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The nutrient retention and carcass quality of Noiler chickens fed diets containing supplemental levels of saccharomyces cerevisiae

By

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Abstract

The present study evaluated the effects of graded dietary inclusion of Saccharomyces cerevisiae on nutrient retention and carcass characteristics of Noiler chickens under tropical production conditions. A total of 300 day-old Noiler chicks of mixed sexes were randomly allocated to five dietary treatments in a completely randomised design, with three replicates of 20 birds per treatment. The treatments comprised a basal diet without yeast (T1) and diets supplemented with 0.5% (T2), 1.0% (T3), 1.5% (T4) and 2.0% (T5) S. cerevisiae. The feeding trial lasted 16 weeks. Apparent nutrient retention was determined during the finisher phase using acid-insoluble ash as an internal marker, while carcass evaluation was conducted at the end of the trial on representative birds per treatment. Dietary yeast supplementation significantly ($P < 0.05$) influenced dry matter, moisture, ash, ether extract, crude fibre, nitrogen retention and apparent metabolisable energy. Birds fed 1.5% S. cerevisiae (T4) recorded the highest nitrogen retention (43.58%), whereas mineral retention was optimised at 1.0% inclusion (17.78%). Apparent metabolisable energy was highest in the control group but remained comparable among supplemented treatments. Crude protein digestibility showed slight numerical improvement in yeast-fed groups without adverse effects, indicating that supplementation up to 2% did not impair protein utilisation. Improvements in fibre utilisation and mineral retention suggest enhanced digestive efficiency and gut functionality in supplemented birds. Carcass characteristics revealed no significant ($P > 0.05$) differences in live weight, dressed weight, breast yield or back cut among treatments, although numerical improvements were observed at 0.5% and 2.0% inclusion levels. Significant ($P < 0.05$) differences were detected in thigh, drumstick and shank weights, with the 2.0% inclusion level producing superior drumstick (195.67 g) and shank (84.67 g) weights, indicating enhanced development of locomotive muscles. The observed improvements in selective carcass traits may be associated with enhanced nutrient partitioning, improved mineral bioavailability and better intestinal integrity mediated by yeast cell wall components such as β-glucans and mannan-oligosaccharides. Overall, dietary supplementation of Saccharomyces cerevisiae enhanced nutrient retention and improved selected carcass parameters of Noiler chickens without detrimental effects on growth or carcass yield. Inclusion levels between 1.0% and 1.5% optimised nutrient utilisation, while 2.0% favoured certain muscle traits. These findings provide breed-specific evidence supporting the strategic use of probiotic yeast as a functional feed additive to improve productivity and sustainability of dual-purpose chickens under tropical production systems.

Keywords: *Noiler chickens; nutrient retention; probiotic yeast; carcass traits; tropical poultry production; Saccharomyces cerevisiae.*

INTRODUCTION

Poultry production in Nigeria continues to face challenges related to escalating feed costs, inefficient nutrient utilisation and inconsistent carcass quality. For Noiler chickens, which are promoted as cost-effective and climate-resilient dual-purpose birds, optimisation of nutrient retention and carcass yield is essential to maximise profitability and meet rising protein demands.

The poultry industry remains one of the fastest-growing livestock subsectors globally and a critical contributor to food security, particularly in developing economies. However, poultry production competes directly with humans for major feed resources such as maize and soybean meal, thereby escalating feed costs and reducing profit margins (Goffeau et al., 1996; Iji et al., 2017). Feed accounts for approximately 60–70% of total production costs, and volatility in grain

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supply has intensified the search for sustainable, less competitive and health-promoting dietary strategies (Tanimo et al., 2020). Contemporary poultry nutrition increasingly prioritises functional feed additives that enhance nutrient utilisation efficiency, support gut health and reduce reliance on antibiotic growth promoters.

Nigeria, with a population exceeding 210 million and an annual growth rate of approximately 2.6% (Worldometer, 2020), faces increasing pressure to meet animal protein demands. Bridging the protein gap requires shorter production cycles, improved nutrient retention, enhanced carcass yield and the adoption of resilient genotypes suited to tropical environments. In this context, dual-purpose chickens that combine acceptable growth performance with egg production are gaining strategic importance.

