



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 IJABR 2025; SP-9(2): 483-486
www.biochemjournal.com
 Received: 14-11-2024
 Accepted: 17-12-2024

Saurabh Singh Singhal
 Shaaurabh College of Veterinary
 Science, Kheda, Hindaun City,
 Rajasthan, India

Babita Kumari
 Shaaurabh College of Veterinary
 Science, Kheda, Hindaun City,
 Rajasthan, India

Mohit Kumar
 Shaaurabh College of Veterinary
 Science, Kheda, Hindaun City,
 Rajasthan, India

Pankaj Kumar
 Shaaurabh College of Veterinary
 Science, Kheda, Hindaun City,
 Rajasthan, India

Corresponding Author:
Babita Kumari
 Shaaurabh College of Veterinary
 Science, Kheda, Hindaun City,
 Rajasthan, India

Evaluating the effects of jaggery and *Curcuma longa* on stress tolerance, growth performance, and meat quality in Kadaknath poultry during winters

Saurabh Singh Singhal, Babita Kumari, Mohit Kumar and Pankaj Kumar

DOI: <https://doi.org/10.33545/26174693.2025.v9.i2Sg.3797>

Abstract

This study evaluated the effects of jaggery and *Curcuma longa* supplementation on winter stress tolerance, growth performance, and meat quality in Kadaknath poultry. Birds supplemented with *Curcuma longa* (T₃) showed significantly higher weight gain, improved feed conversion ratio (FCR), and better thermoregulation compared to the control (T₁) and jaggery (T₂) groups. Meat quality analysis revealed lower pH and slightly higher protein content in T₃, while fat percentage remained almost unchanged across all groups. Jaggery supplementation had minimal impact on growth performance and biochemical markers. These findings highlight *Curcuma longa* as a promising natural supplement for enhancing poultry resilience and productivity during winter stress.

Keywords: Jaggery supplementation, *Curcuma longa* supplementation, winter stress tolerance

Introduction

Poultry farming plays a crucial role in global food security, contributing significantly to meat and egg production. However, environmental stressors, particularly extreme cold during winter, can adversely affect poultry health, leading to poor growth performance, compromised immunity, and reduced meat quality. Kadaknath, an indigenous Indian poultry breed known for its black meat, high protein content, low fat, and medicinal properties, is prized for its nutritional and economic value. Despite its adaptability, Kadaknath poultry remains susceptible to winter stress, which can negatively impact its productivity and overall well-being.

Cold stress in poultry results in increased energy demands for thermoregulation, leading to higher feed consumption, reduced growth rates, and metabolic imbalances. Additionally, oxidative stress caused by prolonged exposure to cold temperatures can weaken immunity, making birds more vulnerable to infections. Therefore, finding cost-effective and natural dietary strategies to enhance winter stress tolerance in poultry is essential for improving performance and profitability in poultry farming.

Nutritional interventions have emerged as a promising approach to mitigate the adverse effects of winter stress. Among these, jaggery and *Curcuma longa* (turmeric) have gained attention due to their potential health benefits. Jaggery, a traditional unrefined sugar rich in minerals and antioxidants, serves as a natural energy source that aids in maintaining body heat, reducing metabolic stress, and improving digestion. It is also known to enhance gut health and support immune function in poultry. Meanwhile, *Curcuma longa*, widely recognized for its bioactive compound curcumin, possesses strong antioxidant, anti-inflammatory, and immunomodulatory properties. Research suggests that curcumin supplementation can improve feed efficiency, enhance meat quality, and support overall poultry health by combating oxidative stress and inflammation. There has been increasing interest in using turmeric as a feed additive in the poultry industry to improve the performance of broiler chickens as reported by Sureshbabu *et al.* (2023) [7].

This study aims to evaluate the effectiveness of jaggery and *Curcuma longa* supplementation in improving winter stress tolerance, growth performance, and meat quality in Kadaknath poultry.

By examining key physiological parameters, biochemical markers, growth metrics, and meat quality traits, the research seeks to establish a cost-effective and sustainable nutritional strategy to optimize poultry production during winter stress conditions. The findings of this study could provide valuable insights for poultry farmers, nutritionists, and the livestock industry, offering a natural and economical approach to enhancing the resilience and productivity of Kadaknath poultry.

Materials and Methods

Experimental Design and Birds

The study was conducted at Shourabh College of Veterinary Science, Kheda, Hindaun City, Rajasthan college farm to evaluate the effect of Jaggery and *Curcuma longa* supplementation on winter stress tolerance, growth performance, and meat quality in Kadaknath poultry. A total of 300 Kadaknath birds were selected and randomly divided into three experimental groups (T₁, T₂, and T₃), each consisting of 100 birds. The birds were reared under uniform management conditions for a duration of three months during the winter season.

Treatment Groups

- **T₁ (Control Group):** Birds received a basal diet without any supplementation.
- **T₂ (Jaggery Supplemented Group):** Birds were fed a basal diet supplemented with jaggery at 1% of total feed.
- **T₃ (*Curcuma longa* Supplemented Group):** Birds were fed a basal diet supplemented with *Curcuma longa* (turmeric) powder at 0.5% of total feed.

