

*Research article*

## **Influence of probiotic on productive and reproductive traits of Indigenous Naked Neck chicken**

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### ABSTRACT

This study aimed to evaluate the productive and reproductive performance of Indigenous Naked Neck (INN) chickens supplemented with probiotics (*Clostridium butyricum* and *Lactobacillus plantarum*). A total of 120 mature INN chickens (19 weeks old; 12 males and 108 females) were divided into four dietary treatment groups with three replicates each, consisting of one male and nine females per replicate. The groups were fed diets supplemented with 0 g/kg (control, T1), 2 g/kg (T2), 4 g/kg (T3), and 8 g/kg (T4) of probiotics. Parameters assessed included live weight at sexual maturity, age at first laying, egg production, egg quality, fertility and hatchability rates, embryonic mortality, and weights of eggs and day-old chicks (DOCs). Results indicated that live weight at sexual maturity averaged 1820 g for males and 1200 g for females, with an average age at first laying of 20.43 weeks. Birds in the T4 group achieved the highest egg production (21 eggs per hen per clutch), significantly outperforming the control group (12 eggs per hen per clutch). Fertility and hatchability rates were 78.57% and 51.28%, respectively, while early and late embryonic mortality rates were 5.45% and 5.54%. Cost-benefit analysis indicated economic advantages with higher probiotic supplementation. The average egg weight was 38.29 g, and DOC weight was 18.0 g. These findings highlight the significant ( $P < 0.05$ ) potential of probiotics in enhancing INN chicken productivity, particularly in egg production and growth, without adversely affecting reproductive traits or egg quality.

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### 1. INTRODUCTION

Livestock is a cornerstone of Bangladesh's agricultural economy, contributing significantly to both agricultural and national GDP. According to recent statistics, the livestock sector contributes approximately 14.21% of agricultural GDP and 3.40% of the national GDP, playing a critical role in food security, employment, and rural livelihoods (DLS, 2023). Poultry, being a major component of this sector,

supports both nutrition and income generation at the household level, especially among smallholder farmers.

Among indigenous poultry, the Naked Neck (NN) chicken is widely recognized for its adaptability to tropical climates, disease resistance, and efficient foraging behavior. These chickens are an essential genetic resource for resource-poor farming systems in rural areas, offering meat and eggs with minimal input (Ahmed et al., 2021). However, low

productivity, especially poor growth rate and limited egg output, remains a key constraint to their broader commercial adoption (Barman et al., 2022).

The INN chicken's featherless neck is considered an adaptive trait for better heat tolerance in hot-humid climates, which enhances survivability and thermoregulation (Sarker et al., 2021). Their resilience under suboptimal management and feeding conditions makes them ideal for extensive and backyard systems typical in Bangladesh.

Despite these advantages, genetic dilution due to indiscriminate crossbreeding with commercial strains has threatened the conservation of indigenous chicken germplasm. This concern has prompted ongoing national and institutional efforts toward conservation breeding and selective improvement (Haque et al., 2020).

To address the productivity limitations of indigenous chickens, nutritional strategies such as probiotic supplementation have gained attention as environmentally friendly alternatives to antibiotics. Probiotics are live microorganisms that enhance gut health, immune response, and nutrient utilization, ultimately improving performance in poultry (Khalil et al., 2022). Recent studies have reported that dietary probiotics can positively affect growth, egg production, and survivability in local chicken breeds reared under rural conditions (Rahman et al., 2023; Hasan et al., 2021).

Particularly, species like *Clostridium butyricum* and *Lactobacillus plantarum* have shown promising effects on improving intestinal health, feed conversion, and laying performance in native poultry under heat stress (Islam et al., 2023). Given these promising outcomes, probiotic supplementation may offer a sustainable strategy for improving the performance of INN chickens in Bangladesh. Therefore, this study aimed to evaluate the effects of dietary probiotics on the productive and reproductive performance of Indigenous Naked Neck (INN) chickens under semi-intensive conditions. The findings are expected to inform better nutritional practices for

enhancing the profitability and sustainability of smallholder poultry farming in tropical environments.