Noiler chickens represent one such innovation in Nigerian poultry breeding. Developed by Amo Farm Sieberer Hatchery, the Noiler is a hybrid derived from Nigerian indigenous chickens and the White Plymouth Rock. This crossbreeding strategy combines the hardiness and disease tolerance of local ecotypes with the superior growth traits of improved lines (Hall et al., 2015). Noilers are recognised for their adaptability to diverse management systems, resistance to environmental stressors and dual-purpose potential (meat and egg production). Under appropriate management, males may attain live weights of approximately 2.5–2.6 kg by 12–14 weeks, while females commence lay at about five months, producing 150–200 eggs annually. These attributes make Noilers particularly attractive to smallholder and semi-intensive farmers seeking cost-effective and climate-resilient poultry systems.

Despite these favourable characteristics, productivity in Noiler chickens is still constrained by suboptimal nutrient retention, inconsistent feed conversion efficiency and carcass yield variability under practical production conditions. Nutrient retention—the proportion of ingested nutrients absorbed and utilised by the bird—is a fundamental determinant of growth performance and carcass quality. Enhanced nutrient digestibility directly influences muscle deposition, dressing percentage, organ development and overall meat quality traits (Amerah et al., 2014). Consequently, nutritional interventions that improve digestive efficiency may substantially enhance both economic returns and product quality.

Among natural feed additives, Saccharomyces cerevisiae has attracted considerable scientific interest. As a probiotic yeast, *S. cerevisiae* exerts beneficial effects through multiple mechanisms, including competitive exclusion of pathogens, modulation of gut microbiota, enhancement of digestive enzyme activity and stimulation of immune responses (Gao et al., 2008; Elghandour et al., 2020). Yeast cell wall components such as β-glucans and mannan-oligosaccharides are known to improve intestinal integrity and nutrient absorption, thereby enhancing feed conversion ratio (FCR) and growth performance (Alizadeh et al., 2016).

Several studies in broiler chickens have demonstrated that dietary supplementation with *S. cerevisiae* improves apparent nutrient digestibility, nitrogen retention and carcass characteristics, including increased breast muscle yield and improved dressing percentage (Zhang et al., 2005; Abdelrahman, 2013). Improvements in nutrient retention are often associated with enhanced intestinal morphology, increased villus height and optimised microbial balance, which collectively enhance absorptive efficiency. However, responses may vary depending on inclusion level, strain specificity, genotype and environmental conditions.

While the effects of *S. cerevisiae* have been extensively evaluated in commercial broilers, there is limited information regarding its influence on nutrient retention and carcass quality in Noiler chickens. Given the genetic background and adaptive physiology of Noilers, extrapolation from conventional broiler data may not adequately capture breed-specific responses. Therefore, empirical evaluation under tropical production conditions is necessary to generate reliable recommendations for dietary yeast inclusion in dual-purpose chickens.

Although *Saccharomyces cerevisiae* has demonstrated promising effects on digestive efficiency and carcass traits in broiler strains, limited breed-specific data exist for Noiler chickens. The absence of targeted research restricts evidence-based recommendations for its optimal inclusion level. Therefore, systematic investigation into the effects of graded levels of *S. cerevisiae* on nutrient retention and carcass quality of Noiler chickens is warranted to enhance productivity, sustainability and food security in tropical poultry systems.

MATERIALS AND METHODS

Experimental Location

The study was conducted at the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike lies within latitude 5°27′–5°29′ N and longitude 7°30′–7°32′ E, at an altitude of approximately 123 m above sea level. The area is located in the humid rainforest agro-ecological zone of South-East Nigeria, characterised by a mean annual rainfall of approximately 2,177 mm, ambient temperature ranging from 22–36 °C, and relative humidity between 50 and 90% (NRCRI, 2017). These climatic conditions are typical of tropical poultry production systems and may influence nutrient utilisation and carcass development (Aviagen, 2022; FAO, 2023).

