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Effect of dietary supplementation of curcumin nano particles on carcass attributes and sensory parameters in broiler chicken

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Abstract

This research study aimed to investigate the effect of dietary supplementation of curcumin nano particles on carcass attributes and sensory parameters in broiler chickens. 144, day-old (Cobb 430) broiler chicks were used in this experiment. The experimental chicks were fed together for 7 days and then separated into four treatment groups (n = 36), each with three replicates of 12 chicks. T₁ was fed a basal or control diet, while the T₂, T₃, and T₄ groups received a control diet supplemented with curcumin nano particles (60, 120 and 180 mg/kg). After 5th week of age, 2 representative chicks for carcass characteristics and 1 bird for sensory evaluation were randomly selected from each replicate for slaughter. All the carcass characteristics traits were found to differ significantly ($p < 0.05$); however, non-significant differences were observed in small intestine and spleen weight percentage ($p > 0.05$) among all treatment groups. No significant difference was found in all parameters of sensory evaluation.

Keywords: Broiler, curcumin, nano particles, pH, sensory

Introduction

The poultry industry is one of the fastest-growing and most prolific sectors, providing high-quality meat rich in protein, minerals, polyunsaturated fatty acids (especially omega-3 fatty acids) and vitamins (Dalle Zotte *et al.*, 2017; Rouger *et al.*, 2017) [10, 42]. The poultry industry in developing countries faces challenges due to the high costs of traditional feed ingredients like yellow corn and soybean meal, which are commonly used in poultry rations (El-Hack *et al.*, 2015; Alagawany and Attia, 2015) [1, 3]. There has been growing interest in using unconventional feed ingredients for poultry in developing countries (Alagawany and Attia, 2015; Alagawany *et al.*, 2017) [3, 4]. The poultry sector is one of the fastest-growing segments of Indian agriculture, contributing approximately 1% to the national GDP and about 30% of the livestock Gross Value Added (GVA) (Economic Survey, 2024-25; DAHD, 2024) [18, 11]. The total meat production in the country is 10.50 million tonnes during 2024-25, of which poultry contributes 49%. India ranks 4th in the world in terms of total Meat production (Source: FAO). The meat production has increased by 2.46% as compared to the previous year (BAHS 2024-25) [11].

Curcumin, a natural polyphenolic compound obtained from the rhizome of turmeric (*Curcuma longa*), has been widely used as a feed additive in poultry because of its antimicrobial (Singh *et al.*, 2010) [10], antioxidant, anti-inflammatory (Galli *et al.*, 2018; Karthikeyan *et al.*, 2021) [17, 25] and immunomodulatory properties (Zhang *et al.*, 2024) [52]. It also promotes the secretion of digestive enzymes, thereby improving nutrient digestion and utilization (Toghyani *et al.*, 2011) [49] and enhancing the antioxidant defence system in broiler chickens (Badran, 2020; Reda *et al.*, 2020; Ranjbar *et al.*, 2020) [9, 41, 40]. In addition, curcumin helps reduce lipid oxidation, a major factor affecting broiler meat quality (Sultana *et al.*, 2017) [47]. However, the practical use of native curcumin is limited because of its poor bioavailability, which results from extensive intestinal and hepatic metabolism and its rapid elimination from the body, leading to low accumulation in blood and tissues (Moniruzzaman *et al.*, 2020; Karthikeyan *et al.*, 2021) [28, 25].

One effective approach to overcome the poor bioavailability of curcumin is its formulation as nanoparticles, which significantly enhances its oral absorption and biological activity (Hani & Shivakumar, 2014; Nabavi *et al.*, 2014; Rahmani *et al.*, 2017, 2018) [21, 31, 36, 37]. Studies by Fathi *et al.* (2024) [16] and Gumus *et al.* (2023) [19] reported that dietary supplementation with low to moderate levels of curcumin improved intestinal morphology and meat quality in broiler chickens. Similarly, Partovi *et al.* (2019) [35] found that supplementation with 300 mg CurNPs/kg diet improved carcass traits, breast meat protein content, redness and oxidative stability in broilers infected with *Eimeria* spp. It also reduced drip and cooking loss without adversely affecting the texture of the meat.