## 2. MATERIALS AND METHODS

### Study location and duration

This study was conducted at the Advanced Avian Research Farm, Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh. The experiment lasted for 14 weeks, covering the period from 19 to 32 weeks of age of the birds. The location's hot-humid climatic conditions provided a suitable environment for evaluating the performance of INN chickens under realistic field conditions.

### Experimental design

A total of 120 mature INN chickens (12 males and 108 females) were used. The birds were randomly assigned to four dietary treatment groups, each receiving different levels of probiotic (*Clostridium butyricum* and *Lactobacillus plantarum*) supplementation: T1 (Control): 0 g/kg probiotics; T2: 2 g/kg probiotics; T3: 4 g/kg probiotics and T4: 8 g/kg probiotics.

Each treatment group consisted of three replicates, with one male and nine females per replicate. This design ensured adequate representation and minimized bias in data collection.

### Housing and management

Birds were housed in open-sided pens measuring 457.2 cm × 152.4 cm. The pens were equipped with rice husk bedding at a depth of 2–3 cm to ensure comfort. Strict biosecurity measures were maintained, including disinfection of the premises and restricted access to unauthorized personnel. Each bird was marked with colored leg bands to facilitate identification according to treatment groups. Natural ventilation and lighting were provided, and after reaching 5% egg production, additional artificial lighting was introduced to maintain a 16-hour light regimen. Environmental

parameters, including temperature and humidity, were monitored regularly to ensure bird comfort.

### Feeds and Feeding

The experimental diets were formulated using a commercial layer feed as the basal diet. Probiotics (Miyalacto, containing *Clostridium butyricum* and *Lactobacillus plantarum*) were added at the specified inclusion levels. The nutrient composition of the basal diet included 21% crude protein, 2% calcium, and 3000–3100 kcal/kg metabolizable energy. Birds were fed twice daily (9:00 AM and 4:30 PM), with an average daily feed intake of 120 g per bird.

### Data Collection

Data were collected on the following parameters: Live Weight and Growth Performance: Weekly live weight measurements were taken using a digital scale to calculate weight gain.

Age at Sexual Maturity: The age at first egg-laying was recorded for each bird.

Egg Production and Quality: Daily egg production was recorded. Eggs were evaluated for weight, shape, shell thickness, albumen index, and yolk index using digital calipers and a spherometer.

Reproductive Performance: Fertility and hatchability rates were assessed by candling eggs at 7 and 14 days of incubation and recording hatch outcomes.

Embryonic Mortality: Early and late embryonic mortality rates were calculated by examining unhatched eggs.

Survivability: Mortality rates were recorded to evaluate bird health and management efficiency.

### Incubation and hatchability

Eggs selected for incubation were cleaned and stored under controlled conditions (18–22°C) for 7–10 days before setting in an automatic

incubator (Brinsea Incubator, UK). During the setting period (first 18 days), the incubator temperature was maintained at 99.5°F (37.5°C) with 55–60% relative humidity. During the hatching period (days 19–21), the temperature was slightly reduced to 98.5°F (36.9°C) and the humidity was increased to 65–70% to facilitate successful hatching.

Candling was performed at 7 and 14 days of incubation to assess fertility and embryonic development. After hatching, chicks were evaluated for weight, vitality, and physical condition.

### Vaccination and health management

All birds were vaccinated according to a standard schedule, which included vaccines for Ranikhet Disease and Fowl Pox. Antibiotics were administered only, when necessary, based on veterinary recommendations, to prevent respiratory and gastrointestinal infections.

### Statistical analysis

The collected data were analyzed using the General Linear Model (GLM) procedure in SPSS software (version 22.0). Duncan's Multiple Range Test was employed to compare treatment means, with significance set at  $P \leq 0.05$ .

### Ethical considerations

The study was conducted in compliance with the ethical guidelines of the Animal Care and Use Committee of Hajee Mohammad Danesh Science and Technology University (HSTU). All procedures ensured minimal stress and discomfort to the birds.

