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Use of Probiotics for Safe Quail Meat Production

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ABSTRACT

Safe meat production is an important aspect to avoid human health hazards. The use of probiotics in poultry is an important tool to produce safe meat among several established biotechnological approaches. In this experiment, we studied the effects of probiotics for producing safe Japanese quail meat. 150 Japanese quail chicks were reared for a period of six weeks using various doses of probiotics (0, 0.5, 1, 1.5, and 2g per litre of water). The chicks were randomly distributed into five treatment groups with three replications each. The number of birds in each replication was 10. After rearing six weeks, significantly high body weight was found at probiotic concentrations of 1, 1.5, and 2g per litre of water. The feed intake in various treatments did not differ significantly, but comparatively better feed conversion ratios were observed at probiotic treatments. Water quality was not significantly differed as a result of addition of probiotics to the water. The reason for this better growth performance is probably due to the multiple benefits of probiotics in poultry. Probiotics could have maintained gut health with better nutrient utilization and availability that might have been led to higher body weight gain in the quail. In future experiments, challenging the birds with diseases or comparing probiotics with antibiotic growth promoters is required to ensure the efficiency of probiotics.

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Introduction

The poultry sector is playing a vital role in fulfilling protein requirements worldwide. The demand for poultry has increased over the past few years due to the diversified uses of poultry meat and eggs (Mottet and Tempio, 2017). The source of protein might be unsafe due to the transmission of infectious diseases and antimicrobial resistance, leading to human health hazards. One of the most commonly used techniques was to use antibiotic growth promoters to mitigate disease load and trigger the productive performance of poultry. For the safety of human health, the European Union banned the use of these growth promoters in 2006 (Huyghebaert et al., 2011). Almost all countries are now concerned about the use of antibiotics in the poultry industry. The governments of many countries have banned the use of these growth promoters in animals, but the research findings show that growth promoters are still being used in the poultry industry after being banned by the government (Islam et al., 2023). As the withdrawal of antibiotic growth promoters has led to poor poultry performance and increased production costs (Maria Cardinal et al., 2019), dishonest entrepreneurs and farmers are using growth promoters in spite of being banned by the government.

Production of antibiotic-free safe poultry, a nutritional biotechnological approach might be introduced in the poultry industry to replace antibiotic growth promoters and improve productivity (Abd El-Hack et al., 2022). Among the feed additives used in the poultry industry, probiotics could probably be a potential candidate to replace antibiotic growth promoters (Yaqoob et al., 2022). Probiotics might play an important role in improving overall productive performance through maintaining gut health, boosting immunity, decreasing disease load, and improving feed efficiency. Due to the beneficial effects of probiotics, several experiments have been conducted on several species. The researchers also reviewed the effects of probiotics in a multidimensional approach and explored the multi-benefits of probiotics on animal as well as poultry performance. In most cases, the effects in poultry were based on single probiotic species, like the effect of

Lactobacillus spp. (Fesseha et al., 2021), and *Bacillus* spp. (Biswas et al., 2022) on chicken performance. Even though there is research on the effects of compound probiotics on gut health and chicken performance (Chang et al., 2020), the research is not sufficient to fully understand their mode of action and health benefits. As a poultry species, the effects of probiotics on quail performance are limited, and the use of probiotics in quail production is yet to be elucidated. Among the poultry species Japanese quail is important and considered a potential species if managed scientifically and efficiently. Moreover, the doses of probiotics in quail have not been set up for optimum production. For this reason, the study has been designed to investigate the effects of probiotics in a dose-dependent manner to determine growth performance in Japanese quail. The research will help to determine the efficiency of probiotics in a dose-dependent manner on the production performance of quail.

Materials and Methods

Experimental birds and diets

The current study was conducted with 150 Japanese quails for six weeks at Poultry Farm, Department of Poultry Science, Patuakhali Science and Technology University, Babuganj, Barishal-8210. Before the arrival of chicks, the poultry shed was cleaned, washed, and disinfected properly. The day-old Japanese quail chicks were brooded and reared with the same management for two weeks. After two weeks of incubation, all chicks were weighed and distributed evenly into five treatments with three replications each. The number of birds in each replication was 10. A hand-mixed, balanced diet was prepared using available feed ingredients, and the prepared feed was analyzed at the laboratory of the Department of Livestock Services, Farmgate, Dhaka (Table 1). Feeds were supplied twice a day, and the birds were allowed to consume feed *ad libitum*.

