Review Article

Saccharomyces cerevisiae as Natural Growth Promoter in Broilers: Meta-analysis of Performance and Meat Quality

Muhammad Rizwan Yousaf[1], Bilal Ahmed[1], Shinta Pandupuspitasari Nuruliarizki[1], Mohammad Miftakhus Sholikin[2, 3, 4, 5], Asep Setiaji[1], Faheem Ahmed Khan[6, 7], Dela Ayu Lestari[1], Azhar Ali[1], Hasliza Abu Hassim[8, 9], Muhammad Asif Raza[10], Rahmeen Ajaz[11], Ikania Agusetyaningsih[1], Sugiharto Sugiharto[1*]

1. Department of Animal Science, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Indonesia.
2. Research Center for Animal Husbandry, Research Organization for Agriculture and Food, National Research and Innovation Agency (BRIN), Bogor, Indonesia.
3. Meta-Analysis in Plant Science (MAPS) Research Group, Bandung, Indonesia.
4. Center for Tropical Animal Studies (CENTRAS), The Institute of Research and Community Empowerment of IPB (LPPM IPB), Bogor, Indonesia.
5. Animal Feed and Nutrition Modelling (AFENUE) Research Group, IPB University, Bogor, Indonesia.
6. Research Center for Animal Husbandry, National Research and Innovation Agency, Jakarta Pusat, Indonesia.
7. Stem Cell and Cancer Research Indonesia, Semarang, Indonesia.
8. Institute of Tropical Agriculture and Food Security, Universiti Putra Malaysia, Serdang, Malaysia.
9. Department of Veterinary Preclinical Science, Faculty of Veterinary Medicine, Universiti Putra Malaysia, Serdang, Malaysia.
10. Department of Zoology, Wildlife & Fisheries, Faculty of Veterinary and Animal Sciences, Muhammad Nawaz Shareef University of Agriculture, Multan, Pakistan.
11. Department of Occupational Health and Safety, Faculty of Public Health, Universitas Indonesia (UI), Jakarta, Indonesia.

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ABSTRACT

The global demand for meat is increasing, and recent bans on antibiotic growth promoters (AGPs) have heightened the need for sustainable, effective alternatives in poultry production. Probiotic yeast *Saccharomyces cerevisiae* has emerged as a promising natural growth promoter in this context. This meta-analysis aims to evaluate the effects of *S. cerevisiae* on growth performance, feed efficiency, and meat quality (both physical and chemical) by synthesizing findings from previously reported studies. This meta-analysis used data from PubMed and Scopus to screen 377 studies and identify 14 relevant trials published from 2000 to 2025. It examined the effects of *S. cerevisiae*on broiler chicken growth and meat quality parameters (body weight (BW), feed conversion ratio (FCR), color, pH, dressing rate, cooking/drip loss, shear force, and water holding capacity [WHC]). Randomized controlled trials were analyzed with OpenMEE software to determine standard mean differences and heterogeneity. *S. cerevisiae* supplementation significantly improved broiler BW (standard mean difference [SMD]=0.446, P<0.001) and FCR (SMD=-0.442, P=0.001). *S. cerevisiae* also enhanced meat tenderness by reducing shear force (SMD=-4.662, P<0.001). Effects on other meat quality parameters (pH, cooking/drip losses, dressing rate, water-holding capacity (WHC), color) were not statistically significant. These findings suggest *S. cerevisiae* potential

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*** Corresponding Author:**
Sugiharto Sugiharto, Professor.
Address: *Department of Animal Science, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Indonesia.*
Phone: *+62 (812) 1598-4225*
E-mail: *sgh_undip@yahoo.co.id*

as a natural growth promoter for broiler performance and physical and chemical meat quality. *S. cerevisiae* supplementation enhances performance and meat quality. While some meat quality parameters were not significantly affected, *S. cerevisiae* shows promise as a natural alternative to AGPs in broiler production.

Keywords: Broiler performance, Feed efficiency, Growth promoter, Meta-analysis, *Saccharomyces cerevisiae*

Introduction

The global demand for food and protein is rising day by day, and poultry is one of the most promising industries to meet these demands for food security (Maharjan et al., 2021). In broiler chicken farming, efficiency and optimal performance are highly sought after for the efficient and economic well-being of farmers and consumers simultaneously (Chibanda et al., 2024). Sustainable and stable yield of broilers is attributed to several factors, including breed of broiler, environmental conditions, feed, and management practices. All these factors influence the output of the poultry industry and its profitability, and long-term solutions are always desired for sustainable production (Arikan et al., 2022; Tuncel & Kara, 2022).

The poultry industry is under various challenges globally, the latest and most challenging of which is the ban on antibiotic growth promoters (AGPs) (Bean-Hodgins & Kiarie, 2021). The AGPs have stood their ground for a long time since their first use for excellent growth and health benefits in broiler chicken, but recent awareness regarding their role for antimicrobial resistance, ethical issues, and raising consumer demands have shifted the focus towards friendly and sustainable alternatives (Adli et al., 2024; Harahap et al., 2024; Choi et al., 2022; Polidoro et al., 2024; Mayahi et al., 2025). Many alternatives have emerged and are under scientific exploration for optimization methods, some of which include the use of herbal compounds and essential oils, as well as the probiotic yeast *Saccharomyces cerevisiae* (Zhen et al., 2023; Roy & Ray, 2023; Hippenstiel et al., 2011). *S. cerevisiae* has proven to be a strong alternative to improve feed conversion, increase body weight (BW), promote the colonization of a healthy microbiome, and enhance the physical and chemical quality of broiler meat and large ruminants (Ahmed et al., 2024a; Sun et al., 2021; Dos Santos et al., 2021). However, its applicability and effectiveness are inconclusive, with large variations and fluctuations in the reported findings (Poberezhets et al., 2023a; Lin et al., 2023).

To address these discrepancies and show their true effects, a meta-analysis is urgently needed at this time. This analysis will synthesize literature reports on several parameters and aim to assess the full-scale applicability of using *S. cerevisiae* in broiler chickens and its effects on performance, feed utilization, and physical and chemical parameters.

Material and Methods

Search strategy

A comprehensive search strategy was employed to retrieve relevant studies from the Scopus and PubMed databases published from 2000 to 2025. The search used a combination of keywords, including "broiler chicken," broiler, AND/OR ("growth performance" OR "chicken meat") AND/OR "*S cerevisiae*" AND/OR "yeast." Titles and abstracts were screened to remove irrelevant studies, followed by a full-text review of shortlisted articles to confirm eligibility (Figure 1).