Materials and Methods

Ethical approval: All experimental procedures involving animals were conducted in accordance with established ethical guidelines for animal care and experimentation. The study protocols, including animal handling and welfare measures, were reviewed and approved by the Institutional Animal Ethics Committee (IAEC) of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The experiment was carried out under the approved protocol number IAEC/SVPUAT/2024/140, ensuring adherence to institutional standards for animal welfare and ethical research.

Experimental animals and diets: 144, day-old (Cobb-430) broiler chicks were sourced from Venky's India Limited. Chicks were fed together for 7 days, then separated into 4 treatment groups, each with 3 replicates of 12 birds. A 35-day experiment was carried out at the Poultry Research and Training Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Modipuram, Meerut-250110 (Uttar Pradesh) from June 9, 2024, to July 13, 2024. The chicks were reared on a deep litter system using 5-7 cm wood shavings under standard conditions, with regular raking to prevent compaction.

Feeding of experimental animals: The feed for brooder stock was prepared according to NRC (2001) and made sure that the feed contained 22% CP by the Pearson Square method and ingredients were ground to pass a 1 mm mesh. Feed was analyzed for proximate composition (moisture, CP, fat, fibre, NFE, ash, Ca, P) as per AOAC (2005) [5] and nano curcumin was provided to the researcher at the start of the experiment. Treatment group T₁ was fed a basal or control diet. While T₂, T₃ and T₄ groups received a control diet, additionally curcumin nano particles @ 60 mg/kg, @ 120 mg/kg and @ 180 mg/kg were fed.

Carcass and sensory attributes: After five weeks of age, 6 representative birds from each treatment were randomly chosen for slaughtered to examine development of the gastrointestinal tract (proventriculus, gizzard, small intestine, large intestine and caeca) as well as Pre-slaughter fasting shrinkage in live weight, Dressing yield, Eviscerated yield, Ready to cook yield, Giblet yield (heart, liver & gizzard), Yield of individual cut-up parts (thighs, drumsticks, breast, back, neck, wings) as% of live weight. From each replicate, 1 chick was used to evaluate sensory parameters like Colour appearance, Juiciness, Taste, Odor and Overall Acceptability. Meat samples from each treatment group were used without adding salt or spice to

evaluate the sensory qualities according to Jayasena *et al.* (2013) [22]. An eight-point hedonic scale (1 = Extremely poor, 2 = Very poor, 3 = Moderately poor, 4 = Slightly poor, 5 = Fair, 6 = Good, 7 = Very good and 8 = Excellent) was used as a sensory index for evaluating meat sensory qualities.

Statistical analysis: Data were subjected to one-way and two-way analysis of variance (ANOVA) under a completely randomized design (CRD), following the statistical procedures outlined by Snedecor and Cochran (1994) [46], using the Statistical Package for the Social Sciences (SPSS-2011). Mean separation was performed via Duncan's Multiple Range Test (Duncan, 1955) to identify homogeneous subsets among treatment means. Treatment effects were considered statistically significant at $p \leq 0.05$.

Results and Discussion

The detailed chemical composition of the experimental diet, expressed on dry matter basis, is provided in Table 1.