Preparation of probiotics solutions

Probiotics were dissolved in water, and prepared different probiotic concentrations. The probiotics contained *Bacillus subtilis*, *Bacillus coagulans*, and *Saccharomyces boulardii* 4.5×10^9 CFU in each gram. Five treatments (T1: 0g probiotics per litre of water; T2: 0.5g probiotics per litre of water; T3: 1g probiotics per litre of water; T4: 1.5g probiotics per litre of water; and T5: 2g probiotics per litre of water) were considered in the experiment. Clean, safe, and sufficient drinking water was supplied to the birds throughout the experimental period.

Housing management

The chicks were reared in a cage with a space of 30 cm × 30 cm per 10 birds. The cages, feeders, drinkers, and surroundings of the shed were cleaned regularly. Bird droppings were collected in trays, and the trays were cleaned and disinfected twice a week. The poultry shed and cage were well ventilated. Strict biosecurity was maintained in the experimental area. The shed was open-sided, and the environmental temperature ranged from 26.1 to 34.5 °C with a relative humidity of 61 to 89% during the experimental period. Natural daylight was used as a light source; the average photoperiod was 12 hours of light and 12 hours of darkness.

Water quality measurement

We prepared various concentrations of probiotics in water and measured the water's quality with a multifunctional water quality tester (model: EZ-9909SP, China). At first, the water quality tester was calibrated with a standard pH solution at 6.86, 4.00, and 9.18. Then, placed the electrode in various concentrations of probiotics (0, 0.5, 1, 1.5, and 2g per litre of water) to determine water temperature (°C), pH, total dissolved solids (TDS) (ppm), salinity (%), and electrical conductivity (EC) (µS/cm).

Statistical analysis

Means ± standard deviations are used to represent data. The data were analyzed using IBM SPSS version 20. Differences among treatments were analyzed using Tukey's honestly significant difference test, and the significance level was declared based on $P < 0.05$.

Table 1. Ingredients and chemical composition of diet

Ingredients (%)	Basal diet
Yellow maize	56.3
Soybean meal (44%)	36.0
Protein concentrate	4.41
Limestone coarse	1.06
Dicalcium phosphate	0.811
Soyabean oil	0.531
Common salt	0.300
Vitamin premix	0.150
Mineral premix	0.150
Salmonella killer	0.100
L-lysine	0.050
DL-methionine	0.050
Toxin binder	0.050
Multi-enzyme	0.050
Choline chloride	0.040
Calculated values (% on DM basis)	
Moisture	12.57
Dry matter (DM)	87.43
Crude protein (CP)	25.93
ME (Kcal/kg)	3377
Total ash (TA)	6.06
Acid insoluble ash (AIA)	0.56
Crude fiber (CF)	3.53
Crude fat (EE)	3.86
Calcium (Ca)	1.11
Phosphorus (P)	0.63

Results and discussion

To produce safe poultry meat, the effects of probiotics were studied in a dose-dependent manner to observe the growth performance of Japanese quail. After 6 weeks of rearing, the average body weight of quail was 147.9, 154.6, 159.9, 157.9, and 154.9 g/bird when probiotics were added at 0, 0.5, 1, 1.5, and 2g per litre of water, respectively (Table 2).