Eligibility criteria

The eligibility criteria for this meta-analysis were established to ensure the inclusion of relevant and high-quality studies. Only studies involving broiler chickens as the primary experimental subjects were considered, regardless of breed or strain, while those focusing on other poultry species or mixed populations were excluded. The intervention had to involve the use of *S. cerevisiae* as a dietary supplement or feed additive in any form, such as live yeast, dried yeast, yeast derivatives, or cell wall components, and the differences in effect among these forms could not be specifically studied due to data availability limitations. Studies using other probiotics or combinations where the specific effects of *S. cerevisiae* could not be isolated were excluded. Eligible studies were required to include control and experimental

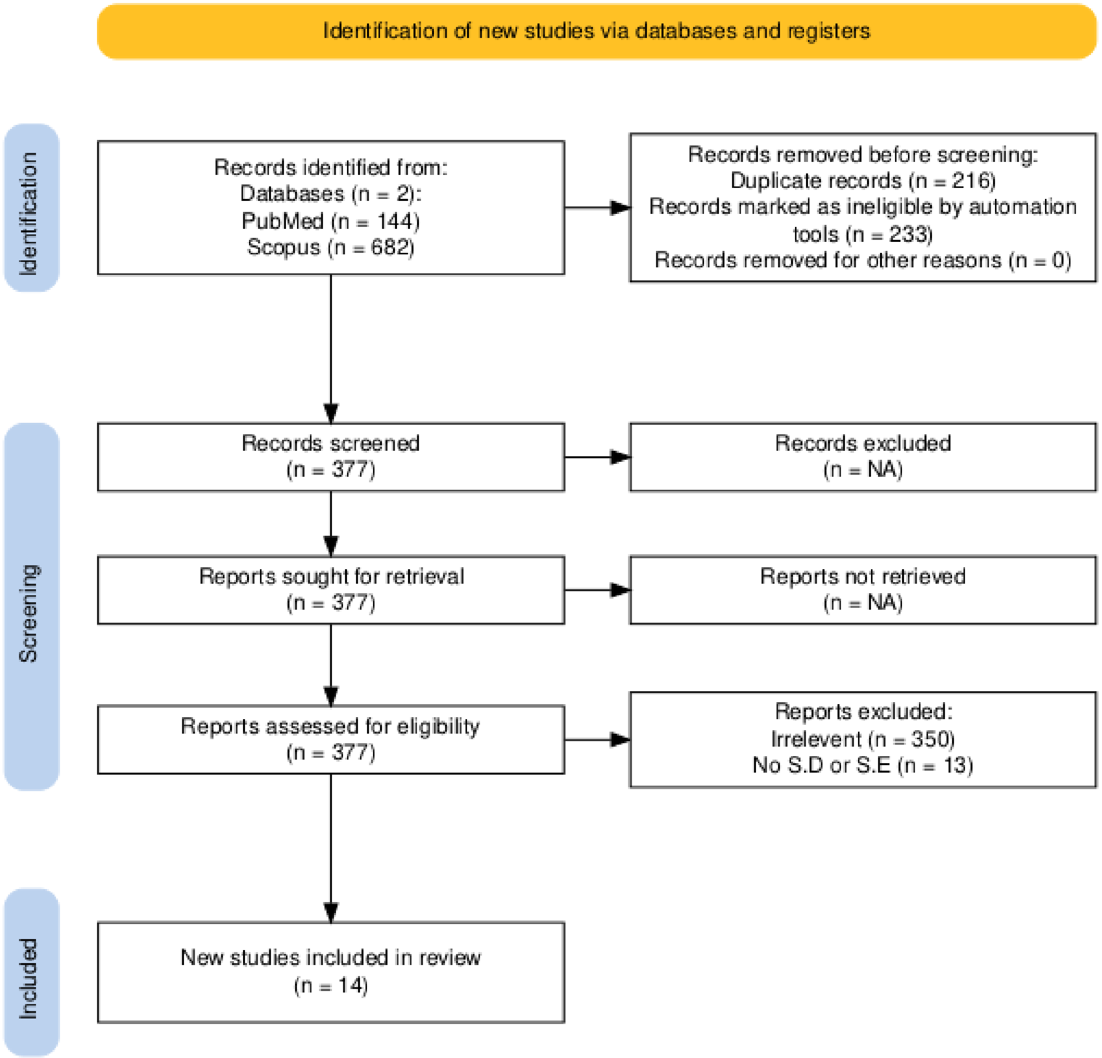

Figure 1. A PRISMA flowchart showing initial identified records, screening, and finalized studies

PRISMA: Preferred reporting items for systematic reviews and meta-analyses.

groups fed diets without *S. cerevisiae* supplementation and selected parameters. Studies without quantitative results or unrelated to these outcomes were excluded. Only experimental studies with a clear control-treatment design, such as randomized controlled trials or completely randomized designs, were included. At the same time, reviews, editorials, or conference abstracts without full data were excluded. Furthermore, the analysis was limited to peer-reviewed English-language articles.

Study parameters

The parameters measured in the study include growth feed efficiency and various physical and chemical quality traits for both the control and treatment groups. These parameters include performance parameters such as BW and feed conversion ratio (FCR). The physical and chemical parameters included the meat color, which was assessed (L, a, and b) for the breast meat, pH levels of the breast meat, dressing rate, cooking loss, and drip loss, shear force, and water holding capacity (WHC) were measured. These parameters collectively provide a comprehensive overview of the growth and meat quality characteristics of broiler chickens under *S. cerevisiae* supplementation.

Data extraction and analysis

The information was extracted and classified in Microsoft Excel sheets; the data included general study details (first author name and publication year). The selected parameters (as mentioned earlier) were used to extract metadata, including frequency, Mean±SD. These data sheets from Microsoft Excel were used to analyze the data in OPENMEE software, Version 2016.07.26 for standard meta-analysis, including the standard mean difference and heterogeneity analysis (Ahmed et al., 2024a).

Results

The main findings of this meta-analysis include the effects of *S. cerevisiae* supplementation on performance parameters and the chemical quality of meat in broiler chickens. Data from several trials were evaluated, and statistical validation was performed to ensure the meta-analysis's validity.