## 3. RESULTS

### Productive performance

#### Live Weight

The live weight of INN chickens at the time of sexual maturity fed the diets supplemented with different levels of probiotics is presented in Figure 1. The live weight was significantly

influenced by dietary probiotic supplementation. Birds in the T4 group (8 g/kg probiotics) exhibited the highest live weight at sexual maturity, with an average of 1980g for males and 1340 g for females, followed by T3 (1920g for males and 1300 g for females) and T2 (1850 g for males and 1260 g for females) groups. Control group birds (T1) had the lowest average live weights (1760 g for males and 1200 g for females).

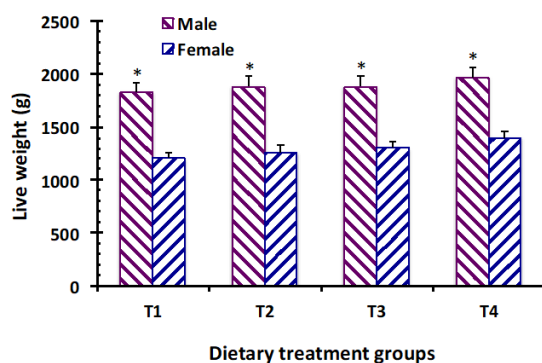


Figure 1. The live weight at sexual maturity in male and female INN chickens fed the diets supplemented with different levels of probiotics. Each bar with an error bar represents Mean  $\pm$  SEM value. Asterisk (\*) indicates significant ( $P < 0.05$ ) difference between male and female INN chickens under the dietary treatment groups.

Males consistently achieved higher weights than females across all treatment groups, with T4 males significantly surpassing those in other groups ( $P < 0.05$ ). These results underscore the positive impact of probiotics on growth performance, particularly at higher inclusion levels.

### Egg production

Egg production was significantly influenced by dietary probiotics (Figure 2). T4 birds laid the highest number of eggs per hen (21 eggs) during the 14-week experimental period, followed by T3 (16 eggs), T2 (15 eggs), and T1 (12 eggs). Based on the duration of the study, the average number of eggs per clutch was approximately 12–14 eggs, suggesting that birds could produce 3 to 4 clutches per year under similar management. This indicates a projected annual egg production of approximately 63–84 eggs per

hen for the T4 group, compared to only 36–48 eggs in the control group.

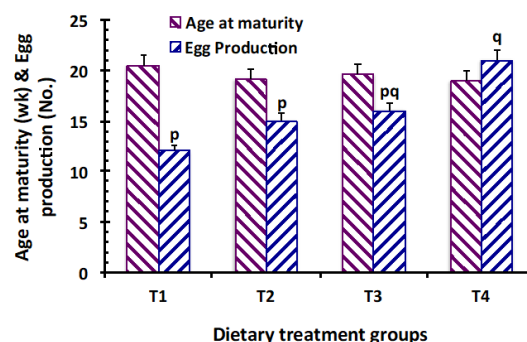


Figure 2. The age at sexual maturity and egg production of INN chickens fed the diets supplemented with different levels of probiotics. Each bar with an error bar represents Mean  $\pm$  SEM value. Different letters indicate significant difference ( $P < 0.05$ ) in case of egg production and no significant ( $P > 0.05$ ) differences in age at maturity among the dietary treatment groups.

The results demonstrate that increasing levels of probiotic supplementation can substantially improve laying performance both in terms of eggs per clutch and potential annual productivity, with the highest inclusion level (8 g/kg) yielding the best outcomes.

### External and internal quality of eggs

The results of the study on external and internal egg quality parameters across different dietary treatment groups (T1, T2, T3, and T4) shown in Table 1. The results indicated no significant differences in any of the measured traits. For external quality, parameters such as egg weight, length, width, shape index, surface area, and shell percentage showed no significant variation between the groups. Similarly, internal quality parameters including albumen weight, yolk weight, shell weight, shell thickness, albumen length, width, height, and various yolk characteristics did not differ significantly across treatments. Additionally, indices such as albumen percentage, yolk percentage, and Haugh unit were comparable among the groups. Overall, the dietary treatments had no measurable impact on both the external and internal qualities of the eggs.