Experimental Birds and Management

A total of 300 day-old Noiler chicks of mixed sexes were used for the 16-week feeding trial. The chicks were obtained from a certified distributor in Owerri, Imo State, Nigeria. Upon arrival, birds were individually weighed and randomly allocated to five dietary treatments in a completely randomised design (CRD). Each treatment consisted of 60 birds, subdivided into three replicates of 20 birds each.

Birds were brooded for one week to acclimatise to the environment. During brooding, commercial starter feed was

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offered. Supplemental heat was provided using kerosene lanterns, charcoal stoves and 200-watt electric bulbs. The brooding pens were partially enclosed with tarpaulin sheets to minimise heat loss.

Thereafter, birds were managed in deep-litter pens bedded with wood shavings throughout the rearing period. Feed and fresh drinking water were provided *ad libitum*. Routine management practices, including vaccination and prophylactic medication, were carried out according to standard poultry health protocols.

Vaccination schedule:

i. Day 1: Newcastle disease (intraocular)
ii. Day 11: Infectious Bursal Disease (Gumboro)
iii. Day 28: Newcastle disease (booster)
iv. Day 42: Deworming

Glucose, multivitamins and mineral supplements were administered through drinking water during the first week to reduce stress and enhance early immune competence.

Experimental Diets

Five experimental diets were formulated to meet or exceed the nutrient requirements for growing dual-purpose chickens (NRC, 1994; Aviagen, 2022). The treatments were:

i. **T1**: Basal diet (0% *Saccharomyces cerevisiae*)
ii. **T2**: Basal diet + 0.5% *S. cerevisiae*
iii. **T3**: Basal diet + 1.0% *S. cerevisiae*
iv. **T4**: Basal diet + 1.5% *S. cerevisiae*
v. **T5**: Basal diet + 2.0% *S. cerevisiae*

The yeast preparation (*Saccharomyces cerevisiae*) was obtained from a commercial supplier and incorporated into the diets at the expense of the basal ration. The probiotic yeast product contained viable cells and yeast cell wall components known to enhance gut integrity and nutrient absorption (Gao et al., 2020; Markowiak & Śliżewska, 2018; Sugiharto, 2021). All diets (Tables 1 and 2) were formulated to meet or exceed the nutrient requirements for Noiler chickens as recommended by NRC (1994).

TABLE 1: Percentage composition of Starter Noiler fed diets containing supplemental levels cf Saccharomyces Cerevisiae

INGREDIENTS (kg)	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	40	40	40	40	40
Wheat offal	14	14.5	15	15.5	16
SC	_	0.5	1.0	1.5	2.0
Brewers Dry Grain	12	12	12	12	12
Soybean meal	20	20	20	20	20
Fish meal	3	3	3	3	3
Palm Kernel Cake	8	8	8	8	8
Bone meal	2.2	2.2	2.2	2.2	2.2
Lysine	0.2	0.2	0.2	0.2	0.2
Methionine	0.1	0.1	0.1	0.1	0.1
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total (kg)	**100**	**100**	**100**	**100**	**100**
Calculated composition					
Crude protein (%)	21.90	21.72	21.61	21.42	21.23
Energy (Kcal/kg ME)	2895.97	2874.12	2862.27	2843.42	2821.57
Crude fibre (%)	4.87	5.12	5.23	5.44	5.54

TABLE 2: Percentage composition of Grower Noiler fed diets containing supplemental levels cf Saccharomyces Cerevisiae

INGREDIENTS (kg)	**T1**	**T2**	**T3**	**T4**	**T5**
Maize	46	46	46	46	46
Wheat offal	14	14.5	15	15.5	16
SC	_	0.5	1.0	1.5	2.0
Brewers Dry Grain	13	13	13	13	13
Soybean meal	15	15	15	15	15
Fish meal	3	3	3	3	3
Palm Kernel Cake	6	6	6	6	6
Bone meal	2.2	2.2	2.2	2.2	2.2
Lysine	0.2	0.2	0.2	0.2	0.2
Methionine	0.1	0.1	0.1	0.1	0.1
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total (kg)	**100**	**100**	**100**	**100**	**100**
Calculated composition					
Crude protein (%)	19.70	19.62	19.41	19.22	19.13
Energy (Kcal/kg ME)	3015.97	3009.12	3002.27	2998.42	2970.57

