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Exploration of *Saccharomyces cerevisiae* as a Feed Additive in Poultry

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ABSTRACT

This review aimed to explore the role of *Saccharomyces cerevisiae* (*S. cerevisiae)* as a probiotic in poultry nutrition, with a focus on its effects on growth performance, gut health, immunity, and production parameters. The increasing demand for poultry products necessitates the development of sustainable strategies to increase productivity while maintaining animal health and ensuring food safety. The ban on antibiotic growth promoters (AGPs) due to concerns over antimicrobial resistance (AMR) has led to a search for viable alternatives, with probiotics emerging as promising candidates. Among these strains, *Saccharomyces cerevisiae* has gained attention for its multifaceted benefits in poultry nutrition. This study explored the role of *S. cerevisiae* as a probiotic, focusing on its effects on growth performance, gut health, immunity, and production parameters. Extensive research has shown that *S. cerevisiae* improves nutrient digestibility, enhances the gut microbiota balance, strengthens immune responses, and mitigates the effects of environmental stressors. In laying hens, *S. cerevisiae* supplementation has been associated with improved egg production and quality by optimizing nutrient absorption and calcium metabolism. However, inconsistencies in research findings, which are influenced by environmental conditions and supplementation protocols, necessitate further investigation. This review synthesizes current evidence on the application of *S. cerevisiae* in poultry diets, highlighting its potential as a sustainable alternative to antibiotics and providing insights into optimizing its use in antibiotic-free poultry farming.

Keywords: Egg production, feed additive, *Saccharomyces cerevisiae*, Poultry

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INTRODUCTION

The rising global demand for poultry products has placed immense pressure on the industry to optimise productivity while ensuring food safety and sustainability. Traditionally, antibiotic growth promoters (AGPs) play a pivotal role in enhancing poultry performance. However, the widespread use of AGPs has contributed to the development of antimicrobial resistance (AMR), which poses a significant threat to public health (World Health Organisation, 2018). As a result, most countries have enacted stringent regulations banning AGPs in animal feed. This shift has created challenges in poultry farming, including reduced growth performance, increased disease susceptibility, and compromised feed efficiency. These issues have intensified the search for effective alternatives to AGPs, with probiotics emerging as a promising solution.

Probiotics, defined as live microorganisms that confer health benefits to the host when administered in adequate amounts, have gained considerable attention in poultry nutrition. Various probiotics, including lactic acid bacteria, *Bacillus* species and yeasts, have been studied for their ability to enhance gut health, improve immunity, and increase growth performance (Sapsuha et al., 2021; Ahiwe et al., 2021; Susalam et al., 2024; Kumalasari et al., 2025; Du et al., 2025). Among these strains, *Saccharomyces cerevisiae* has garnered particular interest because of its multifaceted benefits for poultry. As a yeast species,

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S. cerevisiae not only acts as a probiotic but also provides prebiotic components such as mannan-oligosaccharides and β-glucans, which further increase the gut microbiota balance and immune modulation (Abd El-Hack et al., 2020; Bagaskara et al., 2025).

Extensive research highlights the positive impacts of *S. cerevisiae* on poultry performance, including improved nutrient digestibility, enhanced gut integrity, and increased resistance to stressors such as pathogens and environmental challenges (Elghandour et al., 2020). Moreover, *S. cerevisiae* has demonstrated potential in layers, improving egg production and quality through its role in nutrient absorption and calcium metabolism (Attia et al., 2020; Liu et al., 2021; Wang et al., 2021). Despite these benefits, some studies have reported inconsistent results, which are often influenced by environmental conditions, management practices, and variations in supplementation protocols (Ugwuoke et al., 2021; Sedghi et al., 2022). This paper explores the role of *Saccharomyces cerevisiae* as a probiotic in poultry nutrition, focusing on its effects on growth performance, gut health, immunity, and production parameters. By addressing current research findings and variability in outcomes, this discussion aims to provide insights into optimising *S. cerevisiae* application to meet the challenges of antibiotic-free poultry farming.

In the context of antibiotic-free poultry production, this review *highlights the* multifaceted role of *S. cerevisiae* not only as a live probiotic but also as a source of yeast-derived prebiotics and fermentation hydrolysate. For example, *S. cerevisiae* hydrolysate is produced by the enzymatic processing of yeast cells. Generally, they contain abundant nucleotides, amino acids, yeast cell wall polysaccharides (mannan and β-glucans), and B vitamins (Takalloo et al., 2020). These components serve as prebiotics and immunomodulators in the gut. Similarly, dietary supplementation with *S. cerevisiae* cells has been shown to increase performance, enhance feed digestibility, improve feed efficiency (FCR), and reduce pathogenic bacteria (Armando et al., 2011; Elghandour et al., 2020). Unlike earlier reviews that treated yeast supplementation narrowly (often focusing on probiotics alone), our article unites evidence on live yeast, the yeast cell wall (YCW) fraction, and yeast hydrolysate (YH). This integrated perspective provides a comprehensive strategy for leveraging all forms of *S. cerevisiae* to optimise the health, immunity, and productivity of animals in modern antibiotic-free poultry systems. This review provides a unique perspective by integrating evidence on the use of *Saccharomyces cerevisiae* in poultry not only as a live yeast probiotic but also through its derivatives, such as yeast cell wall fractions and yeast hydrolysates. Unlike previous reviews that mainly addressed one form of yeast supplementation, our article synthesises findings across all three forms to highlight their complementary roles in enhancing growth performance, gut health, immune modulation, and production efficiency. By combining these strands of evidence within the context of antibiotic-free poultry production, this work offers a comprehensive framework that is new to the literature and provides practical insights for optimising the application of *S. cerevisiae* in modern poultry systems.

MATERIALS & METHODS

Experimental Design

Searching, Evaluating and Selecting Articles

The processes of identification, screening, eligibility assessment, and inclusion were conducted in accordance with the PRISMA-P guidelines (Fig. 1), as previously applied in studies by Adli et al. (2024). A comprehensive search was performed across two electronic databases, PubMed (n = 50) and Scopus (n = 44), yielding a total of 94 records. The PubMed search retrieved 49 original research articles and one review article, whereas the Scopus search identified 43 original research articles and one review article.

During the initial screening of titles, abstracts, and keywords, 44 records from Scopus were excluded because they were duplicates of those already identified in PubMed. A further 18 records from PubMed were excluded because they did not meet the predefined eligibility criteria. These included one review article, four studies in swine, two in sheep, five in laying hens, two in turkeys, one in rabbits, two that did not specify the use of *Saccharomyces cerevisiae*, and one that did not report the relevant parameters.

The remaining records underwent full-text assessment against the inclusion criteria, which required the presence of treatment and control groups, the reporting of relevant and continuous parameters, and the use of randomisation. Following this rigorous process, a total of 42 studies were deemed eligible and included for data extraction and subsequent analysis.

The relevant search terms were developed based on the PICO framework, following the approach used in earlier studies by Adli et al. (2024), as shown in Table 1. The intervention element was represented by keywords such as "*Saccharomyces cerevisiae*", "live yeast", "yeast culture", "yeast cell walls", "mannan-oligosaccharide*", "MOS", "β-glucan*", "yeast hydrolysate*") Moreover, the population/outcomes (e.g., "poultry", "chicken*", "broiler*", "layer*", "performance", "feed conversion", "intestinal", "microbiota", "immun*", "pathogen*"), while the population was specified via the term "broiler chicken". Articles were selected based on the presence of comparative data between the control and treatment groups.

These keywords were selected based on the core components of the PICO framework, which served as a guiding model for formulating the research question. In this study, the population was broiler chickens, the intervention was dietary supplementation with *Saccharomyces cerevisiae* at varying concentrations, the comparison referred to the control or untreated groups, and the outcomes included growth performance, feed efficiency, immune responses, and other physiological indicators.

Article Extraction

The initial search resulted in a total of 150 potentially relevant articles. These articles were imported into Mendeley (version 1.19.8) for reference management and deduplication. After removing duplicates and clearly irrelevant entries, a structured screening process was undertaken to determine article eligibility. This involved a stepwise application of the following inclusion criteria:

Following the initial retrieval of articles, a rigorous selection process was conducted to ensure that only high-quality and relevant studies were included in the review. Each article underwent a detailed screening based on a set of predefined eligibility criteria designed to ensure consistency, scientific validity, and relevance to the research question.

First, only articles written in English were considered, as this ensured consistency in interpretation and avoided issues related to translation ambiguity. Moreover, only studies published in full-text format were included, thereby excluding conference abstracts or summary-only publications, which often lack sufficient methodological and statistical detail. The focus was explicitly restricted to studies published in peer-reviewed journals to ensure that the included works had undergone scholarly evaluation and met acceptable scientific standards. Central to the inclusion process was the need to investigate the effects of dietary supplementation with *Saccharomyces cerevisiae* in broiler chickens. Studies that used other poultry species or did not report the use of *Saccharomyces cerevisiae* were excluded from the analysis. Each selected article needed to clearly specify the source or form of the *Saccharomyces cerevisiae* used, as variations in different structures could significantly influence biological outcomes. To ensure transparency and reproducibility, the number of experimental replicates for each treatment group was reported. Additionally, articles need to state the total number of broiler chickens used, as this information is essential for understanding the statistical power and generalizability of the results. The age of the birds at the start of the trial also had to be clearly specified, as physiological responses to dietary interventions may vary depending on the birds' developmental stage.

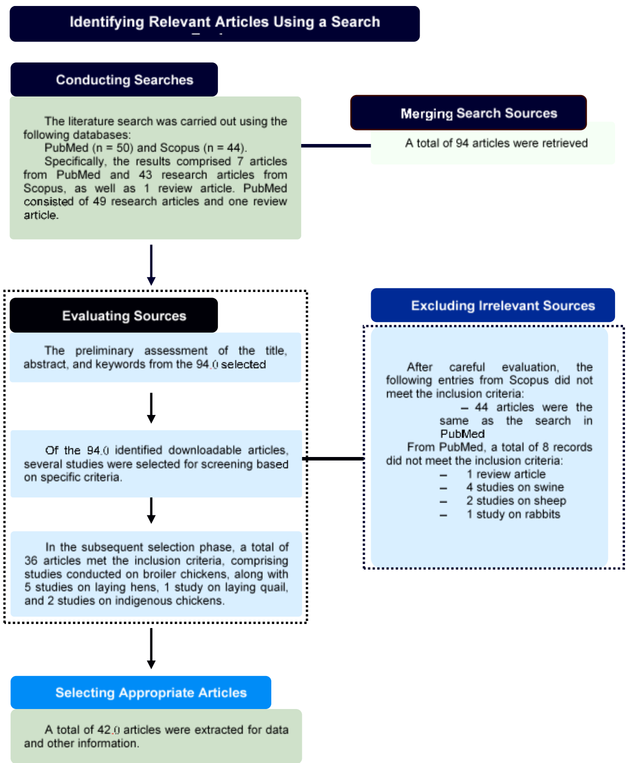

Fig. 1: PRISMA Flow Diagram of the Study Selection Process for the review.