**Egg weight and day-old chicks (DOC) weight**

The average egg weight and day-old chick (DOC) weight in INN chickens fed diets supplemented with different levels of probiotics are presented in Figure 3. The average egg weights were 30.80±2.40, 32.75±2.50, 33.25±2.60, and 33.50±2.60 g for the T1, T2, T3, and T4 groups, respectively. The analysis indicated that there were no significant differences ( $P>0.05$ ) in the average egg weights among the dietary treatment groups. Regarding the DOC weights, the values were 18±1.50,

19±1.50, 20±1.60, and 21±1.68 g in the T1, T2, T3, and T4 groups, respectively.

Similar to the egg weights, the DOC weight also did not differ significantly ( $P>0.05$ ) among the treatment groups. Nonetheless, a trend of slightly higher weights of egg and DOC was observed in the INN chickens fed diets supplemented with probiotics compared to the INN chickens fed diet without probiotics (control).

Table 1. External and internal qualities of eggs of Indigenous Naked Neck chicken

Egg quality parameters	Dietary treatment group				Level of significance
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	
<b>External quality</b>					
Egg wt (g)	40.61±3.2	38.04±2.6	39.40±3.12	35.12±2.10	NS
Egg length (mm)	49.53±3.8	54.33±4.3	56.95±4.4	48.95±3.36	NS
Egg width (mm)	38.84±3.04	36.33±2.8	38.04±3.04	36.19±2.60	NS
Shape Index	78.42±6.2	66.87±5.2	66.80±3.9	73.93±4.30	NS
Egg surface area	54.29±4.2	51.85±4.08	53.15±3.7	49.00±3.40	NS
Shell %	11.31±0.77	12.59±0.96	11.51±0.66	12.16±0.96	NS
<b>Internal quality</b>					
Albumen wt (g)	21.66±1.5	20.68±1.5	22.04±1.7	19.39±1.14	NS
Yolk wt (g)	14.36±1.1	12.57±0.96	12.83±0.96	11.46±0.77	NS
Shell wt (g)	4.59±0.32	4.79±0.32	4.53±0.32	4.27±0.32	NS
Shell thickness (mm)	0.68±0.05	0.73±0.05	0.74±0.05	0.62±0.04	NS
Albumen length (mm)	80.03±6.4	85.75±6.8	85.88±6.8	70.71±4.20	NS
Albumen width (mm)	65.43±4.5	64.87±5.12	66.97±5.28	57.19±4.50	NS
Albumen height (mm)	4.08±0.32	3.30±0.24	3.67±0.24	3.94±0.24	NS
Yolk length (mm)	40.13±3.2	38.01±3.04	37.25±2.9	36.97±2.52	NS
Yolk width (mm)	39.59±2.9	36.34±2.8	36.39±2.5	36.07±2.50	NS
Yolk height (mm)	14.45±1.1	14.43±1.1	15.52±1.1	15.84±1.05	NS
Yolk diameter	39.86±2.5	37.17±2.9	36.82±2.5	36.52±2.50	NS
Albumen Index	5.60±0.4	4.39±0.32	4.80±0.33	6.17±0.42	NS
Albumen %	53.34±4.2	54.36±4.3	55.95±3.3	55.22±3.30	NS
Yolk %	35.36±2.8	33.04±2.6	32.56±2.24	32.63±2.22	NS
Yolk Index	36.26±2.8	38.81±3.04	42.15±3.3	43.36±3.40	NS
Haugh Unit	69.78±5.5	64.01±5.1	66.76±4.5	71.57±4.20	NS

The average values are expressed as the Mean ± SEM value; NS, Not significant at ( $P>0.05$ )

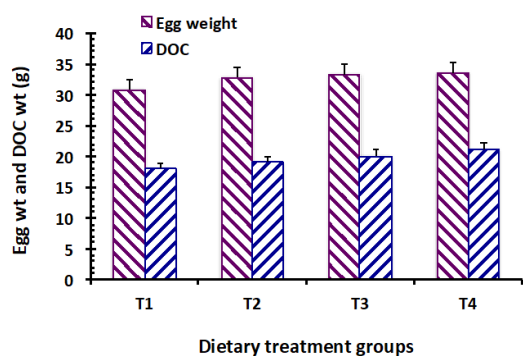


Figure 3. The egg weight and day-old chick (DOC) weight in INN chicken fed the diets supplemented with different levels of probiotics. Each bar with an error bar represents Mean  $\pm$  SEM value. No significant ( $P > 0.05$ ) differences in case of egg weight and DOC among the dietary treatment groups.

