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EFFECT OF DIETARY INCLUSION OF A SUGARCANE EXTRACT ON GROWTH PERFORMANCE OF BROILER CHICKENS

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SUMMARY: Polyphenol-rich natural sugarcane extract can protect living cells against oxidative damage that could negatively affect broiler performance. The objective was to evaluate the effect of graded levels of a dietary sugarcane extract on the growth performance of broiler chickens under local conditions. A study was conducted by housing a total of 960 broilers (Cobb 500) in litter floor pens and feeding graded levels of dietary sugarcane extract (0, 0.1, 0.2 and 0.3%) from 0 to 35 days. Each of the four rooms (replications) was portioned into four pens (60 birds/pen). Each treatment was randomly assigned to four pens in each room. Birds were fed commercial starter (crumbles; day 0 to 18) and finisher (pellets; day 19 to 35) diets according to Cobb 500 broiler performance objectives, and water was given *ad-libitum* throughout the study. Treatment diets were prepared by adding the respective levels of sugarcane extract to the commercial diets. Mortality was recorded daily, and body weight gain, feed intake, and feed-to-gain ratio were evaluated weekly (day 7, 14, 21, 28 and 35) on a pen basis. Data were analyzed using one-way ANOVA for randomized complete block design. Statistical significance was $P \leq 0.05$. The dietary level of sugarcane extract did not significantly affect the broiler performance parameters each week and overall trial period and did not negatively affect Cobb 500 performance targets. Sugarcane extract levels of 0, 0.1, 0.2 and 0.3%, respectively, resulted in 2.268, 2.261, 2.242 and 2.227 kg body weight gain ($P = 0.437$) and 3.429, 3.417, 3.348 and 3.350 kg feed intake ($P = 0.245$) for the total trial period. Feed-to-gain ratios ($P = 0.207$) for the entire trial length were 1.51, 1.51, 1.49 and 1.50 for 0, 0.1, 0.2 and 0.3% sugarcane extract, respectively. Dietary sugarcane extract levels did not affect broiler performance.

KEYWORDS: feed additive, antioxidant, broiler performance, phytochemical, polyphenol compound

INTRODUCTION

The reduction of in-feed antibiotics is a common practice in the poultry industry globally, with the emergence of antibiotic-resistant genes in animals and humans (Nhung *et al*., 2017; Osman *et al*., 2018). However, it negatively affects the growth performance of chickens, causing a substantial economic loss to the poultry industry (Immerseel *et al*., 2004), and the evaluation of feed additives has become a significant research priority to address this concern (Suresh *et al*., 2018; Ayalew *et al*., 2022). The commonly used poultry feed additives include prebiotics, probiotics, organic acids, feed enzymes, and antioxidative compounds (Abd El-Hack *et al*., 2022).

Sugarcane (*Saccharum officinarum*) is a perennial grass commonly found in South Asia, Southeast Asia, and other tropical and subtropical regions (Singh *et al*., 2015; El Chami *et al*., 2020), and is a source of refined sugar and biofuel (Hoang *et al*., 2015; Martins *et al*., 2016). The polyphenolic compounds found in sugarcane include phenolic acids, flavonoids, glycosides, and fatty acids, and many of them have been identified as having anti-inflammatory and immunomodulatory effects in humans (Duarte-Almeida *et al*., 2006; Ji *et al*., 2020). Further, plant polyphenolic compounds act as antioxidants in living cells through the absorption of reactive oxygen species (Ji *et al*., 2019). The antioxidant potential is vital in reducing oxidative stress caused by the imbalance of reactive oxygen species in living organisms (Fellenberg and Speisky, 2006; Surai *et al*., 2019). In poultry, oxidative stress

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is a significant concern in the industry as various sources, including mycotoxicosis and heat stress (Awad *et al*., 2014; Akbarian *et al*., 2016), can induce lipid peroxidation and cell apoptosis that affects broiler performance and results in increased mortality through immune suppression (Lin *et al*., 2006).