Saccharomyces cerevisiae as a Probiotic in Poultry

For decades, antibiotics have been used to increase poultry productivity. Antibiotic growth promoters (AGPs), which are synthesised by microorganisms, also contribute to bacterial resistance in humans (WHO, 2018). However, following the prohibition of AGPs in most countries, numerous challenges have emerged in poultry farming, particularly a decline in productivity, increased disease incidence, and increased poultry mortality rates. Researchers have sought alternatives to antibiotics in the poultry industry, one of which is the use of probiotics. Probiotics are defined as feed additives containing live microorganisms. In poultry, probiotics can improve production, maintain physiological status, reduce stress, control diseases, and stabilise the gut microflora (Sugiharto et al., 2021; Pratama et al., 2021). Various microorganisms are classified as probiotics, including lactic acid bacteria, fungi, and particular yeast species (Al-Khalaifa et al., 2019). These microorganisms are known to increase the physiological condition, health, and production performance of poultry.

Among probiotics, *Saccharomyces cerevisiae* has garnered significant attention in recent decades. *S. cerevisiae* is a yeast widely applied in the poultry industry as a probiotic (Pratama et al., 2021). The recommended dosage of yeast in poultry feed ranges between 10^8 and 10^{10} CFU (Maksimović et al., 2022). Numerous studies have reported the positive effects of yeast supplementation on poultry hosts. Yeast improves gut health, modulates immunity, enhances growth performance, and alleviates stress challenges, including inflammatory and environmental stressors (Ahiwe et al., 2021). Elghandour et al. (2020) reported that *S. cerevisiae* enhances feed efficiency, digestibility, and production performance; reduces pathogenic bacterial populations; and mitigates the adverse effects of environmental stress on poultry.

Effects of *S. cerevisiae* on Poultry Health and Performance

Research on *S. cerevisiae* supplementation as a probiotic in poultry feed (Table 1) has demonstrated its ability to mitigate the effects of the AGP ban. The prevention of AGPs aims to minimise the risks associated with antibiotic residues in poultry-derived food products, such as meat and eggs. However, the ban has led to reduced poultry performance. Studies highlight the efficacy of *S. cerevisiae* in maintaining intestinal health and immune status to achieve optimal production in broiler chickens (Wickramasuriya et al., 2022). *S. cerevisiae* balances the gut microbiota and stimulates the immune system (Al-Shawi et al., 2020). It facilitates competitive exclusion of pathogenic bacteria in the gut, as pathogenic bacteria adhere to the yeast surface, which removes them from the gut and inhibits their colonisation of the intestinal wall (Elghandour et al., 2020; Maoba et al., 2021). Additionally, yeast releases antibacterial compounds that target pathogens and toxins (Gil-Rodríguez & Garcia-Gutierrez, 2021). Furthermore, *S. cerevisiae* lowers the intestinal pH through the production of various organic acids during fermentation (Chichlowski et al., 2007). These organic acids contribute to gut colonisation and provide metabolites, such as amino acids and B vitamins, which support intestinal development (Elghandour et al., 2020; Gil-Rodríguez & Garcia-Gutierrez, 2021). Notably, gut colonisation is critical for gastrointestinal tract development and mucosal immune protection during the neonatal period.

In recent years, *S. cerevisiae* has been recognised for its role in enhancing intestinal barrier integrity by upregulating tight junction proteins, including claudin, occludin, zona occludens-1 (ZO-1) and junctional adhesion molecule A (JAM-A) (Ducray et al., 2019). These proteins regulate intercellular spacing in the intestine, ensuring barrier stability and function (Massacci et al., 2019). Yeast also serves as a bioregulator of the gut microflora, improving the gut morphology and mucosal structure (Xu et al., 2018).

Yeast stimulates the secretion of digestive enzymes, such as protease, amylase, and lipase, which enhance the digestion and absorption of nutrients, including proteins, carbohydrates and fats (Ahiwe et al., 2019c; Śliżewska et al., 2020). Efficient nutrient absorption directly improves poultry performance (Muthusamy et al., 2011; Shankar et al., 2017).

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Impact on Egg Production and Quality

S. cerevisiae also benefits layer poultry (Table 2), improving egg production in terms of both quality and quantity (Hassanein & Soliman, 2010; Özsoy et al., 2018). Yeast reduces the intestinal pH and secretes antimicrobial compounds, supporting the growth of beneficial probiotics and the accumulation of short-chain fatty acids (Forte et al., 2016). Live yeast cells contain various digestive enzymes that increase nutrient absorption and serum calcium levels, thus improving eggshell quality (Attia et al., 2020). Probiotics further stimulate follicular development by increasing the serum levels of follicle-stimulating hormone (FSH) and estradiol (E2), leading to improved reproductive performance (Lei et al., 2013).

Challenges and Variability in Research Findings

Despite the reported benefits, some studies have reported inconsistent results. For example, Ugwuoke et al. (2021) reported no significant effect of *S. cerevisiae* supplementation on broiler chicken performance. Similarly, its effects on blood biochemistry and antioxidant enzymes in native broiler chickens are limited (Sugiharto et al., 2019). Stress factors, including environmental challenges, may undermine the physiological benefits of probiotics by disrupting immune responses and gut function (Abo-Al-Ela et al., 2021).

Saccharomyces cerevisiae as a Prebiotic in Poultry

In recent years, prebiotics have gained considerable attention as alternatives to antibiotic growth promoters (AGPs). Prebiotics contribute to gut health, prevent pathogenic agents, and improve production performance (Table 3). Yeast, a microorganism with prebiotic properties, plays a crucial role in this process. Mannan oligosaccharides (MOSs), fructo-oligosaccharides (FOSs), galacto-oligosaccharides (GOSs), and trans-galacto-oligosaccharides (TOSs) are the most common carbohydrate components found in yeast cell walls. Prebiotics provide nutrients (Adli et al., 2023) to probiotics in the gut, aiding fermentation processes that require carbohydrates as an energy source. Fermentation by gut microorganisms produces short-chain fatty acids (SCFAs) and organic acids, including lactic acid, butyric acid, and propionic acid (Davani-Davari et al., 2019), which improve the performance of broiler chickens (Adli et al., 2024).

Among various yeast species, *Saccharomyces cerevisiae* is the most widely used additive in poultry farming because of its beneficial effects on gut health. Optimal gut health and immunity are closely linked to

Table 1: Effects of *S. cerevisiae* on poultry performance and health

Commodity	Levels in feed	Treatment period	Effects on poultry	References
Broiler chickens	0.7, 1.2, and 1.7 g/kg	1-28 days of age	Improved body weight gain and FCR in broiler chicken	Osita et al. 2020
Broiler chickens	1.5 g/kg	2-6 weeks of age	Increase body weight gain, fcr, and decrease cholesterol and glucose in the blood	Rafique et al. 2018
Broiler chickens	0.2%	1–42 days of age	Increase body weight gain, fcr, carcass traits, blood parameters, and immunity	Mousa 2018
Broiler chickens	0.3%	1-43 days of age	Highest carcass yield and lowest abdominal fat compared with the control	Hana et al. 2015
Broiler chickens	0.5, 1, and 1.5 g/kg	14-36 days of age	Enhanced lactic acid bacteria, decreased *E. coli* intestinal microflora, and reduced cholesterol content of broiler meats	Wulandari et al. 2020
Broiler chickens	1.5, 2.0, 2.5, and 3.0%	22-56 days of age	Improved bw and FRC	Lawrence-Azua et al. 2018
Broiler chickens	0.5, 1.0, 1.5 g/kg	14-35 days of age	Improving health status and increasing lactic acid bacteria in the duodenum	Wulandari and Syahniar, 2018
Broiler chickens	1.5 and 2%	1-42 days of age	Improved the carcass traits, including dressing, breast, legs, liver, heart, gizzard, and abdominal fat	Paryad and Mahmoudi 2008
Broiler chickens	0.5 g/kg	1-28 days of age	Decrease in serum nitric oxide content compared to the control on day 27	Wang et al. 2016
Broiler chickens	0.05%	1-35 days of age	Increase in anti-Newcastle virus serum titres (21 d).	Wang et al. 2017
Broiler chickens	2.5 g/kg	1-38 days of age	Increase the villi height and crypt depth in the duodenum, jejunum, and ileum.	Gao et al. 2008
Broiler chickens	0.5-1 g/kg	1-42 days of age	The height of the microvilli of the jejunum and ileum was significantly higher compared to the control.	He et al. 2021
Broiler chickens	2 g/kg	1-36 days of age	*S. cerevisiae* (2 g/kg) improved body weight and feed conversion ratio while reducing cholesterol levels in plasma, liver, and meat	Attia et al. 2023
Indonesian indigenous crossbreed chicken	0.3%	1-8 weeks of age	Improve body weight, cumulative feed intake, FCR, decrease economic cost, and enhance income overall. Increased proventriculus relative weight & wings. Improve serum biochemistry, uric acid of	Sugiharto et al. 2019
Boschveld chickens	2.5, 5.0, 7.5, 10.0, and 12.5g/kg	1-91 days of age	Improved packed cell volume (PCV), haemoglobin (Hb), mean cell haemoglobin (MCH), and mean cell volume (MCV)	Maoba et al. 2021

Table 2: Effects of *S. cerevisiae* on egg production and quality

Commodity	Levels in feed	Treatment period	Effects on poultry	References
Laying hens	0.20%	40-50 weeks of age	Reduced eggshell thickness, improved yolk and albumen weight, haugh unit, egg grading, and increased crude protein digestibility	Hameed et al., 2019
Laying hens	0.05, 0.10, 0.50, 1.0, and 3.0%	37-47 weeks of age	Improved on egg production, egg quality, nutrient digestibility, and gut microflora	Park et al., 2020
Laying hens	0.4% and 0.8%	70-79 weeks of age	Improved egg production, feed conversion, egg mass, and gut microbiota by increasing *Lactobacilli,* reducing pathogenic bacteria, and decreasing blood cholesterol	Hassanein and Soliman, 2010
Laying Quail	2.0 and 2.5%	1-14 weeks of age	Improved egg production rate, egg mass, egg number, and eggshell quality, without affecting feed intake or most internal egg quality traits. Feed conversion ratio improved slightly in one treatment	(Yousif & Kloor, 2023)

improved performance in poultry. The yeast cell wall, which is composed of α-mannan oligosaccharides, mannoproteins, and β-glucans (Klis et al., 2002; Koiyama et al., 2018; Amiri et al., 2019), supports growth, intestinal health, and immune responses (del Valle et al., 2023; Ahiwe et al., 2019b). The cell wall of *S. cerevisiae* contains approximately 30% glucan, 30% mannan, and 12.5% protein (Baek et al., 2024; Lesage & Bussey, 2006) and is rich in proteins such as aspartic acid, glutamic acid, serine, and methionine (Hung Hsu et al., 2015; Baek et al., 2024). Additionally, *S. cerevisiae* produces vitamins, amino acids, and enzymes, while its cell wall components provide energy for the ability of gut probiotics to thrive. Probiotics in the gut suppress pathogenic bacteria by reducing the pH of the gastrointestinal tract (GIT) through organic acid production (Sugiharto & Ranjitkar, 2019; Pratama et al., 2022). A lower gut pH also enhances nutrient absorption.