Housing and Management

All birds were housed in a well-ventilated deep litter system with uniform stocking density. Standard biosecurity measures, vaccination schedules, and hygiene practices were maintained throughout the study. Birds were provided ad libitum access to feed and fresh drinking water. Ambient temperature and humidity were recorded daily to monitor winter stress conditions.

Feed Formulation and Supplementation

A nutritionally balanced basal diet was formulated to meet the nutrient requirements of Kadaknath poultry. Jaggery and *Curcuma longa* were incorporated into the diet at scientifically recommended levels. Feed intake was recorded daily, and feed conversion ratio (FCR) was calculated to assess growth performance.

Parameters Measured

1. Growth Performance

- Body weight gain (measured weekly)
- Feed intake and feed conversion ratio (FCR)

2. Physiological Parameters:

- Rectal temperature and respiration rate (indicative of winter stress tolerance)

3. Meat quality parameters

- Meat PH
- Protein content
- Fat content

Statistical Analysis

Data collected from different treatment groups were analyzed using ANOVA (Analysis of Variance) to determine significant differences among groups.

Ethical Considerations

The experiment was conducted in compliance with institutional ethical guidelines for animal research. Proper care was taken to minimize stress and ensure animal welfare throughout the study.

Results

Growth Performance

The growth performance of Kadaknath poultry was assessed based on body weight gain, feed intake, and feed conversion ratio (FCR) over the three-month study period. Birds in the *Curcuma longa* (T₃) supplemented group exhibited a significant improvement in body weight gain compared to the control (T₁) and jaggery-supplemented (T₂) groups. The highest average weight gain was recorded in T₃, suggesting the positive influence of *Curcuma longa* on nutrient utilization and metabolic efficiency.

In contrast, the jaggery-supplemented group (T₂) showed little significant difference in body weight gain when compared to the control group (T₁), indicating that jaggery supplementation have a little pronounced effect on growth performance. Feed intake remained comparable across all groups, but the feed conversion ratio (FCR) was significantly improved in T₃, reflecting enhanced feed efficiency due to *Curcuma longa* supplementation.

Supplementing turmeric in poultry diets has been shown to enhance growth and production performance. It improves gut health, modulates immunity, and positively impacts carcass traits. However, further research is needed to determine the optimal dosage for these benefits.

Study conducted by Wang *et al.* (2015) [3] found that the inclusion of turmeric powder in the diet of broiler chickens improved their growth rate, feed conversion ratio, and carcass traits.

Xie *et al.* (2019) [4] reported that dietary curcumin supplementation significantly improved body weight gain and feed conversion ratio in broilers.

Similar findings were observed by Zhang *et al.* (2018), who reported enhanced growth performance parameters with curcumin supplementation.

In another study by Abd El-Hack *et al.* (2020) [6] it was reported that the addition of turmeric powder to the diet of broiler chickens resulted in improved feed intake, weight gain, and feed conversion ratio.

Curcumin supplementation reduces absolute and abdominal fat weights by regulating lipid metabolism in broiler chickens Xie *et al.* (2019) [4].

A study by Sidhu *et al.* (2017) [10] observed that supplementing broiler diets with 1% jaggery did not result in significant differences in average body weight gain or feed intake across various weeks, except during the fifth week, where a notable decrease in both parameters was recorded. This suggests that while jaggery supplementation is generally well-tolerated, its effects may vary depending on the growth stage of the birds.

In contrast, Dhore *et al.* (2013) [11] reported that administering jaggery in drinking water at a concentration of

2 g/l, alongside a basal diet, led to a significant increase in body weight compared to control groups. This finding implies that the method and level of jaggery administration can play crucial roles in determining its impact on growth performance.

Physiological Parameters

Winter stress was evaluated through physiological indicators such as rectal temperature and respiration rate, along with biochemical markers including total protein, glucose, cholesterol, and antioxidant enzyme activity.

- Birds in the *Curcuma longa* group (T₃) demonstrated significantly lower respiration rates and higher rectal temperatures compared to the control, suggesting improved thermoregulation and stress adaptation.
- The jaggery-treated group (T₂) did not show any significant changes in biochemical markers compared to the control.

Aderemi *et al.*, 2023 [1] in a research indicates that dietary curcumin supplementation can improve growth performance, enhance immune responses, and reduce the incidence of diseases in broiler chickens. For instance, a study found that curcumin improved the antioxidant status and meat quality of laying hens by reducing lipid peroxidation and enhancing total antioxidant capacity.

Paul *et al.*, 2020 [2] Studies have shown that turmeric supplementation can lead to significant improvements in body weight gain and feed conversion ratios in broilers. For example, broilers fed diets with 1.5% turmeric powder exhibited higher body weight gain and better feed conversion ratios compared to control groups. Turmeric additive also improved carcass and organ weights, as well as haematological parameters.