Growth performance

BW

This primary finding reveals that the supplementation with *S. cerevisiae* enhances BW. The increase in BW is evident by the standard mean difference (SMD) of 0.446. This difference in SMD indicates a significant increase in the treatment groups relative to the control groups across the selected studies and data points. Also, the heterogeneity value of I^2=85.436% indicates uniformity and steadiness in the BW increase across the data points. It suggests a constant elevation in BW (Table 1, Figure 2). This finding is strong evidence of the use of *S. cerevisiae* as an alternative to AGPs.

FCR

Another noteworthy finding of this meta-analysis is the improved FCR, which is a primary indicator of enhanced feed utilization. The FCR exhibited a very significant improvement, having a P value of 0.001 with an SMD of -0.442 (95% CI, -0.599%, -0.284%) (Table 1, Figure 3). This outcome specifically shows that *S. cerevisiae* supplementation improves feed efficiency, lowers production costs, and increases sustainability in the production of broiler chickens. The use as an alternative to traditional AGPs is clearly evident in its effect on FCR. The results' statistical significance and low heterogeneity (I^2=0.001%) support its use as an alternative and suggest that *S. cerevisiae* consistently improves FCR across studies and data points.

Meat quality

Breast meat pH

There was a slight (for general pH) but positive (for breast meat pH) shift in the pH of the breast meat. With a P of 0.116 and an SMD of 0.068 (95% CI, -0.017%, 0.152%), the pH change in the breast was not statistically significant (Table 1, Figures 4 and 5). The lack of statistical significance (for both breast and general pH) suggests that *S. cerevisiae* supplementation has little effect on the pH of breast meat, even if the result indicates a modestly positive shift in pH in the *S. cerevisiae* supplemented group.

Cooking loss

Cooking loss is not affected by *S. cerevisiae*, as evidenced by an SMD of 0.1000 (95% CI) (P=0.439) (Table 1, Figure 6). The overall result indicates that *S. cerevisiae* supplementation does not appreciably change cooking loss in broiler chickens. This finding can be a desirable quality in terms of water-retention properties, as it is an indicator of meat juiciness and tenderness.

Drip loss

The SMD for drip loss was 0.111 and its P was 0.190 (95% CI, -0.055%, 0.276%), indicating that *S. cerevisiae* supplementation had no discernible effect on drip loss (Table 1, Figure 7). This finding suggests that although drip loss may have decreased in certain individual experiments, the combined data do not demonstrate a meaningful effect. It is a very important indicator of water-holding capacity (WHC) and juiciness.

Shear force

A very high and positive nature effect of *S. cerevisiae* is observed on the shear force of meat, with SMD of 4.662 and high significance (P=0.001) (Table 1, Figure 8). Shear force is an indicator of meat softness and tenderness, which is a highly desired quality.

Dressing rate

S. cerevisiae supplementation had a minor effect on the dressing rate. This effect is shown by a minor SMD of 0.247 (P=0.057) (Table 1, Figure 9). This finding implies that while *S. cerevisiae* might have a small impact on the dressing rate, it should not be considered significant in the large. The lack of a substantial effect of *S. cerevisiae* on the dressing rate, a crucial factor that affects the amount of usable meat, suggests that *S. cerevisiae* supplementation has little effect on carcass output.

Studies	Estimate (95% C.I.)
Ionel Toader et al 2018	1.322 (0.710, 1.934)
Ionel Toader et al 2018-2	1.935 (1.263, 2.606)
Ionel Toader et al 2018-3	1.798 (1.141, 2.454)
Ionel Toader et al 2018-4	0.271 (-0.286, 0.828)
Ionel Toader et al 2018-5	0.497 (-0.065, 1.060)
Ionel Toader et al 2018-6	0.473 (-0.089, 1.035)
Ionel Toader et al 2018-7	0.562 (-0.003, 1.127)
Ionel Toader et al 2018-8	0.834 (0.256, 1.412)
Ionel Toader et al 2018-9	0.997 (0.409, 1.585)
Shafia Tehseen Gul et al 2022	0.082 (-0.538, 0.702)
Shafia Tehseen Gul et al 2022-2	1.081 (0.417, 1.744)
Shafia Tehseen Gul et al 2022-3	1.398 (0.707, 2.090)
Shafia Tehseen Gul et al 2022-4	0.497 (-0.132, 1.127)
Shafia Tehseen Gul et al 2022-5	3.063 (2.149, 3.976)
Shafia Tehseen Gul et al 2022-6	1.716 (0.991, 2.441)
Shafia Tehseen Gul et al 2022-7	0.511 (-0.119, 1.141)
Shafia Tehseen Gul et al 2022-8	1.294 (0.612, 1.975)
Shafia Tehseen Gul et al 2022-9	1.312 (0.629, 1.996)
Vetriselvi Sampath et al 2021	1.844 (1.064, 2.624)
Vetriselvi Sampath et al 2021-2	3.226 (2.235, 4.218)
Vetriselvi Sampath et al 2021-3	0.691 (0.019, 1.364)
Vetriselvi Sampath et al 2021-4	2.586 (1.701, 3.472)
Vetriselvi Sampath et al 2021-5	1.075 (0.377, 1.774)
Vetriselvi Sampath et al 2021-6	1.751 (0.983, 2.520)
A. W. Zhang et al 2005	0.203 (-0.156, 0.561)
A. W. Zhang et al 2005-2	0.375 (0.014, 0.736)
A. W. Zhang et al 2005-3	0.638 (0.271, 1.004)
A. W. Zhang et al 2005-4	0.419 (0.057, 0.781)
A. W. Zhang et al 2005-5	0.380 (0.019, 0.741)
A. W. Zhang et al 2005-6	0.400 (0.038, 0.761)
Wen Yang Chuang et al 2020	0.148 (-0.210, 0.506)
Wen Yang Chuang et al 2020-2	0.285 (-0.075, 0.644)
E. Hussein et al 2018	0.122 (-0.181, 0.424)
E. Hussein et al 2018-2	0.077 (-0.226, 0.379)
A. W. Zhang et al 2005 B	0.072 (-0.286, 0.430)
A. W. Zhang et al 2005 B-2	0.124 (-0.234, 0.482)
A. W. Zhang et al 2005 B-3	0.074 (-0.284, 0.432)
A. W. Zhang et al 2005 B-4	0.228 (-0.131, 0.587)
A. W. Zhang et al 2005 B-5	0.101 (-0.257, 0.459)
A. W. Zhang et al 2005 B-6	0.201 (-0.158, 0.560)
Md-Raihanul Hoque et al 2021	0.298 (0.090, 0.505)
Md-Raihanul Hoque et al 2021-2	0.054 (-0.153, 0.261)
Md-Raihanul Hoque et al 2021-3	0.269 (0.061, 0.476)
L. G. A. Aristides et al 2018	-4.206 (-5.448, -2.964)
L. G. A. Aristides et al 2018-2	-4.948 (-6.344, -3.552)
L. G. A. Aristides et al 2018-3	-1.732 (-2.544, -0.919)
A. Paryad et al 2008	0.047 (-0.311, 0.405)
A. Paryad et al 2008-2	0.280 (-0.080, 0.639)
A. Paryad et al 2008-3	0.187 (-0.172, 0.545)
A. Paryad et al 2008-4	0.035 (-0.322, 0.393)
A. Paryad et al 2008-5	0.288 (-0.071, 0.648)
A. Paryad et al 2008-6	0.083 (-0.275, 0.441)
Hao-Yang Sun et al 2018	0.108 (-0.092, 0.308)
Hao-Yang Sun et al 2018-2	0.072 (-0.128, 0.272)
Hao-Yang Sun et al 2018-3	0.144 (-0.056, 0.344)
Hao-Yang Sun et al 2018-4	0.192 (-0.008, 0.393)
Hao-Yang Sun et al 2018-5	0.117 (-0.083, 0.317)
Hao-Yang Sun et al 2018-6	0.234 (0.033, 0.435)
Sugiharto Sugiharto et al 2018	0.267 (-0.065, 0.600)
Sugiharto Sugiharto et al 2018-2	0.248 (-0.084, 0.581)
Sugiharto Sugiharto et al 2018-3	0.936 (0.587, 1.285)
Sugiharto Sugiharto et al 2018-4	0.127 (-0.204, 0.459)
Sugiharto Sugiharto et al 2018-5	-0.097 (-0.428, 0.235)
Sugiharto Sugiharto et al 2018-6	0.830 (0.485, 1.175)
Youssf.A Attia et al 2023	0.534 (-0.030, 1.098)
Overall (I^2=85.44 % , P< 0.001)	**0.446 (0.322, 0.570)**