Mannan oligosaccharides, mannoproteins, and β-glucans improve growth performance by enhancing gut morphology, immunity, and microbial balance in the GIT (Alqhtani et al., 2024; Morales-López et al., 2009). In particular, MOSs regulate microbial populations in the GIT and positively impact growth performance and health (Teng et al., 2021). In addition to balancing the gut microbiota, *S. cerevisiae* has shown potential in mitigating the effects of mycotoxins, including aflatoxins and ochratoxins, which can impair poultry health (Mendieta et al., 2018). Mycotoxins from feed may also leave residues in poultry products such as meat and eggs (Alaboudi et al., 2022) while inhibiting nutrient absorption. MOS acts as a ligand for pathogenic bacteria, binding pathogens to MOS instead of the intestinal wall, thereby flushing them out without colonisation (Benites et al., 2008; Arif et al., 2020). Moreover, MOS serves as an energy source for gut probiotics, which promote intestinal health and broiler chicken immunity (Kyoung et al., 2023). Yeast cell wall supplementation has been reported to improve feed efficiency and weight gain (Kyoung et al., 2023), while also enhancing carcass yield and the quality of broiler chicken meat (Tavaniello et al., 2018). Notably, broiler chicken meat remains one of the most significant sources of protein worldwide.

β-glucans in yeast cell walls promote the growth of beneficial gut bacteria such as *Lactobacillus* sp., contributing to intestinal health (Zhen et al., 2021; Fathima et al., 2023). Additionally, β-glucans enhance immune responses to vaccines, such as Newcastle disease virus (NDV) vaccines, in broiler chickens (Shahir et al., 2014; An et al., 2008). For example, antibody titres against viruses reflect immune responses regulated by cytokine signalling (Teng et al., 2021; Deist et al., 2017). Rehman et al. (2020) reported that prebiotics provide energy for maintaining a balanced gut microbiota. Probiotics convert β-(1,3)-glucan into usable forms through glucanase and β-(1,3)-glucosidase activity (Helbert et al., 2019; Zhen et al., 2021), thereby increasing nutrient absorption, promoting weight gain, and improving the feed conversion ratio (FCR). Broiler chickens, which are sensitive to temperature fluctuations, often face stress. Studies have shown that MOS supplementation reduces corticosterone levels under heat stress (Sayed et al., 2023; Chen et al., 2020). The hypothalamic-pituitary-adrenal (HPA) axis is activated under heat stress, resulting in increased serum corticosterone concentrations and altered physiological conditions (Huang et al., 2024; Oluwagbenga & Fraley, 2023). Stress markers, such as corticosterone, heterophil/lymphocyte ratios, heat shock protein 70 (HSP70), and mRNA expression, provide insights into physiological stress responses (Wein et al., 2017; Onagbesan et al., 2023).

In addition to its use in broiler chickens, *S. cerevisiae* supplementation has shown promise in laying hens. Studies indicate that yeast supplementation improves both egg quality and egg quantity. Additionally, yeast cell wall supplementation has been shown to lower feed costs in laying hen farming (Muthusamy et al., 2011; Koiyama et al., 2018). The improved feed efficiency contributes to profitability and enhances the physical and chemical quality of eggs, a critical source of global protein. Tang et al. (2015) reported that prebiotic supplementation reduced cholesterol, saturated fatty acid (SFA), and stearic acid levels while increasing the unsaturated fatty acid (UFA)-to-SFA ratio, including linoleic and alpha-linolenic acids, without affecting egg quality or fat, carotenoid, or vitamin E contents. Vitamin E serves as an active antioxidant, reducing free radicals in the body.

Although many studies highlight the benefits of *S. cerevisiae* as a prebiotic, some research presents contrasting findings. For example, Sedghi et al. (2022) reported no significant effects of *S. cerevisiae* supplementation on broiler chicken weight gain, feed intake, or FCR. Dos Santos et al. (2021) reported no influence on broiler chicken body weight, feed conversion, or relative weights of the liver, gizzard, heart, or bursa of Fabricius. Factors such as management conditions and environmental stressors can impact the efficiency of *S. cerevisiae* supplementation (Sedghi et al., 2022). Pathogen challenges in the gut, particularly those involving gram-negative bacteria with endotoxins such as lipopolysaccharides (LPS), may also impede performance (Shaji et al., 2023; Erinle et al., 2022). Physiologically, livestock can tolerate disease and stress, but stress-induced metabolic changes often impair not only performance but also product quality (Akinyemi & Adewole, 2021).

Table 3: Effects of *S. cerevisiae* as prebiotics on poultry

Commodity	Levels in feed	Treatment period	Effects on poultry	References
Broiler chickens	1 g/kg	1-42 days of age	Improve growth and decrease FCR. Increase the level of antibody in broiler, villus height in the jejunum, and Lactobacillus in the duodenal and jejunal broiler chicken	Muthusamy et al. 2011
Laying hens	225, 450, or 900 ppm	21-67 weeks of age	Improved feed intake, egg production, egg quality (albumen height, Haugh unit, shell thickness, yolk color), and profitability in laying hens, despite higher feed costs.	Koiyama et al. 2018
Broiler chickens	500 mg/kg	1-42 days of age	Increased villus height of the jejunal mucosa of the broiler chicken	Morales-López et al. 2009.
Broiler chickens	2 g/kg	1-35 days of age	Ameliorate the adverse effects of Salmonella LPS challenge, improving the performance (BWG & FCR), flock uniformity, and meat yield of broiler chicken	Ahiwe et al (2019a).
Broiler chickens	2 g/kg	1-35 days of age	Improving physiological response and improving performance under subclinical necrotic enteritis challenge in broiler chicken	Ahiwe et al. 2019b
Broiler chickens	0.3%	1-35 days of age	Improved bw and fcr, and reduced oxidation causes stress. The yeast cell wall may improve the ileal villus development of broiler	Zhang et al. 2005
Broiler chickens	0.1, and 0.2%	1-42 days of age	Supplementing with 0.2% SCCW improved body weight gain and feed conversion, while also enhancing intestinal development, as indicated by increased villus height, particularly during the first week of age.	Santin et al. 2001
Broiler chickens	Bio-Mos® (2 g/kg and 4 g/kg), MRF (0.1 g/kg and 0.2 g/kg), Bio-Mos® (2 g/kg) + MRF (0.1 g/kg), Bio-Mos® (4 g/kg) + MRF (0.2 g/kg)	1-15 days of age	Increased goblet cell size and density, suggesting a positive impact on gut health in broilers.	Brümmer et al. 2010
Broiler chickens	0.2%	1-42 days of age	Feeding 0.2% SCCW improved body weight gain and FCR, enhanced gut development as indicated by increased villus height during the first week of life.	Tarekar et al. (2023).
Broiler chickens	0.2%	1-28 days of age	Maintain intestinal integrity in broilers vaccinated against coccidiosis by supporting epithelial turnover	Luquetti et al. 2012
Broiler chickens	2 kg/ton + contaminated ochratoxin A (OTA)	1-49 days of age	Enhanced daily gain, immune response, and vaccine effectiveness in chickens exposed to ochratoxin. It reduced lesion severity and restored phagocytic activity, helping manage ochratoxicosis and immune dysfunction	Awaad et al. 2011
Broiler chickens	1 g/kg	1-42 days of age	Improved immune markers and antioxidant status in broilers, including enhanced SIgA, IgG, and T-SOD activity, and reduced MDA levels.	Li et al. 2016
Laying hens	100, 200 mg β-glucan/kg diet	56-58 weeks of age	Supplementing 200 mg/kg β-glucan in laying hens under heat stress improved FCR, immunity, HSP70 levels, egg production, nutrient digestibility, and reduced stress indicators. Early heat shock and βG together enhanced performance and immune responses during reproduction.	Ezzat et al. 2024

Moreover, probiotics enhance the performance, health, and immunity of poultry across all ages. They promote gut health by balancing gut bacteria, supporting gut maturation, preventing inflammation, and strengthening immune responses (Rehman et al., 2020). Furthermore, probiotics improve feed digestion by increasing digestive enzyme activity, reducing bacterial enzyme activity, lowering methane production, neutralising enterotoxins, and stimulating immune function (Rehman et al., 2020; Alagawany et al., 2020; Soomro et al., 2019).

Saccharomyces cerevisiae Hydrolysate as a Feed Additive for Poultry

Yeast hydrolysate is a relatively novel product in livestock applications and has not been widely studied. Several researchers have explored its positive impacts on the poultry industry, with significant results (Table 4). Hydrolysis can be carried out through various processes, one of which involves enzymatic catalysis (Lin et al., 2023) to release bioactive components from the yeast cell wall (Schiavone et al., 2014). According to Takalloo et al. (2020), enzymatic hydrolysis is considered more effective than other methods, such as autolysis.

Yeasts, or fungal cultures, are unique eukaryotic microorganisms measuring approximately 3–4 microns (Walker et al., 2002). The byproducts or derivatives of yeast fermentation (secondary metabolism) include live yeast cells, dead cells, and yeast cell wall fragments. Yeast is known to be rich in bioactive compounds, including proteins, vitamins, minerals, peptides, oligosaccharides, and enzymes, which are beneficial to animal health (Wang et al., 2021; Perricone et al., 2022). *Saccharomyces cerevisiae* hydrolysate (SCH) typically contains B vitamins, nucleotides, amino acids, and polysaccharides such as β-glucans and mannan-oligosaccharides found in yeast cell walls (Lin et al., 2023; Araujo et al., 2018).

For example, dietary nucleotides aid in improving intestinal epithelial cell maturation, as demonstrated by increased mucosal protein production, DNA synthesis, and intestinal morphological development (Sauer et al., 2010). This contributes to improved gut health, immunity, and production performance in broiler chickens (Kamel et al., 2021; Kreuz et al., 2020; Rady et al., 2023). Moreover, β-glucans and mannan-oligosaccharides function as prebiotics that regulate and maintain the balance of the gut microbiota, which is closely linked to gut health (Lin et al., 2023). Additionally, *Saccharomyces cerevisiae* reportedly enhances feed palatability because of its distinct aroma (Demirgül et al., 2022).

Poultry, including broiler chickens and layers, serve as critical sources of animal protein worldwide. In addition to good farm management, improving gut health, the gut ecological balance, and immunity is essential for optimising production performance (Pratama et al., 2021; Sugiharto et al., 2022). Numerous studies have investigated the efficacy of yeast hydrolysate in poultry production. Sampath et al. (2021) reported that supplementing broiler chicken diets with *S. cerevisiae* hydrolysate improved weight gain, the feed conversion ratio (FCR), nutrient digestibility, and beneficial lactic acid bacteria (LAB) populations while reducing pathogenic bacteria in the gastrointestinal tract. Furthermore, yeast hydrolysate supplementation reduces NH_2 and H_2S gas emissions in poultry houses, which, if excessive, can lead to stress, respiratory damage, and disease outbreaks, significantly affecting production and profitability (Sampath et al., 2021).