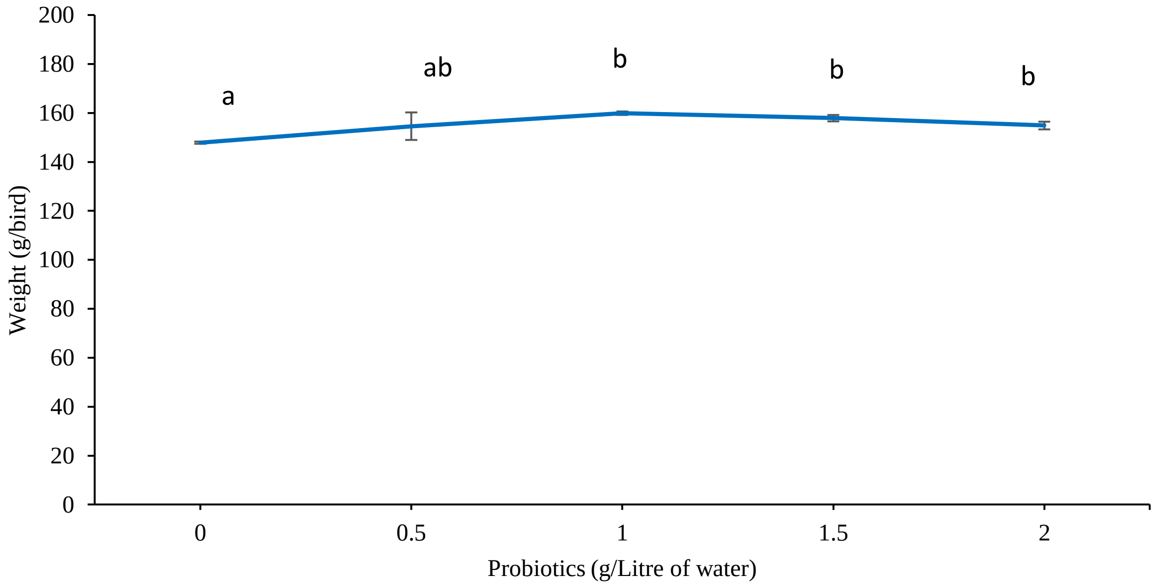

Figure 1. Use of probiotics on the growth performance of Japanese quail

Table 2. Growth performance of Japanese quail at 42 days of age

Parameters	probiotics g per litre of water					SEM
	0	0.5	1	1.5	2	
Final body weight (g/bird)	147.9[a]	154.6[ab]	159.9[b]	157.9[b]	154.9[b]	1.50
Feed intake (g/bird)	607.65[a]	602.10[a]	595.05[a]	605.75[a]	606[a]	1.80
Feed conversion ratio	4.11	3.89	3.72	3.84	3.91	0.063
Mortality (%)	0	0	0	0	0	-

Data are expressed as mean ± standard deviation; [a,b] meaning significant differences among treatment groups. P<0.05. SEM: standard error of the means

Table 3. Water quality after adding probiotics to water

Parameters	probiotics g per litre of water					SEM
	0	0.5	1	1.5	2	
Water temperature (°C)	29.47	29.3	29.03	29.17	28.93	0.071
pH	7.09	8.33	8.33	8.36	8.26	0.135
TDS (ppm)	993.33	980	983.33	980	976.67	2.06
Salinity (%)	0.1	0.09	0.09	0.09	0.09	0.054
EC (µS/cm)	2016.67	1956.67	1956.67	1953.33	1956.67	6.63

SEM: standard error of the means

It was found significantly higher body weight at probiotic concentrations of 1, 1.5, and 2g per litre of water, respectively (Figure 1). The reason for the weight gain might be due to probiotics act as a growth stimulator through multi-functional approach. In addition, several works and reviews have been performed that revealed the health benefits of probiotics. As viable microorganisms, probiotics can function in the intestines of poultry (Schrezenmeir and De Vrese, 2001). In the current study, we used *Bacillus subtilis*, *Bacillus coagulans*, and *Saccharomyces boulardii* 4.5×10^9 CFU in each gram. *Bacillus subtilis* a gram-positive bacteria that can increase apparent metabolism of crude protein, crude fat and organic matters in poultry through better nutrient utilization of feed (Gao et al., 2017). It can also improve kidney functions and increase the digestive enzymes (Mohamed et al., 2022). The lactic acid forming bacterial species *Bacillus coagulans* may increase antioxidant capacity, boost immunoregulatory systems and decrease inflammation with increased microflora in poultry gut (Zhang et al., 2021). Yeast like *Saccharomyces boulardii* helps to available phosphate in the gut and increase calcium digestibility in poultry (Nari and Ghasemi, 2020). Therefore, the individual probiotic species have distinct benefits and probably not yet fully understood. Abd El-Hack et al., (2022) demonstrated the possible mechanisms of probiotic action, stating that probiotics exclude pathogenic microorganisms from the intestinal epithelium. Probiotics produce antimicrobial substances that inhibit the adhesion of toxins and pathogens in the mucus of epithelial cells, and pathogenic microorganisms cannot compete for intestinal nutrients. Thus, probiotics adhere to the intestinal epithelial layer, improve epithelial barrier functions, and enhance antibody production.

