contexts.

The use of novel substances in animal feed might require regulatory approval, especially in regions with strict guidelines.

Continued research may lead to the development of functional feed additives that combine probiotics, immunoglobulins, and other bioactive compounds for synergistic effects. Effective communication is essential to educate consumers about the benefits of this approach, enhancing acceptance and demand [13].

3. Cost-Effective methods for extracting natural immunoglobulin IgY from egg yolk: techniques and applications

Natural immunoglobulin IgY, found in egg yolk, has garnered attention for its potential applications in various industries, including

medicine, food, and agriculture. Extracting IgY from egg yolk is a critical step in harnessing its therapeutic and functional properties (figure 1). There are discussed and studied different methods that have made it possible to harness the potential of IgY efficiently and economically [1].

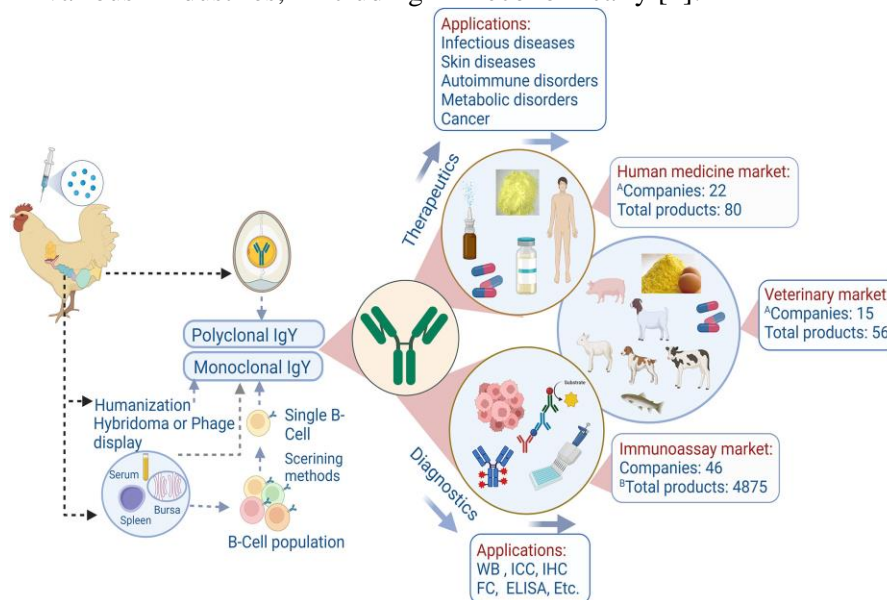


Figure 1. IgY technology [1]

This presentation will delve into several cost-effective methods for extracting IgY, including the use of dextran blue, polyethylene glycol (PEG), chloroform, and cryo-ethanol treatment followed by ammonium sulfate precipitation. These techniques offer efficient and scalable ways to obtain IgY for diverse applications [14, 15].

3.1. The Significance of IgY Extraction:

IgY, an avian counterpart to mammalian immunoglobulins, is a rich source of antibodies that can target specific antigens. Its potential applications range from immunotherapy to enhancing food and feed quality. Efficient extraction methods are crucial to obtain sufficient quantities of high-quality IgY [13, 16, 17]

3.2. Dextran Blue Method:

The extraction of immunoglobulin Y (IgY) from egg yolk is a crucial step in utilizing this valuable resource for various applications. Among the methods available, the dextran blue method offers an innovative and efficient approach. The dextran blue method involves exploiting the affinity of IgY

to dextran blue to separate it from other egg yolk components. The process typically includes selective precipitation and chromatography steps. This technique offers simplicity, efficiency, and moderate yields of IgY [15].

3.3. Polyethylene Glycol (PEG) Method:

PEG precipitation involves using PEG to create an aqueous two-phase system that separates IgY from egg yolk proteins. After phase separation, IgY is collected from the upper phase. This technique is straightforward, cost-effective, and yields relatively pure IgY [15, 18, 19].

3.4. Chloroform Method:

The extraction of natural immunoglobulin Y from egg yolk is a crucial step in harnessing its valuable applications in diagnostics, therapeutics, and food technology. Among the various extraction methods, the chloroform method offers a straightforward and efficient approach. Chloroform extraction involves the addition of chloroform to egg yolk to disrupt lipids and protein complexes. This process results in phase separation, with the lower phase containing lipids and the upper phase containing

IgY. This chloroform method is simple and suitable for large-scale extraction of IgY immunoglobulins [17].

3.5. Cryo-Ethanol Treatment Followed by Ammonium Sulfate Precipitation:

This method combines cryo-ethanol treatment to precipitate lipids and proteins with ammonium sulfate precipitation to isolate IgY (figure 2).

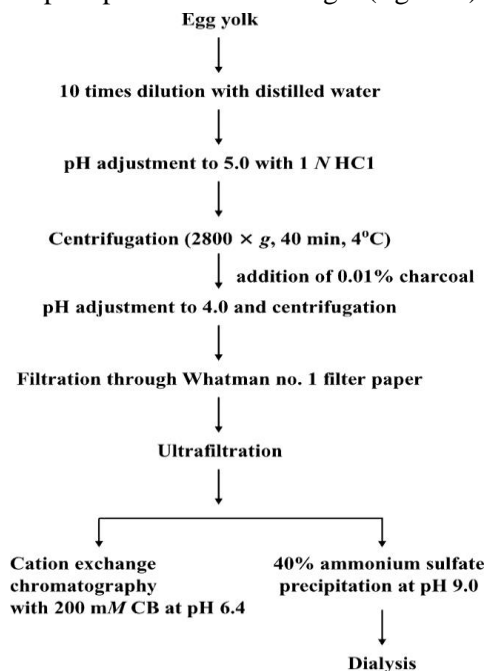


Figure 2. Stages in sulfate precipitation extraction of IgY

The cryo-ethanol step improves IgY purity by removing lipids, while ammonium sulfate precipitation concentrates IgY. This technique offers high yields and purity levels [16, 17, 19].