Yeast hydrolysate has also been shown to support the antioxidant status of animals (Perricone et al., 2022). Supplementation can modulate serum superoxide dismutase (SOD), glutathione peroxidase (GPX), glutathione (GSH), and total antioxidant capacity (TAC). The effectiveness of yeast hydrolysate supplementation depends on the dosage, with higher doses correlating with improved production performance and health outcomes (Pérez et al., 2020; Al-Abdullatif et al., 2024). Interestingly, studies revealed that broiler chicken chicks from parent stock supplemented with 5 kg/tonne of yeast hydrolysate presented better growth performance and FCR than offspring from supplemented parent stock (Araujo et al., 2018).

However, the most efficient dosage and the specific mechanisms underlying its effects on production performance and cost efficiency remain unclear. Other studies have reported that yeast hydrolysate improves antibody levels, the villus height in the jejunum, and LAB populations in the duodenum and jejunum of broiler chickens (Muthusamy et al., 2011).

The immune system is vital for maintaining health and supporting growth, as disease outbreaks and stress can negatively impact an animal's physiology and metabolism, which are closely tied to optimal production performance.

For laying hens, supplementation with *S. cerevisiae* hydrolysate has been reported to improve egg production, reduce egg cholesterol content, and enhance humoral immunity (Yalcın et al., 2010; Yalcın et al., 2012). Mannan-oligosaccharides (MOSs) in the yeast cell wall play important roles in these effects (Xiao et al., 2012; Yalcın et al., 2013). Fermented MOS and β-glucans by gut bacteria produce short-chain fatty acids (SCFAs), which acidify the colon and serve as substrates for enterocyte energy production (Liu et al., 2021), thereby improving intestinal absorption (Bortoluzzi et al., 2018; Perricone et al., 2022). The acidic gut environment also suppresses the growth of pathogenic bacteria (Cisek & Binek, 2014) and enhances intestinal mucosa integrity, potentially leading to optimal nutrient absorption and egg production (Spring et al., 2000; Shashidhara & Devegowda, 2003).

While yeast hydrolysate shows significant promise, some studies report inconsistent results. Yalcın et al. (2010) reported no significant effects of *S. cerevisiae* supplementation on egg characteristics, including the Haugh unit, yolk index, shell thickness, albumen height, and shell strength. These findings align with earlier research by Yalcın et al. (2008), suggesting that the bioactive compounds in yeast, such as β-glucans, may not always yield significant results.

Mechanism of Action of *Saccharomyces cerevisiae*

The primary mechanism of *S. cerevisiae* in maintaining poultry gut health involves modulating the gastrointestinal microbiota and oxygen scavenging in the digestive tract, thereby favoring the growth of beneficial anaerobic bacteria (Massacci et al., 2019; Soren et al., 2024). Cell wall components, particularly β-glucans and mannan-oligosaccharides, act as prebiotics and immunostimulants that enhance mucosal immune responses, such as increasing secretory IgA production (Anwar et al., 2017; Chacher et al., 2017). In addition, *S. cerevisiae* competes with pathogens for epithelial adhesion sites and prevents the attachment of harmful bacteria (e.g., *Escherichia coli*), thereby reducing intestinal invasion and inflammation (Massacci et al., 2019; Elghandour et al., 2020). Collectively, these mechanisms help maintain gut microbial homeostasis and strengthen host immunity, supporting its role as a safe and functional feed additive in the antibiotic-free era of poultry production (Fig. 2).

Potential Pathogenesis of *Saccharomyces cerevisiae*

Although *Saccharomyces cerevisiae* is widely recognised as a safe and beneficial microorganism, its potential pathogenicity under certain conditions should not be overlooked (Fig. 3). Generally, *S. cerevisiae* is considered nonpathogenic and is granted GRAS (generally recognised as safe) status in food and feed applications. However, in immunocompromised hosts or under specific predisposing factors, this yeast has occasionally been reported to act as an opportunistic pathogen. The pathogenic potential of *S. cerevisiae* is associated with several mechanisms: first, adhesion and colonisation – Certain strains may adhere to epithelial surfaces, facilitating their translocation across mucosal barriers. Second, while acting as immunomodulators, cell wall components, such as β-glucans and mannoproteins, can also trigger excessive inflammatory responses in susceptible hosts. Third, enzymatic activity—Some clinical isolates produce hydrolytic enzymes (e.g., proteases and phospholipases) that may contribute to tissue invasion. Fourth, immune evasion—The thick yeast cell wall can hinder phagocytosis, allowing yeast cells to persist in host tissues.

Table 4: Effect of *Saccharomyces cerevisiae* hydrolysate on Poultry

Commodity	Levels in feed	Treatment period	Effects on poultry	References
Broiler chickens	0.3% of feed	1-35 days of age	Increase body weight and improved feed conversion	El-Manawey et al. 2021
Broiler chickens	0.1%, and 0.2%	1-32 days of age	Improve body weight gain and nutrient digestibility of DM and N, increase the number *of Lactobacillus*, and decrease the *E. coli* counts. Decreased drip loss, noxious gas (NH3 and H2S), and cholesterol level	Sampath et al. 2021
Broiler breeder	5 kg/ton	35-45 weeks of age	Improve gut health, increase egg production, increase fertility, increase egg hatchability, and improve fertile egg hatchability	Araujo et al. 2018
Broiler chickens	1 g/kg	1-42 days of age	Enhance growth performance, feed efficiency, production performance, and humoral immune responses in broilers.	Muthusamy et al. 2011
Broiler chickens	500 mg/kg in starter and grower; 250 mg/kg in finisher	1-42 days of age	Increased cecal bacterial diversity, boosted beneficial SCFA-producing bacteria, and improved gut health, contributing to better growth performance.	Lin et al. 2023
Broiler chickens	1.0; 2.0; 3.0; 4.0 g/kg	1-42 days of age	Increased growth performance, increased immunocompetence, and a reduction in the total amount of *E. coli* in the intestine.	Yalcin et al. 2013

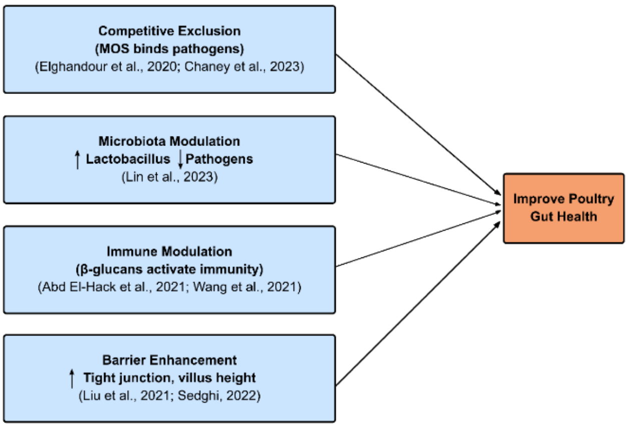

Fig. 2: Mechanism of Action of *S. cerevisiae* in Poultry Gut Health.

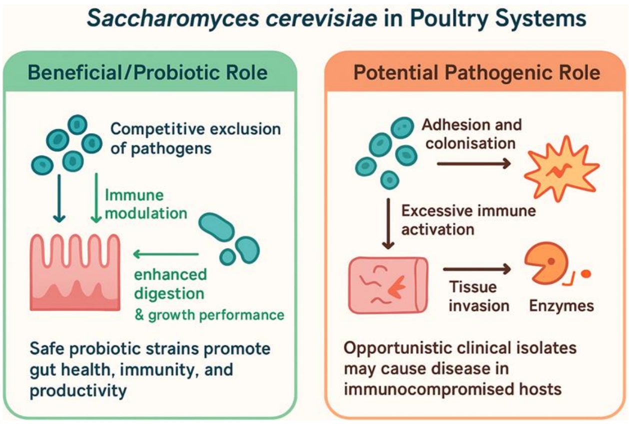

Fig. 3: Probiotic Benefits and Pathogenic Potential of *Saccharomyces cerevisiae* in Poultry.

In veterinary contexts, pathogenic cases are uncommon, and the strains used in poultry feed are specifically selected for their safety and probiotic functionality. Therefore, while the general risk of pathogenicity is very low, a clear understanding of these mechanisms is crucial for differentiating between safe probiotic strains and opportunistic clinical isolates. This distinction reinforces the importance of careful strain selection and controlled supplementation when *S. cerevisiae* is applied in poultry production systems.

Conclusions

In conclusion, *S. cerevisiae* shows great potential as a probiotic in poultry nutrition, addressing issues arising from the AGP ban. However, the variability in research findings underscores the need for further studies to optimise its application in diverse production systems. *Saccharomyces cerevisiae* hydrolysate and its derivatives present potential benefits for improving poultry production through enhanced gut health, immunity, and nutrient absorption. However, further research is needed to establish consistent findings, optimal dosages, and mechanisms of action.

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REFERENCES

Abd El-Hack, M.E., El-Saadony, M.T., Shafi, M.E., Qattan, S.Y.A., Batiha, G.E., Khafaga, A.F., Abdel-Moneim, A.E., & Alagawany, M. (2020). Probiotics in poultry feed: A comprehensive review. *Journal of Animal Physiology and Animal Nutrition,* 104(6), 1835–1850. https://doi.org/10.1111/jpn.13454

Abo-Al-Ela, H.G., El-Kassas, S., El-Naggar, K., Abdo, S.E., Jahejo, A.R., & Al Wakeel, R.A. (2021). Stress and immunity in poultry: Light management and nanotechnology as effective immune enhancers to fight stress. *Cell Stress & Chaperones*, 26(3), 457–472. https://doi.org/10.1007/s12192-021-01204-6

Adli, D.N., Sadarman, S., Irawan, A., Jayanegara, A., Wardiny, T.M., Prihambodo, T.R., Nayohan, S., Permata, D., Sholikin, M.M., & Yekti, A.P.A. (2023). Effects of oligosaccharides on performance, egg quality, nutrient digestibility, antioxidant status, and immunity of laying hens: A meta-analysis. *Italian Journal of Animal Science,* 22, (1) 594–604. https://doi.org/10.1080/1828051X.2023.2223211

Adli, D.N., Sholikin, M.M., Ujilestari, T., Ahmed, B., Sadiqqua, A., Harahap, M.A., Sofyan, A., & Sugiharto, S. (2024). Effect of fermentation of herbal products on growth performance, breast meat quality, and intestinal morphology of broiler chickens: A meta-analysis. *Italian Journal of Animal Science*, 34(4), 734–750. https://doi.org/10.1080/1828051X.2024.2351441

Ahiwe, E.U., Abdallh, M.E., Chang'a, E.P., Al-Qahtani, M., Omede, A.A., Graham, H., & Iji, P.A. (2019a). Influence of autolyzed whole yeast and yeast components on broiler chickens challenged with Salmonella lipopolysaccharide. *Poultry Science*, 98, 1738–1749

Ahiwe, E.U., Chang'a, E.P., Abdallh, M.E., Al-Qahtani, M., Kheravii, S.K., Wu, S., Graham, H., & Iji, P.A. (2019b). Dietary hydrolysed yeast cell wall extract is comparable to antibiotics in the control of subclinical necrotic enteritis in broiler chickens. British *Poultry Science*, 60(6), 757–765.