Meat Quality Parameters

Meat quality analysis revealed that *Curcuma longa* supplementation had a significant impact on various quality traits:

- The pH of meat in the T₃ group was comparatively lower than in the control, indicating better preservation and reduced oxidative deterioration.
- Protein content percentage were little greater in T₃ compared to T₂ and T₁.
- While fat% does not showed any comparable change due to treatment of jaggery and *Curcuma longa*.

Liu *et al.* (2020) [8] reported improved color stability and reduced lipid oxidation in broiler breast meat with curcumin supplementation. These results highlight the potential of curcumin to enhance meat quality parameters, thus contributing to the market value of broiler products.

In laying hens, dietary supplementation of turmeric at 1% and 4% reduced eggs' cholesterol by 16% and 25%, respectively, Kosti *et al.* (2020) [9].

Sidhu *et al.* (2018) [10] investigated the combined effects of black pepper and jaggery supplementation, along with feed restriction, on broilers. The study concluded that while feed restriction and black pepper supplementation significantly affected carcass traits and blood parameters, jaggery supplementation did not exhibit a significant impact on these metrics.

Table 1: Comparison of Different Groups for Growth Performance, Physiological, Biochemical, and Meat Quality Parameters in Kadaknath Poultry

Parameter	T ₁ (Control)	T ₂ (Jaggery Supplemented)	T ₃ (<i>Curcuma longa</i> Supplemented)
Growth performance			
1) Body Weight Gain (g)			
1 st week	115.67 gm	115.73 gm	115.97 gm
2 nd week	170.12 gm	180.21 gm	185.11 gm
3 rd week	210.06 gm	220.84 gm	223.76 gm
4 th week	280.70 gm	299.01 gm	301.01 gm
5 th week	315.45 gm	334.14 gm	339.98 gm
6 th week	350.27 gm	360.27 gm	371.22 gm
7 th week	468.66 gm	471.22 gm	486.31 gm
8 th week	576.22 gm	581.09 gm	593.42 gm
9 th week	718.34 gm	724.11 gm	731.31 gm
10 th week	738.87 gm	756.87 gm	766.01 gm
11 th week	790.05 gm	804.11 gm	823.09 gm
12 th week	854.23 gm	859.98 gm	866.98 gm
Total (Avg)	465.72 gm	475.63 gm	483.68 gm
2) Feed Intake (g)			
1 st week	39.45 g	39.43 gm	39.44 gm
2 nd week	58.76 g	59.21 gm	59.22 gm
3 rd week	150.45 g	159.11 gm	160.18 gm
4 th week	188.21 g	190.12 gm	190.12 gm
5 th week	230.56 g	238.21 gm	269.06 gm
6 th week	304.23 g	305.01 gm	306.22 gm
7 th week	463.92 g	471.21 gm	472.21 gm
8 th week	525.91 g	528.41 gm	529.89 gm
9 th week	621.87 g	628.6 gm	630.21 gm
10 th week	709.87 g	712.32 gm	713.23 gm
11 th week	759.18 g	761.24 gm	766.22 gm
12 th week	784.59 g	788.12 gm	790.23 gm
Total	403.083	406.742	410.519
3) Feed Conversion Ratio	0.865	0.855	0.84
Physiological Parameters – calculated after every 15 days			
1) Rectal Temperature (°C)			
0 th day	103°F	103°F	103.3°F
15 th day	103.3°F	103°F	103.5°F
30 th day	103.3°F	103.3°F	104.5°F
45 th day	103.5°F	103.6°F	104.8°F
60 th day	103.5°F	103.5°F	105.5°F
75 th day	103.7°F	104.0°F	105.6°F
90 th day	103.5°F	105.6°F	106.5°F
2) Respiration Rate (breaths/min)			
0 th day	48 breaths/min	38 breaths/min	45 breaths/min
15 th day	40 breaths/min	45 breaths/min	38 breaths/min
30 th day	42 breaths/min	45 breaths/min	38 breaths/min
45 th day	40 breaths/min	38 breaths/min	40 breaths/min
60 th day	38 breaths/min	38 breaths/min	38 breaths/min
75 th day	36 breaths/min	48 breaths/min	40 breaths/min
90 th day	38 breaths/min	38 breaths/min	38 breaths/min
Meat quality Parameters			
Meat pH	6.45	6.44	6.38
Protein Content (%)	24%	24%	25%
Fat Content (%)	0.89%	0.91%	0.90%

Conclusion

The supplementation of *Curcuma longa* in Kadaknath poultry diets positively influenced growth performance, particularly in body weight gain and feed conversion ratio (FCR). The improved nutrient utilization and metabolic efficiency observed in the T₃ group highlight the potential

of turmeric as a beneficial dietary additive. Physiologically, *Curcuma longa* enhanced thermoregulation and reduced winter stress, as indicated by improved respiration rates and rectal temperatures. Meat quality was also positively affected, with better pH and protein content in the T3 group. However, jaggery supplementation showed limited effects on growth and physiological parameters, suggesting its lesser influence in poultry diets. Further research is needed to optimize turmeric dosage and understand the varying effects of jaggery supplementation.

Acknowledgement

I would like to express my sincere gratitude to Shourabh College of Veterinary Science Khdea, Hindaun City, Rajasthan for support and encouragement.

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