3.6. Applications of Extracted IgY:

Immunoglobulin Y (IgY) extracted from egg yolk has emerged as a valuable resource with diverse applications across various industries. This presentation explores the wide-ranging applications of extracted IgY, highlighting its significance in diagnostics, therapeutics, food safety, and animal health [20].

Biomedical Research: IgY has been explored for its potential in diagnostics, drug development, and immunotherapy due to its specificity and reduced cross-reactivity with mammalian antibodies. The IgY is used also in diagnostic applications, like: Enzyme-Linked Immunosorbent Assays (ELISAs), where IgY is utilized as a primary antibody in

ELISAs for detecting various antigens, including pathogens and biomarkers; Point-of-Care Tests, which is a rapid diagnostic tests based on IgY antibodies enable quick and cost-effective disease detection.

IgY-based assays are employed in clinical laboratories to identify infectious diseases, cancer markers, and autoimmune conditions.

Also, IgY immunoglobulins are used in different therapeutic applications: IgY-based immunotherapies have been developed for treating bacterial and viral infections. These therapies offer a safer alternative to traditional antibiotics. IgY can be administered passively to provide immediate immunity to specific diseases, making it valuable in emergency situations. Research is ongoing to explore the potential of IgY in cancer immunotherapy.

Food and Feed Industry: IgY can enhance food safety by targeting pathogens in food and feed products, thereby reducing the need for chemical additives or antibiotics.

IgY can be used in animal feed to improve health, growth rates, and disease resistance. IgY antibodies target foodborne pathogens like Salmonella, E. coli, and Campylobacter, reducing the risk of foodborne illnesses. Also, IgY-based coatings on food packaging materials inhibit microbial growth and extend the shelf life of perishable products. IgY can neutralize foodborne toxins, enhancing food safety.

In animal feed additives, IgY is added to animal feed to enhance health, growth, and disease resistance in livestock and poultry. IgY-based assays assist in diagnosing animal diseases, including those affecting pets and livestock.

In aquaculture, IgY is used to improve the health and growth of fish and aquatic organisms.

Research and Development: IgY serves as an alternative to mammalian antibodies in research applications, being used to generate antibodies against specific antigens for vaccine production. Researches demonstrated that IgY is valuable in elucidating how pathogens interact with the host immune system. Ensuring the purity and specificity of extracted IgY is critical for its effectiveness in applications. Compliance with local regulations and standards is essential, especially in medical and food-related applications. Methods for IgY production must be scalable to meet industrial demands. Enhanced

biosecurity measures in food production using IgY-based technologies. Exploring IgY extraction from other avian species or genetically engineered birds for higher IgY production [20].

3.7. Challenges and future Developments

Extraction methods must balance high yields with IgY purity, as impurities can affect its applications. Scaling up extraction methods to industrial levels requires optimization and cost-effectiveness analysis. IgY's ability to target specific antigens can be an advantage or limitation, depending on the application. Developing automated and optimized extraction processes can enhance efficiency and reproducibility.

Exploring IgY extraction from other avian species or engineering hens for higher IgY production could yield novel sources. The quest for high-quality and sustainable meat production has led to innovative approaches in the agricultural industry.

One such approach is the utilization of egg yolk immunoglobulins (IgY), as additives in animal feeding diet. This review research presentation explores the very good potential of egg yolk immunoglobulins to enhance meat quality while addressing concerns about antibiotics and animal welfare, and also the questions about how healthy is animal food for human consumption!

4. Conclusions

Egg yolk immunoglobulin Y (IgY) presents a promising natural alternative to antibiotics in animal feed, addressing the concerns surrounding antibiotic use and promoting both animal health and meat quality. As research continues to uncover the potential benefits of IgY supplementation, its incorporation into animal diets has the potential to revolutionize the animal production industry by offering a safer and more sustainable approach to enhancing meat quality and nutritional value.

The synergistic combination of probiotics, immunoglobulins, and other immunological substances, like IgY, offers a multifaceted approach to enhance meat production, animal health, and product quality. This innovative strategy contributes to sustainable and ethical animal production by reducing antibiotic use, supporting organic practices, and meeting the demands of

health-conscious consumers. As research continues, the potential to revolutionize animal agriculture while simultaneously satisfying economic, environmental, and ethical considerations becomes increasingly promising.

Cost-effective methods for extracting IgY from egg yolk hold immense potential for applications in diverse fields. Techniques such as dextran blue, PEG, chloroform, and cryo-ethanol treatment followed by ammonium sulfate precipitation offer efficient ways to obtain IgY with varying yields and purity levels. As research continues, the broad utility of IgY extraction methods will likely expand, fostering advancements in medicine, food safety, animal health, and beyond.

Extracted IgY, with its versatility and wide-ranging applications, continues to play a pivotal role in improving diagnostics, therapeutics, food safety, and animal health. As research and technology advance, the potential for IgY to address existing challenges and open up new possibilities in various industries remains promising, ultimately benefiting human and animal health, as well as food safety and preservation.

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