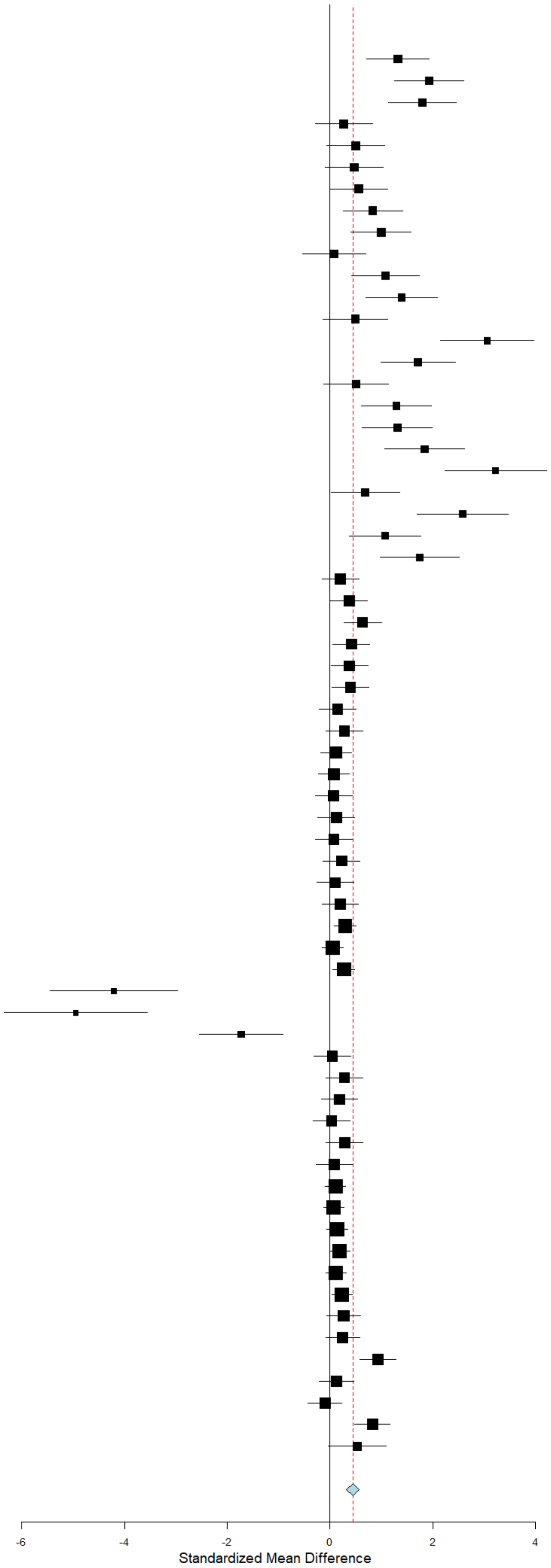

Figure 2. Standard meta-analysis forest plot for BW

Studies	Estimate (95% C.I.)
Ionel Toader et al 2018	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-2	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-3	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-4	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-5	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-6	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-7	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-8	0.000 (-0.554, 0.554)
Ionel Toader et al 2018-9	0.000 (-0.554, 0.554)
Vetriselvi Sampath et al 2021	0.000 (-0.653, 0.653)
Vetriselvi Sampath et al 2021-2	0.000 (-0.653, 0.653)
Vetriselvi Sampath et al 2021-3	0.000 (-0.653, 0.653)
Vetriselvi Sampath et al 2021-4	0.000 (-0.653, 0.653)
Vetriselvi Sampath et al 2021-5	0.000 (-0.653, 0.653)
Vetriselvi Sampath et al 2021-6	0.000 (-0.653, 0.653)
A. W. Zhang et al 2005	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005-2	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005-3	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005-4	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005-5	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005-6	0.000 (-0.358, 0.358)
Wen Yang Chuang et al 2020	0.000 (-0.358, 0.358)
Wen Yang Chuang et al 2020-2	0.000 (-0.358, 0.358)
E. Hussein et al 2018	0.000 (-0.302, 0.302)
E. Hussein et al 2018-2	0.000 (-0.302, 0.302)
A. W. Zhang et al 2005 B	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005 B-2	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005 B-3	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005 B-4	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005 B-5	0.000 (-0.358, 0.358)
A. W. Zhang et al 2005 B-6	0.000 (-0.358, 0.358)
Md-Raihanul Hoque et al 2021	0.000 (-0.207, 0.207)
Md-Raihanul Hoque et al 2021-2	0.000 (-0.207, 0.207)
Md-Raihanul Hoque et al 2021-3	0.000 (-0.207, 0.207)
A. Paryad et al 2008	0.000 (-0.358, 0.358)
A. Paryad et al 2008-2	0.000 (-0.358, 0.358)
A. Paryad et al 2008-3	0.000 (-0.358, 0.358)
A. Paryad et al 2008-4	0.000 (-0.358, 0.358)
A. Paryad et al 2008-5	0.000 (-0.358, 0.358)
A. Paryad et al 2008-6	0.000 (-0.358, 0.358)
Hao-Yang Sun et al 2018	0.000 (-0.200, 0.200)
Hao-Yang Sun et al 2018-2	0.000 (-0.200, 0.200)
Hao-Yang Sun et al 2018-3	0.000 (-0.200, 0.200)
Hao-Yang Sun et al 2018-4	0.000 (-0.200, 0.200)
Hao-Yang Sun et al 2018-5	0.000 (-0.200, 0.200)
Hao-Yang Sun et al 2018-6	0.000 (-0.200, 0.200)