Ahiwe, E.U., Abdallh, M.E., Chang'A, E.P., Omede, A.A., Al-Qahtani, M., Gausi, H., Graham, H., & Iji, P.A. (2019c). Influence of dietary supplementation of autolyzed whole yeast and yeast cell wall products on broiler chickens. *Asian-Australasian Journal of Animal Sciences*, *33*(4), 579–587. https://doi.org/10.5713/ajas.19.0220

Ahiwe, E.U., Tedeschi Dos Santos, H., Graham, H., & Iji, P.A. (2021). Can probiotic or prebiotic yeast (*Saccharomyces cerevisiae*) serve as alternatives to in-feed antibiotics for healthy or disease-challenged broiler chickens? – A review. *Journal of Applied Poultry Research*, 30(9), 100164. https://doi.org/10.3382/japr.2021.00314

Akinyemi, F., & Adewole, D. (2021). Environmental stress in chickens and the potential effectiveness of dietary vitamin supplementation. *Frontiers in Animal Science,* 2, 775311. https://doi.org/10.3389/fanim.2021.775311

Al-Abdullatif, A.A., Alhotan, R.A., Al-Badwi, M.A., Dong, X., Kettunen, H., Vuorenmaa, J., Sakr, S.A., & Azzam, M.M. (2024). Effects of hydrolysed yeast on growth performance, intestinal redox homeostasis, and woody breast myopathy in heat-stressed broilers. *Frontiers in Veterinary Science*, 11, 1484150. https://doi.org/10.3389/fvets.2024.1484150

Alaboudi, A.R., Osaili, T.M., & Otoum, G. (2022). Quantification of mycotoxin residues in domestic and imported chicken muscle, liver, and kidney in Jordan. *Food Control,* 132, 108511. https://doi.org/10.1016/j.foodcont.2021.108511

Alagawany, M., Elnesr, S.S., Farag, M.R., Tiwari, R., Yatoo, M.I., Karthik, K., Michalak, I., & Dhama, K. (2020). Nutritional significance of amino acids, vitamins and minerals as nutraceuticals in poultry production and health – a comprehensive review. *The Veterinary Quarterly,* 41(1), 1–29. https://doi.org/10.1080/01652176.2020.1857887

Al-Khalaifa, H., Al-Nasser, A., Al-Surayee, T., Al-Kandari, S., Al-Enzi, N., Al-Sharrah, T., Ragheb, G., Al-Qalaf, S., & Mohammed, A. (2019). Effect of dietary probiotics and prebiotics on the performance of broiler chickens. *Poultry Science,* 98, 4465–4479. https://doi.org/10.3382/ps/pez282

Alqhtani, A.H., Al Sulaiman, A.R., Alharthi, A.S., & Abudabos, A.E. (2024). Dietary supplementation of prebiotic yeast *Saccharomyces cerevisiae* cell wall promotes growth performance and intestinal health in broiler chickens challenged with *Clostridium perfringens*. *British Poultry Science*, 65(2), 129–136. https://doi.org/10.1080/00071668.2023.2296938

Al-Shawi, S.G., Dang, D.S., Yousif, A.Y., Al-Younis, Z.K., Najm, T.A., & Matarneh, S.K. (2020). The potential use of probiotics to improve animal health, efficiency, and meat quality: A review. *Agriculture,* 10(10) 452. https://doi.org/10.3390/agriculture10100452

Amiri, M.M., Fazeli, M.R., Babaee, T., Amini, M., Hayati Roodbari, N., Mousavi, S.B., & Samadi, N. (2019). Production of vitamin D_3 enriched biomass of *Saccharomyces cerevisiae* as a potential food supplement: Evaluation and optimisation of culture conditions using Plackett–Burman and response surface methodological approaches. *Iranian Journal of Pharmaceutical Research,* 18(2): 974–987. https://doi.org/10.22037/ijpr.2019.1100660

An, B.K., Cho, B.L., You, S.J., Paik, H.D., Chang, H.I., Kim, S.W., Yun, C.W., & Kang, C.W. (2008). Growth performance and antibody response of broiler chicks fed yeast derived β-glucan and single-strain probiotics. *Asian-Australasian Journal of Animal Sciences,* 21(7), 1027–1032. https://doi.org/10.5713/ajas.2008.70571

Anwar, M.I., Muhammad, F., Awais, M.M., & Akhtar, M. (2017). A review of β-glucans as a growth promoter and antibiotic alternative against enteric pathogens in poultry. *World's Poultry Science Journal*, 73(3), 651–661. https://doi.org/10.1017/s0043933917000241

Araujo, L.F., Bonato, M., Barbalho, R., Araujo, C.S.S., Zorzetto, P.S., Granghelli, C.A., Pereira, R.J.G., & Kawaoku, A.J.T. (2018). Evaluating hydrolysed yeast in the diet of broiler breeder hens. *Journal of Applied Poultry Research,* 27(1), 65–70. https://doi.org/10.3382/japr/pfx041

Arif, M., Iram, A., Bhutta, M.A.K., Naiel, M.A.E., Abd El-Hack, M.E., Othman, S.I., Allam, A.A., Amer, M.S., & Taha, A.E. (2020). The biodegradation role of *Saccharomyces cerevisiae* against harmful effects of mycotoxin contaminated diets on broiler performance, immunity status, and carcass characteristics. *Animals*, 10(2), 238. https://doi.org/10.3390/ani10020238

Armando, M., Cavaglieri, L., Dogi, C., Escobar, F., Pizzolitto, R., Dalcero, A., Salvano, M., Sabini, L., Peirano, M., & Combina, M. (2011). *Saccharomyces cerevisiae* strains from animal environment with in vitro aflatoxin B1 binding ability and anti-pathogenic bacterial influence. *World Mycotoxin Journal*, 4(1), 59–68. https://doi.org/10.3920/wmj2010.1208

Attia, Y.A., Al-Khalaifah, H., Abd El-Hamid, H.S., Al-Harthi, M.A., & El-Shafey, A.A. (2020). Growth performance, digestibility, intestinal morphology, carcass traits and meat quality of broilers fed marginal nutrient deficiency diet supplemented with different levels of active yeast. *Livestock Science,* *233*, 103945. https://doi.org/10.1016/j.livsci.2020.103945

Attia, Y.A., Basiouni, S., Abdulsalam, N.M., Bovera, F., Aboshok, A.A., Shehata, A.A., & Hafez, H.M. (2023). Alternative to antibiotic growth promoters: beneficial effects of *Saccharomyces cerevisiae* and/or *Lactobacillus acidophilus* supplementation on the growth performance and sustainability of broilers' production. *Frontiers in Veterinary Science*, 10, Article 1259426. https://doi.org/10.3389/fvets.2023.1259426

Awaad, M.H.H., Atta, A.M., Abd El-Ghany, W.A., & Elmenawe, M. (2011). Effect of a specific combination of mannan-oligosaccharides and β-glucans extracted from yeast cell wall on the health status and growth performance of ochratoxicated broiler chickens. *Journal of American Science*, 7(3).

Baek, K.R., Ramakrishnan, S.R., Kim, S.J., & Seo, S.O. (2024). Yeast cell wall mannan structural features, biological activities, and production strategies. *Heliyon,* 10(2), e27896. https://doi.org/10.1016/j.heliyon.2024.e27896

Bagaskara, B., Zain, M., Elihasridas, Shafura, P.O. & Rahmita, S., (2025). The effect of adding *Saccharomyces cerevisiae* and sulfur mineral in ammoniated citronella waste basal ration to consumptions, nutrient digestibility, milk production, and milk quality of Etawa crossbreed goat. *International Journal of Veterinary Science,* 14(2): 386-396. https://doi.org/10.47278/journal.ijvs/2024.243

Benites, V., Gilharry, R., Gernat, A.G., & Murillo, J.G. (2008). Effect of dietary mannan oligosaccharide from Bio-MOS or Saf-Mannan on live performance of broiler chickens. *Journal of Applied Poultry Research*, 17(3), 471–475. https://doi.org/10.3382/japr.2008-00023

Bortoluzzi, C., Barbosa, J.G.M., Pereira, R., Fagundes, N.S., Rafael, J.M., & Menten, J.F.M. (2018). Autolyzed yeast (*Saccharomyces cerevisiae*) supplementation improves performance while modulating the intestinal immune system and microbiology of broiler chickens. *Frontiers in Sustainable Food Systems*, 2, 85. https://doi.org/10.3389/fsufs.2018.00085

Brümmer, M., Jansen van Rensburg, C., & Moran, C.A. (2010). *Saccharomyces cerevisiae* cell wall products: The effects on gut morphology and performance of broiler chickens. *South African Journal of Animal Science*, 40(1), 14–21.

Chacher, M.F.A., Kamran, Z., Ahsan, U., Ahmad, S., Koutoulis, K.C., Qutab Ud Din, H.G., & Cengiz, Ö. (2017). Use of mannan oligosaccharide in broiler diets: an overview of underlying mechanisms. *World's Poultry Science Journal*, 73(4), 831–844. https://doi.org/10.1017/s0043933917000757

Chen, Y., Wen, C., Zhou, Y., & Cheng, Y. (2020). Protective effects of dietary mannan oligosaccharide on heat stress-induced hepatic damage in broilers. *Environmental Science and Pollution Research*, *27*(23), 29000–29008. https://doi.org/10.1007/s11356-020-09212-2

Chichlowski, M., Croom, J., McBride, B.W., Havenstein, G.B., & Koci, M.D. (2007). Metabolic and physiological impact of probiotics or direct fed microbial on poultry: A brief review of current knowledge. *International Journal of Poultry Science,* 6(10), 694–704. https://doi.org/10.3923/ijps.2007.694.704

Cisek, A. A., & Binek, M. (2014). Chicken intestinal microbiota function with a special emphasis on the role of probiotic bacteria. *Polish Journal of Veterinary Sciences*, *17*(2), 385–394. https://doi.org/10.2478/pjvs-2014-0057

Davani-Davari, D., Negahdaripour, M., Karimzadeh, I., Seifan, M., Mohkam, M., Masoumi, S.J., Berenjian, A., & Ghasemi, Y. (2019). Prebiotics: Definition, types, sources, mechanisms, and clinical applications. *Foods,* 8(3), 92. https://doi.org/10.3390/foods8030092

Del Valle, C., Bonadero, M.C., & Fernández-Gimenez, A.V. (2023). *Saccharomyces cerevisiae* as probiotic, prebiotic, synbiotic, postbiotics, and parabiotics in aquaculture: An overview. *Aquaculture*, 569, 739342. https://doi.org/10.1016/j.aquaculture.2023.739342