During the experimental period, feed consumption per bird was 607.65, 602.10, 595.05, 605.75, and 606g at probiotic concentrations of 0, 0.5, 1, 1.5, and 2g per litre of water, respectively. It was not found any differences in feed intake among the treatment groups. Several researchers studied the effects of probiotics on feed consumption in poultry and observed that the feed consumption was not affected by probiotic treatment in chicken (dela Cruz et al., 2019) and Japanese quail (Abdel-Moneim et al., 2020). The research finding also reveals feed consumption increased significantly due to the application of dietary probiotics in Japanese quail (Taksande et al., 2009). Whatever the situation, the feed conversion ratio (FCR) was improved due to the application of probiotics in quail (Kazemi et al., 2019; Abou-Kassem et al., 2021). However, in the current study, the feed conversion ratios were 4.11, 3.89, 3.72, 3.84, and 3.91 when probiotics were added at 0, 0.5, 1, 1.5, and 2g per litre of water, respectively. There was no mortality of quail during the experimental period.

Probiotics in water improved growth performance, carcass quality, and antioxidant capacity in poultry (Zhang et al., 2021). The route of probiotics in poultry may be different, such as feed, water, oral gavage, and litter, but regardless of the route of probiotics in birds, probiotics reduce the load of harmful pathogens and increase the beneficial microflora in birds (Olnood et al., 2015). As we added probiotics to water and supplied to birds, we measured water temperature, pH, TDS, salinity, and EC to know the water quality at various concentrations of probiotics (Table 3). The water temperature for all the treatment groups ranged from 28.93 to 29.47 °C. The pH for the control group was 7.09, whereas it increased when probiotics were added to the water. The pH was 8.33, 8.33, 8.36, and 8.26 at probiotic concentrations of 0.5, 1, 1.5, and 2g per litre of water, respectively. The TDS values were 993.33, 980, 983.33, 980, and 976.67 for 0, 0.5, 1, 1.5, and 2g of probiotics per litre of water, respectively (Table 3). The EC was higher in the control group compared to others. The reason for this increase was probably due to the fact that the higher the TDS values, the higher the EC (Islam et al., 2017). The increase in this TDS might be safe for poultry because it can only affect growth adversely at higher doses of TDS. Higher TDS levels, like 3154 and 3448 ppm, affect growth negatively in poultry (Ahmed, 2013). The water quality should be checked regularly, and the salinity of the water should not exceed 1% NaCl (common salt) when balanced feed is provided to poultry. In our experiment, the salinity of the water ranged from 0.09 to 0.1%. The EC also seems to be the same in groups and ranges from 1953.33 to 2016.67.

Generally, probiotics increase the production of antimicrobial substances, exclude pathogenic microorganisms, reduce the pH of the lumen, increase villus length, and trigger the immune system in poultry (Anee et al., 2021). The performance of quail was also improved in various conditions when probiotics were added to the experimental conditions (Abdel-Moneim et al., 2020; Aydın et al., 2022). Currently, probiotics are used in humans and several animals to prevent diseases by controlling pathogenic bacteria and improving the gut microflora for a healthy life. It increases feed efficiency, growth, egg production, and profitability in poultry (Lokapirnasari et al., 2017). So, the findings show the multiple benefits of probiotics in poultry. In the current study, it is possible to maintain good gut health with better nutrient utilization, which likely leads to high body weight gain in the quail. In future studies, it might be useful to challenge disease birds or compare probiotics with antibiotic growth promoters to ensure the efficiency of probiotics.

Conclusions

The results show the higher body weight of quail at probiotic concentrations of 1, 1.5, and 2 g per litre of water. The feed intake did not differ significantly in various treatments, but comparatively better feed conversion ratios were seen at probiotic treatment. Water quality was not differed as a result of the addition of probiotics to the water. Probiotics might be used to produce safe meat and higher body weight in quail.

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Research Ethics Approval

We received departmental approval considering research ethics to use probiotics for safe quail meat production. The approval number was PSC/2023/272, dated March 1, 2023.

Authors' Contribution

Prodip Kumar Sarkar planned, designed, and conducted the experiment. He also prepared tables, graph and wrote the manuscript. Dip Majumder Ridoy and Mehedi Islam Moon conducted the experiment and collected the data. Swapon Kumar Fouzder reviewed the manuscript. All the authors confirmed the data and approved the final manuscript.

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