Sugiharto Sugiharto et al 2018	0.000 (-0.331, 0.331)
Sugiharto Sugiharto et al 2018-2	0.000 (-0.331, 0.331)
Sugiharto Sugiharto et al 2018-3	0.000 (-0.331, 0.331)
Sugiharto Sugiharto et al 2018-4	0.000 (-0.331, 0.331)
Sugiharto Sugiharto et al 2018-5	0.000 (-0.331, 0.331)
Sugiharto Sugiharto et al 2018-6	0.000 (-0.331, 0.331)
Youssf.A Attia et al 2023	0.000 (-0.554, 0.554)
Overall (I^2=0 % , P=1.000)	**0.000 (-0.045, 0.045)**

Figure 3. Standard meta-analysis forest plot for FCR

WHC

WHC was slightly positively affected by *S. cerevisiae* supplementation; however, there was substantial heterogeneity. The slight minor change in WHC is evident by SMD of 0.11 under a confidence interval of 95% and a statistical significance P at 0.190 (Table 1, Figure 10). The heterogeneity is high, with an I^2 value of 73.374%, due to variations in *S. cerevisiae* dosage, broiler breeds, and study designs. This finding suggests that although *S. cerevisiae* can occasionally increase water storage capacity, the impact varies depending on the circumstances. Meat's ability to retain water has a significant impact on its quality.

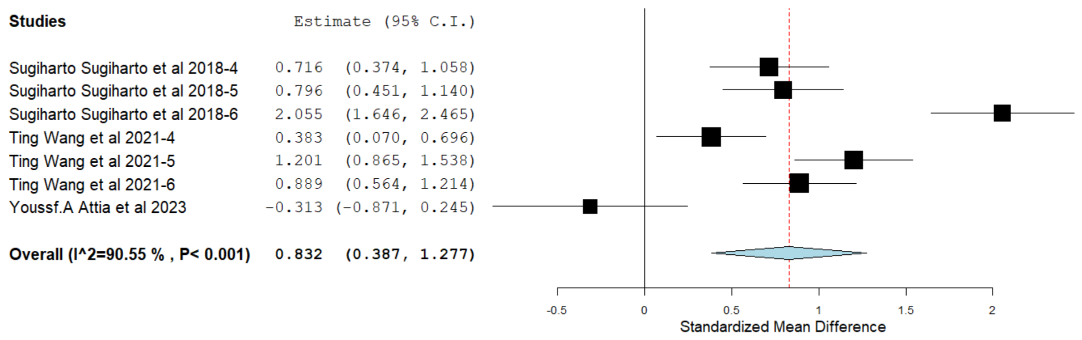

Figure 4. Standard meta-analysis forest plot for pH

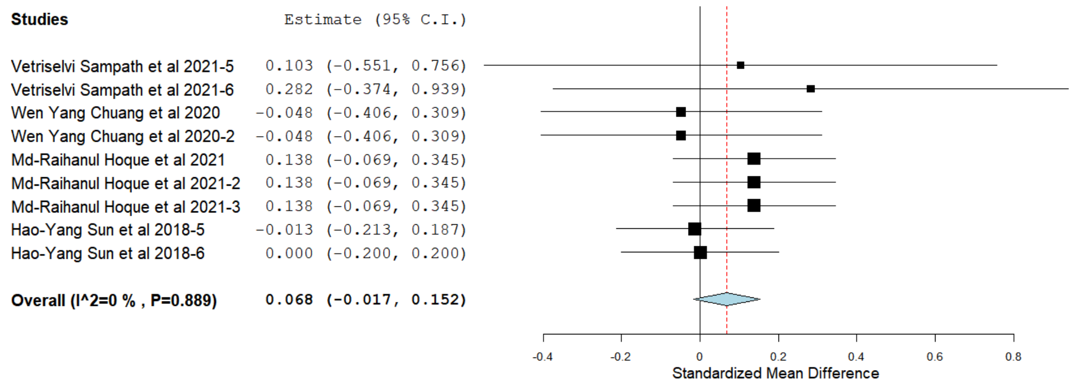

Figure 5. Standard meta-analysis forest plot for breast meat pH

Breast meat color (L, a, b)

The meat color (lightness L*, redness a*, and yellowness b*) is not significantly different between treatment and control groups. The results show SMD of 0.053, -0.000, and -0.009 for L*, b*, and a*, respectively, with P 0.809, 0.967, and 0.999 (Table 1, Figures 11, 12, and 13).

Discussion

Impact of *S. cerevisiae* on growth performance and feed efficiency

The BW of broiler chickens is affected by dietary supplementation with *S. cerevisiae*, with a standardized mean difference of 0.446 (P=0.001). This positive increase in BW and growth performance is consistent across the selected studies (Poberezhets et al., 2023a; Younis et al., 2024). In terms of heterogeneity, there was substantial heterogeneity (I^2=85.436%), further suggesting a smooth and consistent positive impact across studies (A Fwaz et al., 2024; Lin et al., 2023; Ismael et al., 2022). Also, the promotion of an improved FCR adds to these findings. These results support and advocate for *S. cerevisiae*'s role in improving performance and increasing feed utilization, resulting in reduced production costs and benefits to farmers (Lin et al., 2023).