Deist, M.S., Lamont, S.J., Dekkers, J.C.M., Gallardo, R.A., Bunn, D.A., Kelly, T. R., & Zhou, H. (2017). Novel Mechanisms Revealed in the Trachea Transcriptome of Resistant and Susceptible Chicken Lines following Infection with Newcastle Disease Virus. *Clinical and Vaccine Immunology*, *24*(5). https://doi.org/10.1128/cvi.00027-17

Demirgül, F., Şimşek, Ö., Bozkurt, F., Dertli, E., & Sağdıç, O. (2022). Production and characterisation of yeast extracts produced by *Saccharomyces cerevisiae*, Saccharomyces boulardii, and Kluyveromyces marxianus. *Preparative Biochemistry & Biotechnology*, 52(7), 657–667. https://doi.org/10.1080/10826068.2021.1983833

Dos Santos, V.M., Oliveira, G.S., Ribeiro de Lima, C.A., & Curvello, F.A. (2021). Broiler chick performance using *Saccharomyces cerevisiae* yeast cell wall as an anti-mycotoxin additive. *Czech Journal of Animal Science,* 66(2), 65–72. https://doi.org/10.17221/237/2020-CJAS

Du, X., Maqbool, B., Shichiyakh, R., Haque, M.A., Aubakirov, M., Syamsu, J.A. & Khan, A. (2025). Eubiotics improve gut health and overall production in animals by reducing pathogenic bacteria. Pakistan Veterinary Journal, 45(2): 488-498. http://dx.doi.org/10.29261/pakvetj/2025.186

Ducray, H.A.G., Globa, L., Pustovyy, O., Sorokulova, I., Morrison, E., & Vodyanoy, V. (2019). Yeast fermentate prebiotic improves intestinal barrier integrity during heat stress by modulation of the gut microbiota in rats. *Journal of Applied Microbiology*, *127*(4), 1192–1206. https://doi.org/10.1111/jam.14361

Elghandour, M.M.Y., Tan, Z.L., Abu Hafsa, S.H., Adegbeye, M.J., Greiner, R., Ugbogu, E.A., Cedillo Monroy, J., & Salem, A.Z.M. (2020). *Saccharomyces cerevisiae* as a probiotic feed additive to non- and pseudo-ruminant feeding: A review. *Journal of Applied Microbiology*, 128(3), 658–674. https://doi.org/10.1111/jam.14416

El-Manawey, M.A., Yousif, E.Y., Abo-Taleb, A.M., & Atta, A.M. (2021). The effect of dietary inclusion of whole yeast, extract, and cell wall on production performance and some immunological parameters of broiler chickens. *World Veterinary Journal*, 11(2), 257–262

Erinle, T.J., MacIsaac, J., Yang, C., & Adewole, D.I. (2022). Effect of red osier dogwood extract on growth performance, blood biochemical parameters, and gut functionality of broiler chickens challenged or unchallenged intraperitoneally with Salmonella Enteritidis lipopolysaccharide. *Poultry Science,* 101(9), 101861. https://doi.org/10.1016/j.psj.2022.101861

Ezzat, W., Mahrose, K.M., Rizk, A.M., Ouda, M.M.M., Fathey, I.A., Othman, S.I., Allam, A.A., Rudayni, H.A., Almasmoum, H.A., Taha, A.E., Felemban, S.G., Tellez-Isaias, G., & Abd El-Hack, M.E. (2024). Impact of β-glucan dietary supplementation on productive, reproductive performance and physiological response of laying hens under heat stress conditions. *Poultry Science*, 103(1), 103183. https://doi.org/10.1016/j.psj.2023.103183

Fathima, S., Shanmugasundaram, R., Sifri, M., & Selvaraj, R. (2023). Yeasts and yeast-based products in poultry nutrition. *Journal of Applied Poultry Research,* 32(2), 100345. https://doi.org/10.1016/j.japr.2023.100345

Forte, C., Moscati, L., Acuti, G., Mugnai, C., Franciosini, M., Costarelli, S., Cobellis, G., & Trabalza-Marinucci, M. (2016). Effects of dietary *Lactobacillus acidophilus* and *Bacillus subtilis* on laying performance, egg quality, blood biochemistry, and immune response of organic laying hens. *Journal of Animal Physiology and Animal Nutrition,* 100(5), 977–987. https://doi.org/10.1111/jpn.12408

Gao, J., Zhang, H.J., Yu, S.H., Wu, S.G., Yoon, I., Quigley, J., Gao, Y.P., & Qi, G.H. (2008). Effects of yeast culture in broiler diets on performance and immunomodulatory functions. *Poultry Science*, 87, 1377–1384. https://doi.org/10.3382/ps.2007-00418

Gil-Rodríguez, A.M., & Garcia-Gutierrez, E. (2021). Antimicrobial mechanisms and applications of yeasts. *Advances in Applied Microbiology,* 114, 37–72. https://doi.org/10.1016/bs.aambs.2020.11.002

Hameed, R., Tahir, M., Khan, S.H., Ahmad, T., & Iqbal, J. (2019). Effect of yeast supplementation on production parameters, egg quality characteristics and crude protein digestibility in hens. *Advancements in Life Sciences*, 6(4), 147–151.

Hana, S.E., Tabidi, M.H., El Nasri, I.M., & Mukhtar, M.A. (2015). Study of different levels of yeast on performance values and immune response in broiler chicken. *Journal of Animal Research and Veterinary Science*, 8(1), 1–5.

Hassanein, S.M., & Soliman, N.K. (2010). Effect of probiotic (*Saccharomyces cerevisiae*) addition to diets on intestinal microflora and performance of Hy-Line laying hens. *American Journal of Science,* 6(11), 159–169.

He, T., Mahfuz, S., Piao, X., Wu, D., Wang, W., Yan, H., Ouyang, T., & Li, Y. (2021). Effects of live yeast (*Saccharomyces cerevisiae*) as a substitute to antibiotic on growth performance, immune function, serum biochemical parameters and intestinal morphology of broilers. *Journal of Applied Animal Research,* 49(1), 15–22. https://doi.org/10.1080/09712119.2021.1876705

Helbert, W., Poulet, L., Drouillard, S., Drouillard, S., Mathieu, S., Loiodice, M., Couturier, M., Lombar, V., Terraponb, N., Turchetto, J., Vincentelli, R., & Henrissat, B. (2019). Discovery of novel carbohydrate-active enzymes through the rational exploration of the protein sequences space. *Proceedings of the National Academy of Sciences of the United States of America*, 116(13), 6063–6068. https://doi.org/10.1073/pnas.1815791116

Huang, Y., Cai, H., Han, Y., & Yang, P. (2024). Mechanisms of heat stress on neuroendocrine and organ damage and nutritional measures of prevention and treatment in poultry. *Biology,* 13(11), 926. https://doi.org/10.3390/biology13110926

Hung Hsu, P., Chi Chiang, P., Hsun Liu, C., & Wen Chang, Y. (2015). Characterisation of cell wall proteins in *Saccharomyces cerevisiae* clinical isolates elucidates Hsp150p in virulence. *PLoS One,* 10(8), e0135174. https://doi.org/10.1371/journal.pone.0135174

Kamel, N.F., Hady, M.M., Ragaa, N.M., & Mohamed, F.F. (2021). Effect of nucleotides on growth performance, gut health, and some immunological parameters of broiler chickens exposed to high stocking density. *Livestock Science*, 253, 104703. https://doi.org/10.1016/j.livsci.2021.104703

Klis, F.M., Mol, P., Hellingwerf, K., & Brul, S. (2002). Dynamics of cell wall structure in *Saccharomyces cerevisiae*. *FEMS Microbiology Reviews*, 26(3), 239–256. https://doi.org/10.1111/j.1574-6976.2002.tb00613.x

Koiyama, N.T.G., Utimi, N.B., Santos, B.R.L., Bonato, M.A., Barbalho, R., Gameiro, A.H., Araújo, C.S.S., & Araujo, L. (2018). Effect of yeast cell wall supplementation in laying hen feed on economic viability, egg production, and egg quality. *Journal of Applied Poultry Research*, 27(1): 116–123. https://doi.org/10.3382/japr/pfx052

Kreuz, B.S., Rocha, G.C., Campos, P.H.R.F., Silva, F.F., Hannas, M.I., Albino, L.F.T., Borges, S.O., & Calderano, A.A. (2020). Effects of dietary nucleotide supplementation on growth performance and physiology of broiler chickens under pre- and postinflammatory challenge. *Revista Brasileira de Zootecnia*, 49: e20200117. https://doi.org/10.37496/rbz4920200117

Kyoung, H., Kim, E., Cho, J.H., Lee, H., Kim, Y., Park, K.I., Kim, H.B., & Song, M. (2023). Dietary yeast cell wall enhanced intestinal health of broiler chickens by modulating intestinal integrity, immune responses, and microbiota. *Poultry Science,* 102: 102660. https://doi.org/10.1016/j.psj.2023.102660

Kumalasari, C., Asmara, I.Y., Nayan, N. & Adriani, L., (2025). Characteristics of Bacillus subtilis and Bacillus licheniformis consortium as probiotics for late-phase laying hens. *International Journal of Agriculture and Biosciences* 14(2): 238-243. https://doi.org/10.47278/journal.ijab/2024.218

Lawrence-Azua, O.O., Awe, A.O., Saka, A.A., Okotie, U.J., Awodele, O.A., & Isegbe, E.I. (2018). Effect of yeast (*Saccharomyces cerevisiae*) supplementation on the growth performance, haematological and serum biochemical parameters of broiler chicken. *Nigerian Journal of Animal Science*, 20(1), 191–199.