## Reproductive performance of INN chicken

### Age at sexual maturity

The age at sexual maturity and egg production of INN chickens across different probiotic levels are shown in Figure 2. The age at sexual maturity varied among the groups, with T4 birds maturing earliest at 133 days, compared to 143 days in the control group (T1). This reduction in age at maturity positively correlated with the level of probiotic supplementation.

### Fertility and hatchability

The average fertility and hatchability of eggs in INN chickens fed diets supplemented with different levels of probiotics are depicted in Figure 4. The average fertility and hatchability rates for eggs laid by INN chickens in the control group (T1) were  $78.57 \pm 4.7\%$  and  $51.28 \pm 3.5\%$ , respectively. In comparison, fertility and hatchability rates in the treatment groups (T2, T3, and T4) were  $79.59 \pm 3.57\%$ ,  $81.81 \pm 4.9\%$ , and  $83.02 \pm 5.8\%$ , and  $54.54 \pm 3.2\%$ ,  $57.78 \pm 4.0\%$ , and  $63.63 \pm 2.5\%$ , respectively. Although slightly higher fertility and hatchability rates were observed in T2, T3, and T4 groups compared to the control group (T1), no significant differences ( $P < 0.05$ ) were found in the fertility rates among the groups. Similarly, hatchability rates did not differ significantly ( $P > 0.05$ ) among the dietary treatment groups.

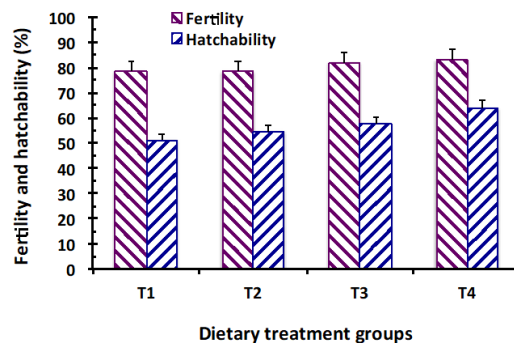


Figure 4. The fertility and hatchability rates of eggs in INN chicken fed the diets supplemented with different levels of probiotics. Each bar with an error bar represents Mean  $\pm$  SEM value. No significant ( $P > 0.05$ ) differences in case of fertility and hatchability among the dietary treatment groups.

### Early and late embryonic mortality during hatching

The effect of probiotic supplementation on early and late embryonic mortality during hatching is illustrated in Figure 5. The early embryonic mortality rates were  $5.45 \pm 0.21\%$ ,  $6.12 \pm 0.24\%$ ,  $7.55 \pm 0.30\%$ , and  $5.35 \pm 0.16\%$  in the T1, T2, T3, and T4 groups, respectively. The late embryonic mortality rates were  $5.45 \pm 0.38\%$ ,  $7.55 \pm 0.30\%$ ,  $5.35 \pm 0.32\%$ , and  $4.08 \pm 0.24\%$  for the same groups. The results showed that early embryonic mortality was significantly higher ( $P < 0.05$ ) in the T3 group compared to the other groups (T1, T2, and T4). Conversely, late embryonic mortality was significantly higher ( $P < 0.05$ ) in the T2 group compared to the other groups (T1, T3, and T4).

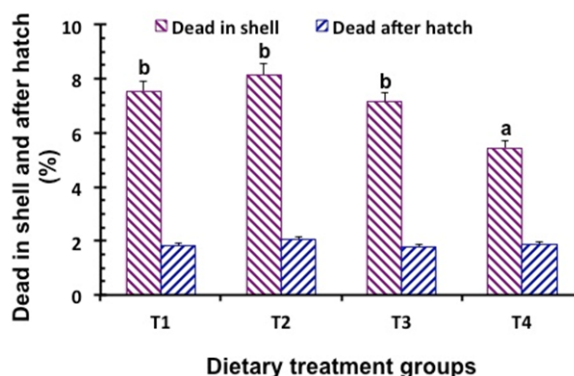


Figure 5. Effect of probiotics (*Clostridium butyricum* and *Lactobacillus plantarum*) on dead in shell and after hatch. Each bar with an error bar represents Mean  $\pm$  SEM value. Different letters indicate

significant difference ( $P < 0.05$ ) among the dietary treatment groups. No significant ( $P > 0.05$ ) differences in case of dead after hatch among the dietary treatment groups.