There are a number of ways that *S. cerevisiae* achieves the reported results: The promotion of a beneficial microbiome, enzymatic action, immune modulation, and anti-pathogenic abilities (Soren et al., 2023; Soren et al., 2023; Attia et al., 2022). The microbiota, such as *Lactobacillus* and *Bifidobacterium*, are promoted by *S.*

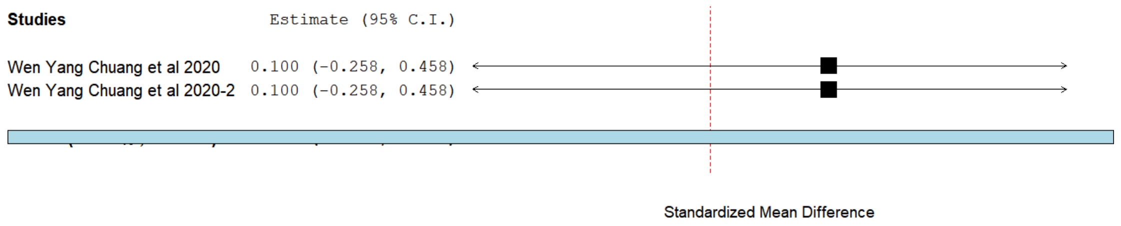

Figure 6. Standard meta-analysis forest plot for cooking loss

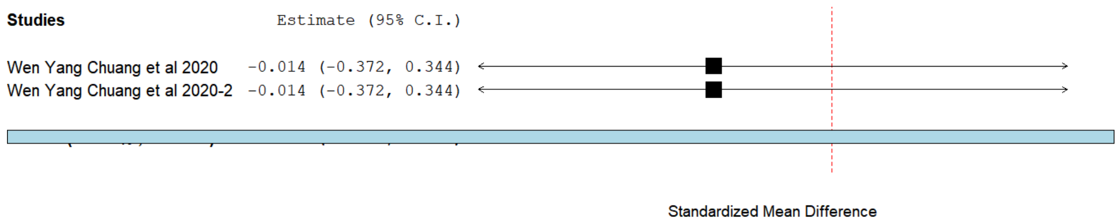

Figure 7. Standard meta-analysis forest plot for drip loss

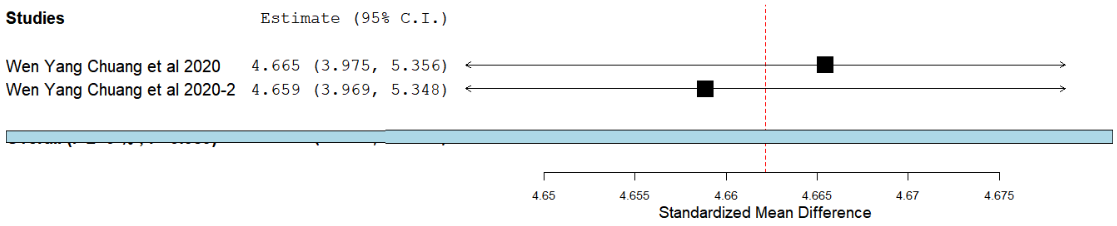

Figure 8. Standard meta-analysis forest plot for shear force

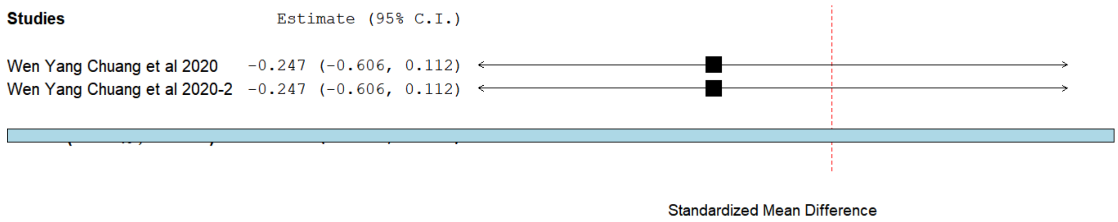

Figure 9. Standard meta-analysis forest plot for dressing rate

cerevisiae. These microbes function to improve nutrient absorption, intestinal integrity, and overall health (Attia et al., 2023). Along with microbiome promotion, *S. cerevisiae* produces amylase and protease enzymes that aid in the digestion and breakdown of feed and improve feed utilization (A Fwaz et al., 2024; Ismael et al., 2022).

The immune modulation effect and mannan-oligosaccharides (in the cell wall of *S. cerevisiae*) help reduce inflammation, prevent pathogenic organisms like *Clostridium perfringens*, and maintain a healthy gut integrity (Faustino et al, 2021; Fornazier et al, 2021; Alqhtani et al, 2024).