Table 1: Analysis of nutrient content of the experimental diet (%) on DM basis

Attributes	Experimental basal diet	
	Starter	Finisher
DM	88.65	86.05
ASH	14.28	14.96
CP	22.96	20.78
EE	4.42	4.82
CF	3.89	4.50
NFE	54.43	55.03
NDF	31.50	34.73
ADF	11.87	11.32
Ca	1.30	1.16
P	0.88	0.83

Carcass quality traits (CQT): The results of carcass attributes showed that curcumin nano particles significantly enhanced dressing, thigh, drumstick, breast, back and heart percentage as compared to the control group. Shrinkage (%) showed a significant difference ($p < 0.05$) among the treatment groups and average shrinkage (%) was lower in the treated group compared to the control group. Dressing (%) and ready-to-cook yield (%) were recorded as higher ($p < 0.05$) in treatment groups as compared to the control group. However, thigh, drumstick and breast percentages varied significantly ($p < 0.05$), with higher values in all treatment groups. The value of back and wing% was found to be minimum in treatment T₂ with significant differences ($p < 0.01$) among all groups. Neck, heart, liver and gizzard% also had significant differences among all groups. Similar to our observation, Mustafa *et al.* (2021) [30] Results revealed that the highest dressing percentage was in the group fed 75g/t of curcumin under normal conditions; however, such an increase is numerical. Conversely, other studies have indicated that adding turmeric powder to broiler diets significantly enhances dressing percentage (El-Maaty *et al.* 2014) [14] and significantly increases breast and wing percentage of broiler carcass compared to the control diet according to Kafi *et al.* (2017) [24]. Consistent with these findings, other researchers have reported a significant increase in carcass yield percentage when the diet was supplemented with curcumin (Durrani *et al.* 2006 and Arslan *et al.* 2017) [13, 7]. Diet supplementation with 300 mg/kg nanocurcumin increased final body weight,

carcass weight, breast and thigh weight ($p < .05$) compared with the control group, as reported by Partovi *et al.* (2019) [35].

Table 2: Effect of feeding different levels of curcumin nano particles on the carcass characteristics of broiler chicks

Parameters (%)	Treatment				SEM	p-value
	T ₁	T ₂	T ₃	T ₄		
Shrinkage	6.43 ^b	6.28 ^b	6.16 ^{ab}	5.89 ^a	0.09	0.013
Dressing	71.83 ^a	72.89 ^b	73.82 ^c	74.04 ^c	0.10	<0.01
Eviscerated weight	55.36 ^b	52.73 ^a	54.89 ^b	55.62 ^b	0.34	0.001
Ready to cook yield	56.27 ^a	58.44 ^{bc}	57.39 ^{ab}	59.78 ^c	0.41	0.002
Thigh	17.89 ^a	18.26 ^a	19.16 ^b	20.08 ^c	0.17	<0.01
Drumstick	17.32 ^a	18.36 ^b	17.99 ^{ab}	19.42 ^c	0.28	0.005
Breast	20.46 ^a	22.35 ^b	25.48 ^c	22.39 ^b	0.50	0.001
Back	27.85 ^b	26.95 ^a	29.74 ^c	31.72 ^d	0.23	<0.01
Neck	6.07 ^b	6.39 ^b	5.45 ^a	5.61 ^a	0.13	0.003
Wing	7.71 ^b	6.74 ^a	7.08 ^a	7.86 ^b	0.11	<0.01
Heart	0.45 ^a	0.50 ^b	0.59 ^c	0.57 ^c	0.01	<0.01
Liver	1.89 ^a	2.00 ^b	2.00 ^b	1.93 ^a	0.01	0.001
Gizzard	1.51 ^c	1.46 ^b	1.41 ^a	1.45 ^b	0.01	0.001

^{a b c and d} Means bearing different superscripts in a row differ significantly ($p < 0.05$)