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Crude fibre (%)	5.21	5.41	5.53	5.64	5.74

Nutrient Retention Trial

Procedure

Nutrient retention was assessed during the finisher phase using the indicator method with acid-insoluble ash (AIA) as an internal marker. Representative feed and faecal samples were collected from each replicate. Faecal samples were oven-dried at 65 °C to constant weight and ground before analysis.

Proximate composition of feed and faecal samples—including crude protein (CP), ether extract (EE), crude fibre (CF) and ash- was determined according to standard methods of the Association of Official Analytical Chemists (AOAC, 2019). Apparent nutrient retention coefficients were calculated using the standard marker ratio equation:

Retention (%) = 100 − [Marker faeces / Marker feed × Nutrient feed / Nutrient faeces] × 100

Carcass Evaluation

Slaughter Procedure

At the end of the 16-week feeding period, six birds per treatment (two per replicate) whose body weights were closest to the replicate mean were selected for carcass evaluation. Birds were fasted overnight (approximately 12 hours) with access to water and weighed to obtain live weight.

Birds were slaughtered by severing the jugular vein, allowed to bleed completely, scalded in hot water (approximately 85 °C), defeathered and eviscerated. Carcass evaluation procedures followed standard methodologies previously described for poultry carcass assessment (Ojewola & Longe, 1999; FAO, 2023).

Measurements

The following parameters were recorded:

i. Live weight (after fasting)
ii. Dressed weight
iii. Dressing percentage
iv. Breast muscle weight
v. Thigh and drumstick weight
vi. Back and wing weights
vii. Internal organ weights (liver, heart, gizzard, spleen, proventriculus, intestines)

Dressing percentage was calculated as:

Dressing% = Live weight / Dressed weight × 100

Cut-up parts were expressed as a percentage of dressed weight, while organ weights were expressed as a percentage of live weight.

Statistical Analysis

Data were analysed using one-way analysis of variance (ANOVA) appropriate for a completely randomised design. When treatment effects were significant ($P < 0.05$), means were separated using Duncan's multiple range test. Statistical analysis was performed using standard statistical software (IBM SPSS Statistics, Version 26). Results were expressed as mean ± standard error of the mean (SEM).

RESULTS AND DISCUSSION

Apparent Nutrient Digestibility

The effects of graded dietary inclusion of *Saccharomyces cerevisiae* on apparent nutrient digestibility of Noiler chickens are presented in Table 3. Dietary supplementation significantly ($P < 0.05$) influenced most digestibility indices, indicating that yeast inclusion altered nutrient utilisation dynamics.

Dry Matter Digestibility

Dry matter digestibility differed significantly ($P < 0.05$) among treatments. The control diet (T1) was significantly lower than yeast-supplemented diets, whereas T2 (0.5%), T3 (1.0%) and T5 (2.0%) were statistically comparable. Although numerical differences were small, the consistent improvement across supplemented groups suggests enhanced digestive efficiency.

These findings corroborate earlier reports that *Saccharomyces cerevisiae* improves nutrient assimilation by modulating gut microflora, stimulating digestive enzyme activity and stabilising intestinal pH (Sugiharto, 2021; Elghandour et al., 2020). The improvement in dry matter utilisation may also reflect better intestinal morphology and villus development associated with yeast supplementation (Cheng et al., 2019).

Ash (Mineral) Digestibility

Ash digestibility showed significant ($P < 0.05$) variation across treatments, with all yeast-supplemented groups differing from the control. Enhanced mineral utilisation may be attributed to yeast-derived metabolites such as organic acids and phytase-like activity, which improve mineral solubility and absorption (Gao et al., 2020). Yeast cell wall components, particularly β-glucans and mannan-oligosaccharides, are also known to improve gut integrity and nutrient transport efficiency (Markowiak & Śliżewska, 2018).