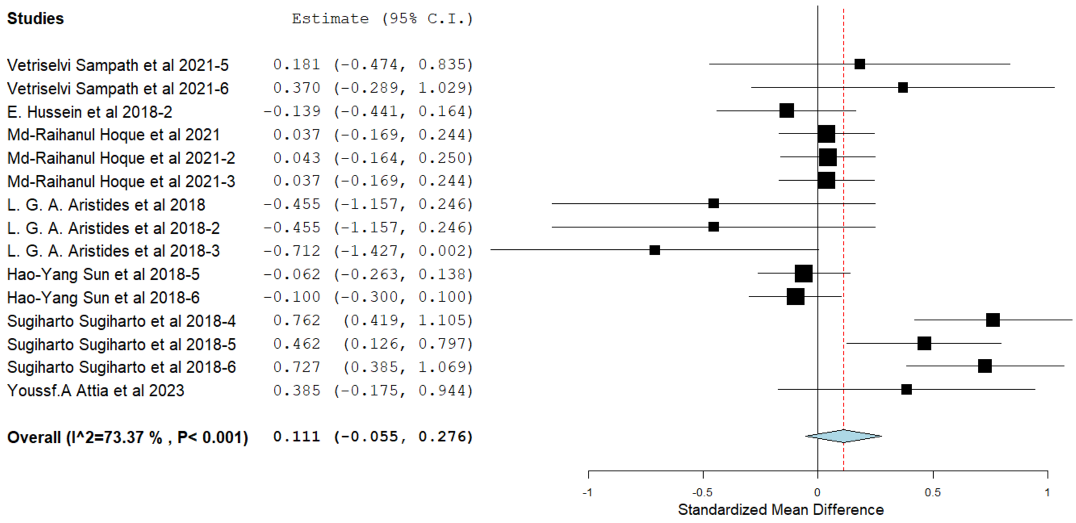

Figure 10. Standard meta-analysis forest plot for WHC

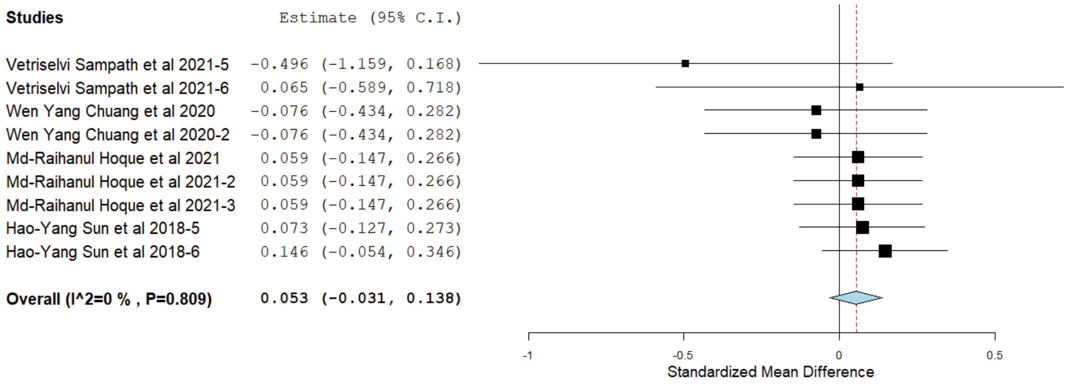

Figure 11. Standard Meta-analysis Forest Plot for Breast Meat Color L (Lightness)

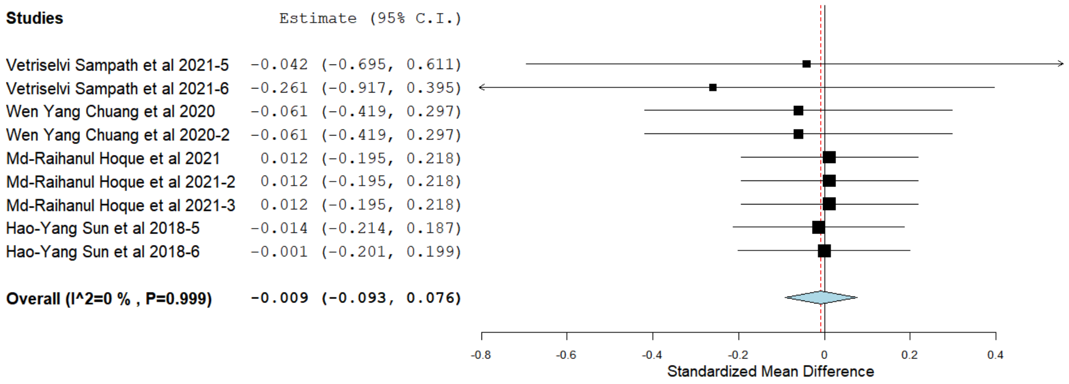

Figure 12. Standard meta-analysis forest plot for breast meat color a (redness)

Effects on meat quality parameters

Breast meat pH

A higher pH in post-slaughter broiler chicken indicates a higher WHC, influencing softness or tenderness, and is associated with lower drip loss, influenced by slaughter conditions, stress, and glycolysis rates (Beauclercq et al., 2022; Hoque et al., 2021; Gumus & Gelen, 2023). This condition results in softer, paler coloration, adding to the visual appeal of chicken (Hoque et al., 2021; Gumus & Gelen, 2023). The overall impact of *S. cerevisiae* on pH is inconsistent when aggregated from the literature. It is speculated to be influenced by variations in *S. cerevisiae* dosage, broiler breed, study design, slaughter conditions, stress, and glycolysis rate (Beauclercq et al., 2022).

Cooking loss and drip loss

Drip loss and cooking loss are two very important parameters for the physical meat quality of broiler chicken. These two parameters influence the moisture-holding

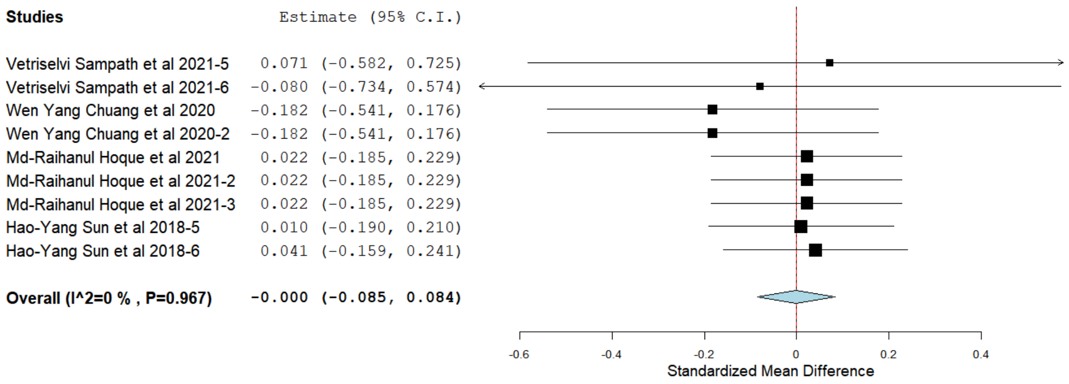

Figure 13. Standard meta-analysis forest plot for breast meat colour b (yellowness)

Table 1. Standard meta-analysis for all parameters: estimate effect size, significance P, and level of heterogeneity

Parameters	Study Effect					Heterogeneity	
	SMD	Lower	Upper	SE	P	I^2 (%)	P
BW	0.446	0.446	0.446	0.446	0.001	85.436	0.001
FCR	-0.442	-0.599	-0.284	0.08	0.001	0.001	0.001
pH	-0.442	-0.599	-0.284	0.08	0.001	0.001	0.001
Breast meat pH	0.068	-0.017	0.152	0.043	0.116	0	0.889
Cooking loss	0.1	0.153	0.353	0.353	0.439	0	0.439
Drip loss	-0.014	-0.267	0.239	0.129	0.914	0	1.000
Shear force	4.662	4.174	5.15	0.249	0.001	0	0.989
Dressing rate	-0.247	-0.501	0.007	0.13	0.057	0	1.000
WHC	0.111	-0.055	0.276	0.084	0.190	73.374	0.001
Breast meat color L (lightness)	0.053	-0.031	0.138	0.043	0.217	0	0.809
Breast meat color a (redness)	-0.009	-0.093	0.076	0.043	0.841	0	0.999
Breast meat color b (yellowness)	-0.0	-0.085	0.084	0.043	0.994	0	0.967

capacity and juiciness of meat and enhance the taste and consumer likeness (Gál et al., 2022; Sun et al., 2024; Dang et al., 2024). In the analysis, some studies report a positive influence and improved water retention, but the substantial variability in the meta-analysis suggests the overall impact is inconsistent and non-significant. Hence, the influence of *S. cerevisiae* on post-slaughtering water retention is inconclusive. This notion can be further explored by studies focusing on muscle fiber composition and proteolytic enzymatic activity (Barido & Lee 2021a).