#### Dead in shell and after hatch

The dietary effects of probiotics on chicks dead in shell and after hatch are presented in Figure 5. The percentage of chicks dead in shell was  $7.55 \pm 0.45\%$ ,  $8.16 \pm 0.57\%$ ,  $7.14 \pm 0.42\%$ , and  $5.45 \pm 0.38\%$  in the T1, T2, T3, and T4 groups, respectively. The percentage of chicks dead after hatch was  $1.82 \pm 0.12\%$ ,  $2.04 \pm 0.12\%$ ,  $1.88 \pm 0.15\%$ , and  $1.79 \pm 0.08\%$  for the same groups. The results indicated that the percentage of chicks dead in shell was significantly lower

( $P < 0.05$ ) in the T4 group compared to the other groups (T1, T2, and T3). However, the percentage of chicks dead after hatch did not differ significantly ( $P > 0.05$ ) among the dietary treatment groups.

#### Cost and Returns Analysis

Cost and returns analysis revealed (Table 2) that total production cost increased slightly with probiotic supplementation, from BDT 589.5 in the control group (T1) to BDT 598.7 in the highest probiotic group (T4), mainly due to the added cost of probiotics. However, revenue from egg sales rose substantially, from BDT 120 per bird in T1 to BDT 210 in T4, resulting in improved economic indicators.

Table 2. Cost and returns per **Indigenous Naked Neck** chicken production using probiotic supplementation

Parameters	Dietary Treatment Groups				Level of significance
	T1 (0 g/kg)	T2 (2 g/kg)	T3 (4 g/kg)	T4 (8 g/kg)	
<b>A. Variable Costs</b>					
Feed cost	50	50	50	50	NS
Probiotic cost	0	2	4	8	*
Management and other costs (15%)	7.5	7.8	8.1	8.7	NS
Total Variable Cost (TVC)	57.5	59.8	62.1	66.7	*
<b>B. Fixed Costs</b>					
Cost of chick	500	500	500	500	NS
Depreciation on housing @5%	29.66	29.66	29.66	29.66	NS
Depreciation on equipment @10%	2.34	2.34	2.34	2.34	NS
Total Fixed Cost (TFC)	532	532	532	532	NS
<b>C. Total Cost</b>	589.5	591.8	594.1	598.7	*
<b>D. Revenue</b>					
Income from eggs	120	150	160	210	*
Total Revenue (TR)	120	150	160	210	*
<b>E. Net Farm Income (NFI)</b>	-469.5	-441.8	-434.1	-388.7	*
<b>F. Profitability Index (PI)</b>	0.20	0.25	0.27	0.35	*
<b>G. Rate of Return on Investment (RRI)</b>					
	-	-	-	-	*
	79.66%	74.65%	73.03%	64.92%	
<b>H. Capital Turnover (CTO)</b>	0.20	0.25	0.27	0.35	*

Values are calculated approximately based on assumed cost structure. NS = Not significant; \* = Statistically significant ( $P < 0.05$ ). Negative NFI values occur because individual egg income alone cannot cover full fixed production costs over a short period; actual farm profitability would depend on total lifetime production.

Net Farm Income (NFI) was least negative in T4 (-388.7 BDT), indicating better financial performance. Profitability Index (PI) and Rate of Return on Investment (RRI) also improved with higher probiotic levels, with T4 showing

the highest PI (0.35) and RRI (-64.92%). These results suggest that probiotic supplementation, especially at 8 g/kg, enhances both productivity and profitability in INN chicken production.

#### 4. DISCUSSION

In this study, dietary supplementation with probiotics significantly influenced several productive traits of INN chickens.