Lei, K., Li, Y.L., Yu, D.Y., Rajput, I.R., & Li, W.F. (2013). Influence of dietary inclusion of *Bacillus licheniformis* on laying performance, egg quality, antioxidant enzyme activities, and intestinal barrier function of laying hens. *Poultry Science*, 92(9): 2389–2395. https://doi.org/10.3382/ps.2012-02686

Lesage, G., & Bussey, H. (2006). Cell wall assembly in *Saccharomyces cerevisiae*. *Microbiology and Molecular Biology Reviews*, 70(2): 317–343. https://doi.org/10.1128/MMBR.00038-05

Li, X.H., Chen, Y.P., Cheng, Y.F., Yang, W.L., Wen, C., & Zhou, Y.M. (2016). Effect of yeast cell wall powder with different particle sizes on the growth performance, serum metabolites, immunity and oxidative status of broilers. *Animal Feed Science and Technology*, 212, 81–89. https://doi.org/10.1016/j.anifeedsci.2015.11.010

Lin, J., Comi, M., Vera, P., Agazzi, A., Qiu, K., Wang, J., Wu, S., Qi, G., & Zhang, H. (2023). Effects of *Saccharyces cerevisiae* hydrolysate on growth performance, immunity function, and intestinal health in broilers. *Poultry Science,* 102: 102237. https://doi.org/10.1016/j.psj.2022.102237

Liu, Y., Cheng, X., Zhen, W., Zeng, D., Qu, L., Wang, Z., & Ning, Z. (2021). Yeast culture improves egg quality and reproductive performance of aged breeder layers by regulating gut microbes. *Frontiers in Microbiology*, 12: 633276. https://doi.org/10.3389/fmicb.2021.633276

Luquetti, B.C., Furlan, R.L., Alarcon, M.F.F., & Macari, M. (2012). *Saccharomyces cerevisiae* cell wall dietary supplementation on the performance and intestinal mucosa development and integrity of broiler chickens vaccinated against coccidiosis. *Brazilian Journal of Poultry Science*, 14(2). https://doi.org/10.1590/S1516-635X2012000200002

Massacci, F.R., Manuali, E., Magistrali, C.F., Trabalza-Marinucci, M., Genovese, D.A., Moscati, L., Tofani, S., Lovito, C., Papa, P., De Leo, A.A.P., Tentellini, M., & Forte, C. (2019). Dietary *Saccharomyces* *cerevisiae* boulardii CNCM I-1079 Positively Affects Performance and Intestinal Ecosystem in Broilers during a *Campylobacter jejuni* Infection. *Microorganisms*, *7*(12), 596. https://doi.org/10.3390/microorganisms7120596

Maksimović, Z., Starčević, M., Šefer, D., Janjić, J., Radovanović, A., Radulović, S., Perić, D., & Marković, R. (2022). Effects of adding different dosages of *Saccharomyces cerevisiae* in diet on growth performance, carcass characteristics, intestinal morphology, and gut microflora of broilers. *Kafkas Universitesi Veteriner Fakültesi Dergisi,* 28(3): 461–468. https://doi.org/10.9775/kvfd.2022.27458

Maoba, S., Ogbuewu, I.P., Oguttu, J.W., & Mbajiorgu, C.A. (2021). Haematological profiles of indigenous *Boschveld* chickens on probiotic-yeast (*Saccharomyces cerevisiae*) supplementation. *Comparative Clinical Pathology,* 30(2): 293–299. https://doi.org/10.1007/s00580-021-03208-1

Mendieta, C.R., Gómez, G.V., Del Río, J.C.G., Cortes Cuevas, A., Arce, J.M., & Ávila, E.G. (2018). Effect of the addition of *Saccharomyces cerevisiae* yeast cell walls to diets with mycotoxins on the performance and immune responses of broilers. *Journal of Poultry Science,* 55(1): 38–46. https://doi.org/10.2141/jpsa.0170019

Morales-López, R., Auclair, E., García, F., Esteve-Garcia, E., & Brufau, J. (2009). Use of yeast cell walls; β-1,3/1,6-glucans; and mannoproteins in broiler chicken diets. *Poultry Science*, 88(3), 601–607. https://doi.org/10.3382/ps.2008-00298

Mousa, M.A.M. (2018). Evaluation of using propionic acid and live yeast in diets low in protein and energy on broiler performance. *Egyptian Poultry Science*, 38, 797–814. https://doi.org/10.21608/EPSJ.2018.17105

Muthusamy, N., Haldar, S., Ghosh, T.K., & Bedford, M.R. (2011). Effects of hydrolysed *Saccharomyces cerevisiae* yeast and yeast cell wall components on live performance, intestinal histomorphology, and humoral immune response of broilers. *British Poultry Science,* 52(6): 694–703. https://doi.org/10.1080/00071668.2011.608728

Oluwagbenga, E.M., & Fraley, G.S. (2023). Heat stress and poultry production: A comprehensive review. *Poultry Science,* 102: 103141. https://doi.org/10.1016/j.psj.2023.103141

Onagbesan, O.M., Uyanga, V.A., Oso, O., Tona, K., & Oke, O.E. (2023). Alleviating heat stress effects in poultry: Updates on methods and mechanisms of actions. *Frontiers in Veterinary Science,* 10: 1255520. https://doi.org/10.3389/fvets.2023.1255520

Osita, C.O., Ani, A.O., Oyeagu, C.E., Akuru, E.A., Ugwuowo, L.C., Udeh, V.C., & Oliobi, U.J. (2020). Effect of different levels of dietary inclusion of *Saccharomyces cerevisiae* on growth performance and hematological parameters in broiler birds. *Bulgarian Journal of Agricultural Science,* 26(5), 1024–1028.

Özsoy, B., Karadağoğlu, Ö., Yakan, A., Önk, K., Çelik, E., & Şahin, T. (2018). The role of yeast culture (*Saccharomyces cerevisiae*) on performance, egg yolk fatty acid composition, and fecal microflora of laying hens. *Revista Brasileira de Zootecnia,* 47: e20180111. https://doi.org/10.1590/rbz4720170159

Park, J.H., Sureshkumar, S., & Kim, I.H. (2020). Egg production, egg quality, nutrient digestibility, and excreta microflora of laying hens fed with a diet containing brewer's yeast hydrolysate. *Journal of Applied Animal Research*, 48(1), 492–498. https://doi.org/10.1080/09712119.2020.1825446

Paryad, A., & Mahmoudi, M. (2008). Effect of different levels of supplemental yeast (*Saccharomyces cerevisiae*) on performance, blood constituents and carcass characteristics of broiler chicks. *African Journal of Agricultural Research*, 3(12), 835–842.

Pérez, M., Milian, G., Bocourt, R., & Caicedo, W. (2020). Effect of a hydrolysate of residual distillers' yeast on growth and immunological status of broiler chickens. *Livestock Research for Rural Development*, 32(7): 145.

Perricone, V., Sandrini, S., Irshad, N., Savoini, G., & Comi, M., & Agazzi, A. (2022). Yeast-derived products: The role of hydrolysed yeast and yeast culture in poultry nutritiona review. *Animals (Basel)*, 12(11): 1426. https://doi.org/10.3390/ani12111426

Pratama, A.R., Mareta, I., Yudiarti, T., Wahyuni, H.I., Widiastuti, E., & Sugiharto, S. (2021). Administration of fermented Averrhoa bilimbi L. fruit filtrate on growth, hematological, intestinal, and carcass indices of broilers. *Tropical Animal Science Journal,* 44(1): 79–89. https://doi.org/10.5398/tasj.2021.44.1.79

Pratama, A.R., Yudiarti, T., Sugiharto, S., & Ayasan, T. (2022). Blood and intestine profile of broilers fed Averrhoa bilimbi fruit, wheat bran, and yeast blends. *Tropical Animal Science Journal*, 45(1): 44–55. https://doi.org/10.5398/tasj.2022.45.1.44

Rady, W.F., Sayed, A.B., & Abdel-Raheem, H.A. (2023). Effect of dietary supplementation of Echinacea and nucleotides on productive performance, intestinal histomorphology, and gene expression of broiler chickens. *Assiut Veterinary Medical Journal,* 69(174): 141–155. https://doi.org/10.21608/avmj.2023.185576.1115

Rafique, K., Sial, A.R., & Mahmood, M. (2018). Effect of dietary supplementation of different levels of *Saccharomyces cerevisiae* on growth performance and hematology in broiler. *Indian Journal of Animal Research*, 54(1), 59-64. https://10.18805/ijar.B-695

Rehman, A., Arif, M., Sajjad, N., Al-Ghadi, M.Q., Alagawany, M., Abd El-Hack, M.E., Alhimaidi, A.R., Elnesr, S.S., Almutairi, B.O., Amran, R.A., Hussein, E.O.S., & Swelum, A.A. (2020). Dietary effect of probiotics and prebiotics on broiler performance, carcass, and immunity. *Poultry Science,* 99(12): 6946–6953. https://doi.org/10.1016/j.psj.2020.09.043

Sampath, V., Han, K., & Kim, I.H. (2021). Influence of yeast hydrolysate supplement on growth performance, nutrient digestibility, microflora, gas emission, blood profile, and meat quality in broilers. *Journal of Animal Science and Technology,* 35(6): 1059–1067. https://doi.org/10.5187/jast.2021.e61

Santin, E., Maiorka, A., Macari, M., Grecco, M., Sanchez, J.C., Okada, T.M., & Myasaka, A.M. (2001). Performance and intestinal mucosa development of broiler chickens fed diets containing *Saccharomyces cerevisiae* cell wall. *Journal of Applied Poultry Research,* 10(3), 236–244. https://doi.org/10.1093/japr/10.3.236

Sapsuha, Y., Suprijatna, E., Kismiati, S., & Sugiharto, S. (2021). Combination of probiotic and phytobiotic as an alternative for antibiotic growth promoter for broiler chickens—a review. *Livestock Research for Rural Development,* 30(4): 100164. http://www.lrrd.org/lrrd33/4/3349yus_ar.html

Sauer, N., Bauer, E., Vahjen, W., Zentek, J., & Mosenthin, R. (2010). Nucleotides modify growth of selected intestinal bacteria in vitro. *Livestock Science*, 133(2-3): 161–163. https://doi.org/10.1016/j.livsci.2010.06.053

Sayed, Y., Hassan, M., Salem, H.M., Al-Amry, K., & Eid, G.E. (2023). Prophylactic influences of prebiotics on gut microbiome and immune response of heat-stressed broiler chickens. *Scientific Reports*, *13*(1). https://doi.org/10.1038/s41598-023-40997-7

Sedghi, M., Mohammadi, I., Sarrami, Z., Ghasemi, R., & Azarfar, A. (2022). Effects of a yeast cell wall product on the performance of broiler chickens and *PGC-1α*, *TLR4*, *IL-10*, and *PPARγ* gene expression. *Italian Journal of Animal Science*, 21(1): 263–278. https://doi.org/10.1080/1828051X.2021.2025161

Schiavone, M., Martin-Yken, H., Vax, A., Dague, E., Formosa, C., & François, J.M. (2014). A combined chemical and enzymatic method to determine quantitatively the polysaccharide components in the cell wall of yeasts. *FEMS Yeast Research*, *14*(6), 933–947. https://doi.org/10.1111/1567-1364.12182

Shahir, M.H., Afsarian, O., Ghasemi, S., & Tellez, G. (2014). Effects of dietary inclusion of probiotic or prebiotic on growth performance, organ weight, blood parameters and antibody titres against influenza and Newcastle in broiler chickens. *International Journal of Poultry Science*, 13(2): 70–75. https://doi.org/10.3923/ijps.2014.70.75

Shaji, S., Selvaraj, R.K., & Shanmugasundaram, R. (2023). *Salmonella* infection in poultry: A review on the pathogen and control strategies. *Microorganisms*, 11(11): 2814. https://doi.org/10.3390/microorganisms11112814

Shankar, P.A., Premavalli, K., Omprakash, A.V., Kirubakaran, J.J., & Hudson, G.H. (2017). Effect of dietary yeast supplementation on the production performance of broilers. *International Journal of Advanced Biological Research*, 7(2): 222–228.