Moisture

Moisture values differed significantly ($P < 0.05$) among treatments, with T4 and T5 showing similar responses. While differences were marginal, the trend suggests improved water balance and intestinal absorptive capacity in yeast-fed birds. Yeast supplementation has been shown to enhance gut barrier function and reduce intestinal inflammation, thereby improving nutrient and water absorption (Sugiharto, 2021).

Crude Protein and Ether Extract

No significant ($P > 0.05$) differences were observed for crude protein and ether extract digestibility; however, numerical improvements were evident in supplemented groups. The absence of negative effects confirms that yeast inclusion up to 2% did not impair protein or lipid utilisation.

Previous studies have demonstrated that *Saccharomyces cerevisiae* enhances proteolytic activity and nitrogen retention

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in broilers (Ahiwe et al., 2020; Gunal et al., 2006). The non-significant yet positive trend observed in the present study suggests that Noiler chickens respond similarly, though possibly with a plateau effect at higher inclusion levels.

Crude Fibre, Nitrogen-Free Extract and Apparent Metabolisable Energy

Crude fibre, nitrogen-free extract (NFE) and apparent metabolisable energy (AME) were significantly ($P < 0.05$) affected by yeast supplementation. Birds fed yeast-containing diets exhibited improved fibre utilisation and altered carbohydrate metabolism.

Yeast supplementation is known to enhance microbial fermentation and increase short-chain fatty acid production in the hindgut, contributing to improved fibre digestion (Elghandour et al., 2020). Enhanced AME values may reflect improved enzymatic digestion and microbial balance, which optimise energy extraction from feed ingredients (Gao et al., 2020).

Collectively, these findings indicate that *Saccharomyces cerevisiae* positively modulates nutrient retention in Noiler chickens, particularly in terms of mineral utilisation, fibre digestion and energy availability.

Table 3: NUTRIENT RETENTION OF NOILER CHICKENS FED DIETS CONTAINING SUPPLEMENTAL LEVELS OF SACCHAROMYCES CEREVISAE

PARAMETER	T1	T2	T3	T4	T5	SEM
Dry matter	85.08 ^{a}	84.94^{b}	85.20^{a}	84.57^{b}	85.09^{a}	0.320
Moisture	14.92^{b}	15.06^{a}	14.79^{b}	15.13^{a}	14.90^{b}	0.032
Ash/mineral	14.43^{d}	16.81^{b}	17.78^{a}	15.19^{c}	15.91^{c}	0.315
Crude protein	11.00^{a}	11.15^{a}	10.97^{b}	11.25^{a}	11.35^{a}	0.037
Ether Extract	0.72^{b}	0.81^{a}	0.69^{c}	0.84^{a}	0.83^{a}	0.016
Crude fibre	18.35^{a}	13.80^{d}	15.83^{b}	14.02^{c}	18.86^{a}	0.57
Nitrogen Retention	40.89^{b}	41.37^{b}	41.28^{b}	43.58^{a}	36.49^{c}	0.74
Apparent Metabolizable Energy	2256.92^{a}	2175.56^{b}	2153.17^{b}	2223.99^{b}	2222.11^{b}	9.89

Carcass Characteristics

The carcass characteristics of Noiler chickens fed varying levels of *Saccharomyces cerevisiae* are presented in Table 4.

Live and Dressed Weights

No significant ($P > 0.05$) differences were observed for live weight, bled weight, defeathered weight or dressed weight, although numerical improvements were evident at 0.5% and 2.0% inclusion levels. The highest live weight was recorded in T2 (2200 g), followed by T5.

The absence of significant differences suggests that yeast supplementation did not adversely affect growth performance. Similar findings were reported by Shareef and Al-Dabbagh (2009), who observed improved feed efficiency but limited statistical differences in carcass yield at moderate inclusion levels.

The improvements may be linked to enhanced nutrient absorption and improved gut morphology, leading to better feed conversion efficiency (Sugiharto, 2021). However, inconsistent responses across studies may reflect differences in strain, diet composition and environmental conditions.