Although probiotic supplementation did not significantly affect the live weight at sexual maturity (Faruque et al. (2007), who observed that INN chickens reached sexual maturity at approximately 151 days, comparable to the results of the present study.

Egg production was significantly enhanced by dietary probiotics, with the T4 group (8 g/kg Miyalacto supplementation) showing the highest number of eggs per hen. These results are consistent with findings by Qiao et al. (2019) and Zhang et al. (2019), who demonstrated that probiotics like *Enterococcus faecalis* can improve laying performance without negatively affecting egg quality. Similarly, Shin et al. (2019) reported improvements in egg production and egg quality parameters such as Haugh unit and shell thickness due to probiotic supplementation.

Regarding egg weight, no significant differences were observed among treatment groups, except for a slight improvement at certain periods with the 8 g/kg Miyalacto supplementation. This partially agrees with the findings of Zhang et al. (2019), who reported that probiotics might not affect overall egg weight but could influence it at specific periods.

The study found that the external and internal egg quality parameters were not significantly influenced by probiotic supplementation. This observation aligns with reports by Aalaei et al. (2018) and Berrin (2011), who stated that probiotics do not markedly affect parameters such as albumen index, yolk index, or shell thickness under standard management conditions.

Fertility and hatchability rates showed slight, non-significant improvements in the probiotic-supplemented groups. These results corroborate previous studies by Aalaei et al. (2018) and Ayasan (2013), who found that probiotic supplementation had minimal effects on fertility

maturity across the treatment groups, males consistently exhibited higher live weights than females. This sexual dimorphism in body weight has been previously reported by Garces et al. (2001) and is attributed to inherent physiological differences between sexes. The findings are consistent with the report of

and hatchability in poultry. Similarly, Swain et al. (2014) observed no significant differences in hatchability in Japanese quail supplemented with probiotics.

Interestingly, although overall fertility and hatchability were not significantly affected, early and late embryonic mortality rates improved in the T4 group. This finding suggests that higher levels of probiotic supplementation may help reduce embryonic mortality, possibly by enhancing maternal gut health and immunity, which might indirectly benefit embryo development.

Regarding day-old chick (DOC) weight, probiotic supplementation did not result in significant differences among treatment groups. However, slightly higher DOC weights were recorded in the probiotic-supplemented groups, aligning with findings reported by Adeyinka et al. (2006) for Naked Neck broilers.

In terms of economic returns, the cost-benefit analysis revealed a clear advantage of probiotic supplementation. The T4 group achieved the highest CBR (1.85), indicating that birds receiving the highest level of probiotics generated substantially higher income relative to their production costs. This economic advantage was primarily driven by improved egg production without a proportionate increase in feed and probiotic costs.

The findings align with earlier reports suggesting that probiotic supplementation not only improves growth and egg production but also offers economic benefits through better feed conversion and health management (Qiao et al., 2019; Shin et al., 2019). Thus, integrating probiotics into indigenous poultry production systems could be a sustainable strategy to enhance both biological performance and farm profitability.

## 5. CONCLUSION

This study demonstrated that probiotic supplementation, particularly at 8 g/kg, significantly enhanced the productive performance of Indigenous Naked Neck (INN) chickens, notably by increasing egg production and improving growth rates without negatively affecting egg quality, fertility, or hatchability. Although the external and internal qualities of eggs remained unaffected, higher probiotic levels contributed to earlier sexual maturity, higher egg output, and a trend towards reduced embryonic mortality. Importantly, the cost-benefit analysis revealed that the group receiving the highest probiotic supplementation (T4) achieved the most favorable economic outcome, with a cost-benefit ratio (CBR) of 1.85 compared to 1.35 in the control group.

These findings suggest that dietary inclusion of *Clostridium butyricum* and *Lactobacillus plantarum* probiotics can enhance not only the biological performance but also the economic returns of INN chicken farming under hot-humid conditions.

Further research is warranted to evaluate the long-term effects of probiotics on genetic traits, disease resistance, and overall adaptability in indigenous poultry breeds, contributing to more sustainable and profitable rural poultry farming systems.

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