Shear force (meat tenderness)

Another important physical quality of meat is shear force, which is a direct measure of the integrity of the muscle fibres and the proteolytic action after slaughter. Shear force of meat is linked to tenderness, protein content, and lowered muscle tension (Gu et al., 2024; Park et al., 2021). The results of the meta-analysis show a standard mean difference of -4.662 (P=0.001), indicating a positive influence on reduced shear force and ultimately improved tenderness and softness of meat.

The improved tenderness resulting from reduced shear force due to *S. cerevisiae* supplementation can be attributed to proteolytic enzymatic action (calpains and cathepsins), along with an improved gut microbiome, leading to greater muscle growth and reduced connective tissue development, which causes meat hardness. This action of *S. cerevisiae* leads to enhanced consumer likeness of meat and a sustainable alternative to AGPs (Barido & Lee, 2021a; Xiang et al., 2024; Barido & Leeb, 2021).

Dressing rate and carcass yield

Dressing percentage (the proportion of edible meat post-processing) is usually influenced by factors, including breed, diet, processing methods, etc. (Kareem-Ibrahim et al., 2021; Zhu et al., 2024; Gumus & Gelen, 2023; Askri et al., 2021). The result of this meta-analysis reports the standard mean difference of 0.247 (P = 0.057), indicating a moderate effect. There is some level of contradiction among the reported studies, leading to minor, significant overall effects.

WHC

WHC is another physical parameter that directly influences meat tenderness, juiciness, the taste of the final product, cooking loss, and drip loss. Under the influence of *S. cerevisiae*, WHC is positively and moderately influenced, with the standard mean difference of (SMD=0.111) and (P=0.190). The lack of a statistically significant p value is attributed to a lack of study points (I^2=73.374%) and context-dependent (Kaewkot et al., 2022; Barido & Lee, 2021a).

Breast meat color (L, a, b*) **

Color is influenced by pH, water content, oxidative stability, and myoglobin contents (Dimitrov et al., 2023; Zhu et al., 2024). The results of this meta-analysis indicate that *S. cerevisiae* supplementation does not directly affect meat color (L*, a*, b*). This result implies that there is no effect of *S. cerevisiae* on oxidative stress or on pigment deposition in the muscles of broiler chickens, thereby maintaining their natural pigmentation and oxidative conditions. This non-significant influence suggests that *S. cerevisiae* maintains the natural coloration and freshness, thereby enhancing consumer appeal (Askri et al., 2021; Ukhro et al., 2021).

Mode of action

The major contribution of *S. cerevisiae* towards enhancing BW and improving the feed utilization is by modulating the beneficial gut microbiome, enhancing absorption of nutrients, digestibility, enzymatic action, and immune modulation (Sun et al., 2024; Matur et al., 2010; Aluwong et al., 201; Bortoluzzi et al., 2018). *S. cerevisiae* functions to improve disease resistance by inhibiting pathogenic microbes while simultaneously promoting the beneficial microbiome of the broiler gastrointestinal tract (Bortoluzzi et al., 2018; Ahiwe et al., 2021). This action not only supports proper breakdown of feed by beneficial microbes but also improves intestinal wall integrity and overall immunity, resulting in enhanced nutrient absorption, increased BW gain, and improved feed utilization. Moreover, the stimulation of VFAs production further enhances the effects by providing a quick and sustainable source of energy to the intestinal wall, resulting in improved immunity and integrity (Elghandour et al., 2020; Luquetti et al., 2012).

The oxidative balance offered by *S. cerevisiae* results in sustained pH, which is desired and favoured by consumers (Aluwong et al., 2013; Elbaz et al., 2025; Shareef et al., 2023). The WHC improvement results in improved tenderness and softness, thereby reducing drip and cooking losses and ultimately making the meat more juicy. In terms of shear force, *S. cerevisiae* works through its enzymatic action to enhance protein metabolism and reduce connective tissue buildup, making the meat more tender and smooth (Aristides et al., 2018; Dávila-Ramírez, 2020; Poberezhets et al., 2023a). The pigmentation is left in its natural state, as desired by consumers, and is unaffected by supplementation of *S. cerevisiae* across the treatment groups, through improved oxidative stability and pigment retention (Qui, 2023; Grigore et al., 2023).

S. cerevisiae works by modulating gut microbiota, improving nutrient digestibility, enhancing enzymatic activity, modulating immune function, influencing meat pigmentation, and improving oxidative stability (Elbaz et al., 2025; Dávila-Ramírez, 2020; Grigore et al., 2023). Overall, *S. cerevisiae* functions as a natural growth promoter, enhancing broiler productivity and meat quality while serving as a promising alternative to AGPs.

Conclusion

This meta-analysis confirms that *S. cerevisiae* as a probiotic supplement significantly improves broiler growth performance and feed efficiency while maintaining several key meat quality parameters at natural levels (pH, cooking loss, and WHC) and coloration at consumer-desired levels. A notable reduction in shear force indicates improved meat tenderness. *S. cerevisiae* supplementation emerges as a potential alternative to AGPs, offering a natural, safe, and sustainable strategy for poultry production. Future research should focus on dose optimization, strain selection, formulations, and mechanistic studies to fully understand *S. cerevisiae*'s functional benefits. As the poultry industry moves toward antibiotic-free production, *S. cerevisiae* represents a promising tool for sustainably enhancing broiler health, performance, and meat quality.

Ethical Considerations

Compliance with ethical guidelines

This article is a meta-analysis with no human or animal sample.

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Authors' contributions

Conceptualization and supervision: Sugiharto Sugiharto and Mo-hammad Miftakhus Sholikin; Data collection: Muhammad Rizwan Yousaf, Bi-lal Ahmed, Shinta Pandupuspitasari Nuruliarizki, and Hasliza Abu Hassim; Data analysis and writing the original draft: Muhammad Rizwan Yousaf and Bilal Ah-med; Review and editing: Asep Setiaji, Faheem Ahmed Khan, Dela Ayu Lestari, Azhar Ali, Muhammad Asif Raza, Ikania Agusetyaningsih, and Rahmeen Ajaz.

Conflict of interest

The authors declared no conflict of interest.

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