Shashidhara, R.G., & Devegowda, G. (2003). Effect of dietary mannanoligosaccharide on broiler breeder production traits and immunity. *Poultry Science*, 82(8): 1319–1325. https://doi.org/10.1093/ps/82.8.1319

Śliżewska, K., Markowiak-Kopeć, P., Żbikowski, A., & Szeleszczuk, P. (2020). The effect of synbiotic preparations on the intestinal microbiota and metabolism in broiler chickens. *Scientific Reports*, 9: 4281. https://doi.org/10.1038/s41598-020-61256-z

Soomro, R.N., Abd El-Hack, M.E., Shah, S.S., Taha, A.E., Alagawany, M., Swelum, A.A., Hussein, E.O.S., Ba-Aawdh, H.A., Saadeldin, I., El-Edel, M.A., & Tufarelli, V. (2019). Impact of restricting feed and probiotic supplementation on growth performance, mortality and carcass traits of meat-type quails. *Animal Science Journal*, 90(11): 1388–1395. https://doi.org/10.1111/asj.13290

Soren, S., Mukherjee, J., Pradhan, S., Mandal, G. P., Banerjee, D., Pakhira, M. C., Samanta, I., Mondal, S., Amla, A., Mondal, A., & Nsereko, V. (2024). Efficacy of *Saccharomyces cerevisiae* Fermentation Product and Probiotic Supplementation on Growth Performance, Gut Microflora and Immunity of Broiler Chickens. *Animals*, 14(6), 866. https://doi.org/10.3390/ani14060866

Spring, P., Wenk, C., Dawson, K.A., & Newman, K.E. (2000). The effects of dietary mannanoligosaccharides on cecal parameters and the concentrations of enteric bacteria in the ceca of *Salmonella*-challenged broiler chicks. *Poultry Science*, 79(2): 205–211. https://doi.org/10.1093/ps/79.2.205

Sugiharto, S., & Ranjitkar, S. (2019). Recent advances in fermented feeds towards improved broiler chicken performance, gastrointestinal tract microecology, and immune responses: A review. *Animal Nutrition*, 5(1): 1–10. https://doi.org/10.1016/j.aninu.2018.11.001

Sugiharto, S., Pratama, A.R., Yudiarti, T., & Ayasan, T. (2021). Effect of novel natural feed additive containing *Averrhoa bilimbi* L. fruit filtrate, wheat bran, and *Saccharomyces cerevisiae* on growth performance and meat characteristics of broilers. *Veterinary World*, 14(10): 3007–3014. https://doi.org/10.14202/vetworld.2021.3007-3014

Sugiharto, S., Widiastuti, E., Sartono, T., Wahyuni, H., Pratama, A.R., & Yudiarti, T. (2022). Growth, blood, and intestinal indices of broilers at high-density pens provided with fermented *Averrhoa bilimbi* fruit filtrate. *Tropical Animal Science Journal*, 45(2): 202–212. https://doi.org/10.5398/tasj.2022.45.2.202

Sugiharto, S., Yudiarti, T., Isroli, I., Widiastuti, E., Wahyuni, H.I., & Sartono, T.A. (2019). Effect of formic acid, *Saccharomyces cerevisiae* or their combination on the growth performance and serum indices of the Indonesian indigenous crossbred chickens. *Annals of Agricultural Sciences*, 64(2), 206–210. https://doi.org/10.1016/j.aoas.2019.12.004

Susalam, M.K., Harnentis, Marlida, Y., Jamsari, & Ardani, L.R., (2024). The effect of probiotics consortium isolated from fermented fish (Budu) on broiler performances and meat quality. *International Journal of Veterinary Science* 13(1): 100-107. https://doi.org/10.47278/journal.ijvs/2023.066

Takalloo, Z., Nikkhah, M., Nemati, R., Jalilian, N., & Sajedi, R.H. (2020). Autolysis, plasmolysis, and enzymatic hydrolysis of baker's yeast (*Saccharomyces cerevisiae*): A comparative study. *World Journal of Microbiology and Biotechnology*, 36(5): 68. https://doi.org/10.1007/s11274-020-02840-3

Tang, S.G.H., Sieo, C.C., Kalavathy, R., Saad, W.Z., Yong, S.T., Wong, H.K., & Ho, Y.W. (2015). Chemical compositions of egg yolks and egg quality of laying hens fed prebiotic, probiotic, and synbiotic diets. *Journal of Food Science*, 80(8): C1686–C1695. https://doi.org/10.1111/1750-3841.12947

Tarekar, A.N., Sarmah, M.P., & Padmapriya, G. (2023). The impacts of *Saccharomyces cerevisiae* cell wall on broiler chicken productivity and gastrointestinal mucosa development. *Revista Electrónica de Veterinaria,* 24(1).

Tavaniello, S., Maiorano, G., Stadnicka, K., Mucci, R., Bogucka, J., & Bednarczyk, M. (2018). Prebiotics offered to broiler chickens exert positive effects on meat quality traits irrespective of delivery route. *Poultry Science*, 97(6): 2979–2987. https://doi.org/10.3382/ps/pey149

Teng, P.Y., Adhikari, R., Llamas-Moya, S., & Kim, W.K. (2021). Effects of combination of mannan-oligosaccharides and β-glucan on growth performance, intestinal morphology, and immune gene expression in broiler chickens. *Poultry Science*, 100(1): 101483. https://doi.org/10.1016/j.psj.2021.101483

Ugwuoke, J.I., Okwesili, O.R., Dim, C.E., Okonkwo, M.N., & Ndofor-Foleng, H.M. (2021). Carcass and organ characteristics of finishing broilers fed diets containing probiotics (*Saccharomyces cerevisiae*). *Agro-Science*, 20(1): 25–30. https://doi.org/10.4314/as.v20i1.5

Walker, K., Skelton, H., & Smith, K. (2002). Cutaneous lesions showing giant yeast forms of *Blastomyces dermatitidis*. *Journal of Cutanous Pathology*, 2(9): 616–618. https://doi.org/10.1034/j.1600-0560.2002.291009.x

Wang, T., Cheng, K., Yu, C.Y., Li, Q.M., Tong, Y.C., Wang, C., Yang, Z.B., & Wang, T. (2021). Effects of a yeast-derived product on growth performance, antioxidant capacity, and immune function of broilers. *Poultry Science*, 100(1): 101343. https://doi.org/10.1016/j.psj.2021.101343

Wang, W., Li, Z., Ren, W., Yue, Y., & Guo, Y. (2016). Effects of live yeast supplementation on lipopolysaccharide-induced inflammatory responses in broilers. *Poultry Science*, 95, 2557–2564. https://doi.org/10.3382/ps/pew191

Wang, W., Ren, W., Li, Z., Yue, Y., & Guo, Y. (2017). Effects of live yeast on immune responses and intestinal morphological structure in lipopolysaccharide-challenged broilers. *Canadian Journal of Animal Science*, 97, 136–144. https://doi.org/10.1139/cjas-2015-0148

Wein, Y., Shira, E.B., & Friedman, A. (2017). Avoiding handling-induced stress in poultry: use of uniform parameters to accurately determine physiological stress. *Poultry Science*, 96: 65–73. https://doi.org/10.3382/ps/pew245

Wickramasuriya, S.S., Park, I., Lee, K., Lee, Y., Kim, W.H., Nam, H., & Lillehoj, H.S. (2022). Role of physiology, immunity, microbiota, and infectious diseases in the gut health of poultry. *Vaccines (Basel)*, 10(2): 172. https://doi.org/10.3390/vaccines10020172

World Health Organisation (WHO) (2018). Antibiotic resistance. Accessed March 2020. Retrieved from http://www.who.int/news-room/fact-sheets/detail/antibiotic-resistance

Wulandari, S., & Syahniar, T.M. (2018). The effect of adding probiotic *Saccharomyces cerevisiae* on dietary antibiotic-free on production performance and intestinal lactic acid bacteria growth of broiler chicken. *IOP Conference Series: Earth and Environmental Science*, 207, 012034. https://10.1088/1755-1315/207/1/012034

Wulandari, S., Syahniar, T.M., & Pantaya, D. (2020). Application of *Saccharomyces cerevisiae* as a probiotic for producing low cholesterol and antibiotic-free broiler meat. *Bulettin in Animal Science*, 44(2), 27–33. https://10.21059/buletinpeternak.v44i2.48544

Xiao, R., Power, R.F., Mallonee, D., Routt, K., Spangler, L., Pescatore, A.J., Cantor, A.H., Ao, T., Pierce, J.L., & Dawson, K.A. (2012). Effects of yeast cell wall-derived mannan-oligosaccharides on jejunal gene expression in young broiler chickens. *Poultry Science*, 91(7): 1660–1669. https://doi.org/10.3382/ps.2012-02435

Xu, J., Li, C., Wu, Z., Yang, Z., Li, Y., Pu, W., & Liang, H. (2018). Yeast Probiotics Shape the Gut Microbiome and Improve the Health of Early-Weaned Piglets. *Frontiers in Microbiology*, *9*(e00092-18). https://doi.org/10.3389/fmicb.2018.02011

Yalcın, S., Eser, H., Cengiz, S., Eltan, Ö. (2013). Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) on performance, carcass and gut characteristics, blood profile, and antibody production to sheep red blood cells in broilers. *Journal of Applied Poultry Research*, 22(1): 55–61. https://doi.org/10.3382/japr.2012-00577

Yalcın, S., Ozsoy, B., Erol, H., & Yalcın, S. (2008). Yeast culture supplementation to laying hen diets containing soybean meal or sunflower seed meal and its effect on performance, egg quality traits, and blood chemistry. *Journal of Applied Poultry Research*, 17(2): 229–236. https://doi.org/10.3382/japr.2007-00064

Yalcın, S., Uzunoğlu, K., Duyum, H.M., & Eltan, Ö. (2012). Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) and black cumin seed (*Nigella sativa* L.) on performance, egg traits, some blood characteristics, and antibody production of laying hens. *Livestock Science*, 145: 13–20. https://doi.org/10.1016/j.livsci.2011.12.013

Yalcın, S., Yalçın, S., Çakın, K., Eltan, Ö., & Dağaşan, L. (2010). Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) on performance, egg traits, egg cholesterol content, egg yolk fatty acid composition, and humoral immune response of laying hens. *Journal of the Science of Food and Agriculture*, 90(9): 1695–1701. https://doi.org/10.1002/jsfa.4004

Yousif, A.L., & Kloor, I.S. (2023). The effect of adding different levels of *Saccharomyces cerevisiae* to the quail birds feed or drinking water on characteristics of the egg production and the qualitative characteristics of local quail eggs. *NTU Journal of Agricultural and Veterinary Sciences*, 3(2), 45–50. https://doi.org/10.56286/ntujavs.v3i2.556

Zhang, A.W., Lee, B.D., Lee, S.K., Lee, K.W., An, G.H., Song, K.B., & Lee, C.H. (2005). Effects of yeast (*Saccharomyces cerevisiae*) cell components on growth performance, meat quality, and ileal mucosa development of broiler chicks. *Poultry Science,* 84(7), 1015–1021. https://doi.org/10.1093/ps/84.7.1015

Zhen, W., Liu, Y., Shao, Y., Ma, Y., Wu, Y., Guo, F., Abbas, W., Guo, Y., Wang, Z. (2021). Yeast β-glucan altered intestinal microbiome and metabolome in older hens. *Frontiers in Microbiology*, 12: 766878. https://doi.org/10.3389/fmicb.2021.766878