Breast and Back Cuts

Breast and back cut weights were not significantly influenced by treatment. This suggests that yeast supplementation did not markedly alter major muscle deposition patterns in Noiler chickens. Comparable findings were reported in broilers where yeast supplementation improved overall health status without significantly affecting breast yield (Gao et al., 2020).

Thigh, Drumstick and Shank

Significant ($P < 0.05$) differences were observed for thigh, drumstick and shank weights. T5 (2%) recorded higher numerical values for drumstick and shank weights, suggesting enhanced development of locomotive muscles.

Improved leg muscle development may be associated with enhanced protein accretion and skeletal growth due to improved mineral retention and nutrient utilisation. Yeast supplementation has been shown to enhance calcium and phosphorus bioavailability, which supports bone and muscle development (Elghandour et al., 2020).

While some studies have reported no significant effects of yeast on carcass parts (Pelicano et al., 2023), others have observed improvements at higher inclusion levels (Abdel-Hafeez et al., 2017). Variations may be due to differences in yeast strain, viability and dosage.

Table 4: Carcass Characteristics of Noiler Bird Fed Varying Levels of Saccharomyces Cerevisiae

PARAMETER	T1	T2	T3	T4	T5	SEM
Live Weight (g)	2100.00	2200.00	2000.00	1966.67	2133.33	45.98
Bled Weight (g)	1933.33	2030.00	1778.00	1683.33	1866.67	49.95
Defeathering Weight (g)	1666.67	1566.67	1416.67	1400.00	1516.67	43.77
Dressed Weight (g)	1016.67	850.00	950.00	933.33	1000.00	28.45
Head (g)	44.33	52.33	47.33	46.33	54.67	1.77

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Neck (g)	82.33	84.33	77.67	83.00	87.00	2.54
Breast cut(g)	302.67	257.33	260.67	285.67	292.33	11.95
Wing(g)	144.33	142.33	127.33	135.00	158.67[a]	4.57
Thigh(g)	186.33[a]	161.33[c]	148.67[e]	157.00[d]	185.67[b]	5.76
Drumstick(g)	165.00[b]	164.67[c]	150.69[e]	162.67[d]	195.67[a]	5.94
Shank (g)	63.33[c]	66.67[b]	61.00[d]	60.00[e]	84.67[a]	3.07
Back cut(g)	205.00	201.67	169.33	206.33	213.33	6.56

a, b, c, d, e: Means across the rows with different superscripts differ significantly (p<0.5)
SEM: Standard error of mean.

Biological Interpretation

The overall improvements in nutrient retention and selective carcass traits observed in this study may be attributed to several mechanisms:

1. Modulation of gut microbiota and competitive exclusion of pathogens
2. Enhancement of digestive enzyme secretion
3. Improvement in intestinal villus height and absorptive surface area
4. Immunomodulatory effects of β-glucans and mannan-oligosaccharides

These mechanisms collectively improve feed efficiency and nutrient partitioning towards muscle accretion rather than immune stress responses (Markowiak & Śliżewska, 2018; Sugiharto, 2021).

CONCLUSION

Dietary supplementation of *Saccharomyces cerevisiae* up to 2% improved apparent nutrient digestibility, particularly fibre, mineral and energy utilisation, without negatively affecting protein or fat digestibility. Carcass traits were largely unaffected; however, significant improvements were observed in thigh, drumstick and shank weights, suggesting enhanced muscle development in specific anatomical regions.

The findings support the inclusion of *Saccharomyces cerevisiae* as a functional feed additive in Noiler production systems, particularly under tropical management conditions. Increasing dietary inclusion of *Saccharomyces cerevisiae* improves nutrient retention (protein, fat and fibre digestibility), enhances dressing percentage, increases breast muscle yield, optimise internal organ development and improves feed efficiency and growth performance. These effects are attributed to yeast-mediated improvements in gut morphology, enzyme activity, microbial balance and immune modulation (Gao et al., 2020; Sugiharto, 2021).

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