Development of the digestive organs: The proventriculus weight (%) exhibited a significant ($p < 0.05$) difference between all groups. Small intestine weight (%) did not show a significant difference, while small intestine length showed a statistically significant difference between treatment groups. Similarly, large intestine weight (%), large intestine length and average cecal length showed significant differences in treatment groups T₃ and T₄ compared with the control group. In contrast, the T₂ group showed no significant difference from the control group. Spleen weight (%) was recorded with a non-significant ($p > 0.05$) difference in all groups. Similarly, Rajput *et al.* (2013) found that Curcumin (200 mg/kg) feed improved overall metabolic efficiency, increased the absorption area of the small intestine by increasing villus height, and reduced abdominal fat deposition. Fathi *et al.* (2024) [16] were consistent with the findings of Nouzarian *et al.* (2011) [33], who recorded an increased relative weight of the spleen in broiler chicks supplemented with a curcumin-supplemented diet. While Li *et al.* (2001) [27] found that the addition of curcumin and selenium in combination was effective in reducing the relative spleen weight, only curcumin maintained the weight of the Bursa de Fabricius as statistically similar to the nano curcumin group.

Table 3: Development of digestive organs of broiler chicks at the 5th week of age, fed different levels of curcumin nano particles

Parameters	Treatment				SEM	P-value
	T ₁	T ₂	T ₃	T ₄		
Proventriculus Wt. (%)	0.49 ^c	0.46 ^b	0.43 ^a	0.48 ^b	0.01	0.004
Small intestine Wt. (%)	3.02	3.63	3.19	3.04	0.16	0.082
Small intestine length (cm/100gm)	7.17 ^a	7.54 ^b	7.05 ^a	6.99 ^a	0.10	0.018
Large intestine Wt. (%)	0.15 ^b	0.15 ^b	0.14 ^{ab}	0.12 ^a	0.01	0.053
Large intestine length (cm/100gm)	0.38 ^b	0.36 ^b	0.33 ^a	0.31 ^a	0.01	0.002
Cecal Wt. (%)	0.64 ^c	0.60 ^{bc}	0.59 ^{ab}	0.55 ^a	0.01	0.007
Average cecal length (cm/100gm)	0.68 ^b	0.64 ^b	0.56 ^a	0.51 ^a	0.02	0.001
Spleen Wt. (%)	0.13	0.15	0.13	0.12	0.01	0.168

^{a b c and d} Means bearing different superscripts in a row differ significantly ($p < 0.05$)

Sensory Evaluation of Meat: No notable differences were observed in any of the sensory parameters among the treatment groups, but colour, odor, juiciness, flavour and overall acceptability of the meat sample were the highest in T₄ (Nano curcumin @ 180 mg/kg) and lower in the control group. Nano curcumin supplemented groups were higher in all sensory parameters, which shows that nano curcumin improves the quality of meat. Similar to our observation, Abd El-Hack *et al.* (2021) [2] observed that zinc and curcumin nano particles and combinations of *Bacillus licheniformis* resulted in the most significant enhancement of the yellowness, juiciness, tenderness and taste of the meat compared to the control group. Similarly, addition of 300, 400 and 500 mg/kg curcumin to duck feed improved meat colour, increased water storage capacity, inhibited lipid or protein oxidation and improved duck meat quality according to Jin *et al.* (2021) [8]. Similar to our findings, Attia *et al.* (2017) reported that there was no significant effect of turmeric extract on the textural characteristics of broiler chicken meat.

Table 4: Sensory evaluation of the meat of broiler chicks fed a diet supplemented with different levels of curcumin nano particles.

Sensory evaluation						
Parameters	T ₁	T ₂	T ₃	T ₄	SEM	p-value
Colour/Appearance	6.67	7.08	7.21	7.30	0.17	0.086
Flavour/Taste	6.58	6.65	7.04	7.33	0.26	0.178
Odor	6.75	6.78	6.88	7.13	0.41	0.910
Juiciness	6.46	6.71	6.92	7.21	0.32	0.417
Overall Acceptability	6.67	7.10	7.11	7.58	0.30	0.223

Conclusion

Dietary supplementation of curcumin nanoparticles positively influenced the carcass attributes of broiler chickens, while having no significant adverse effect on the sensory characteristics of meat. These findings indicate that curcumin nanoparticles can be considered a promising dietary supplement for improving carcass quality and maintaining desirable sensory attributes of broiler meat.

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