Medicinal herbs and spice-deriving plants have been extensively researched for their polyphenol content and beneficial gut health effects in poultry (Abdel-Moneim *et al*., 2020; Mahfuz *et al*., 2021; Al-Mnaser *et al*., 2022). It has been observed that phenolic compounds in plant materials, including sugarcane extracts, have anticoccidial effects through the reduction of *Eimeria* spp. sporulation, coccidia lesion scores, bird mortality, and increased growth performance in coccidiosis-challenged chickens (Akhtar *et al*., 2008; Awais *et al*., 2011; Abbas *et al*., 2012; Daneshmand *et al*., 2021; El-Shall *et al*., 2022). The positive impact of these sugarcane-derived polyphenol compounds on *Eimeria*-challenged broiler chickens might be due to the direct anticoccidial effect (Daneshmand *et al*., 2021), or it might be associated with the indirect effects through antioxidative, anti-inflammatory, or immune-stimulatory impacts of the polyphenol compounds (Akhtar *et al*., 2008; Awais *et al*., 2011). There is limited research in the literature investigating the impact of these plant-based polyphenol compounds, especially sugarcane-derived polyphenols, on broiler growth performance, and the results are less consistent (Khambualai *et al*., 2010; Khonyoung *et al*., 2019; Shakeri *et al*., 2020). It is crucial to investigate this sugarcane extract effects on broiler performance in addition to the anticoccidial effect, as the production performance, including feed conversion, is directly associated with the final profitability of the broiler industry (Mukunthana and Sivarajah, 2015) and the growth performance results are essential to assuring this sugarcane extract polyphenol as an alternative to in-feed antibiotics in poultry.

The current research investigates a sugarcane extract which was manufactured by The Product Makers Pvt Ltd (Melbourne, Australia). The total polyphenol and flavonoid content of the sugarcane extract, which was analyzed by liquid chromatography-mass spectrometry, were 221 and 53.8 mg/g, respectively, and pH was 3.74 in a 1% solution at 20ºC (Ji *et al.,* 2019). The total antioxidant activity of the sugarcane extract was 18,837 µmol/g. The contents of Na, K, Ca, Mg and Zn were equivalent to 170, 130, 6600, 3000 and 15 mg/kg in the extract. Further, the levels of Se and Cr contents were reported as 0.3 and 2.4 mg/kg (Ji *et al.,* 2019).

The objective of the current study was to evaluate the effect of graded dietary levels of a sugarcane extract on the performance of broiler chickens from d 0 to 35 under local conditions. It was hypothesized that rising levels of dietary sugarcane extract would increase broiler performance at different ages and during the overall study period.

MATERIALS AND METHODS

The experimental procedure was approved by the Ethics Committee of the Faculty of Veterinary Medicine and Animal Science at the University of Peradeniya (Ethical clearance certificate number: VERC-21-14) and adhered to the Guidelines for Ethics Review of Research Proposals Involving Animals in Sri Lanka (Forum of Ethics Review Committees of Sri Lanka, 2009).

Birds and housing

A total of 960 newly hatched mixed sex broiler chickens (Cobb 500) were obtained from a commercial hatchery and randomly placed (60 birds per pen) in 16 floor pens (2.54 m length and 2.22 m width) in four open-sided broiler rooms in the Veterinary Teaching Farm of the University of Peradeniya, Sri Lanka. The broilers were weighed on a pen basis prior to the placement. Each broiler room was equally partitioned into four pens. Each of the four dietary treatments was randomly assigned to one pen per room, providing four replications per treatment. An equal amount of paddy husk was placed on the concrete floor in each room with an 8 cm thickness. All the birds were given a brooding period from day (d) 0 to 17 using a gas brooder. Each broiler house (comprising four floor pens) was equipped with a common brooder that was made up of circularly arranged metal brooder guards and a heating lamp. Room temperature was 33°C on d 0, then gradually decreased by expanding the brooder area by adjusting the brooder guards. Further, the brooder guards were adjusted during the brooding period according to the birds' behavior and bird distribution in that area. Each pen was supplied with a plastic turbo feeder (4 L capacity; 27.94 cm pan diameter) and a plastic mini poultry drinker (1 L

water capacity; 20 cm pan diameter) during the brooding period. At d 17, the mini poultry drinker was replaced by a height-adjustable automated bell drinker, and a manual plastic pan feeder (10 kg capacity; 40.5 cm pan diameter) was provided in addition to the turbo feeder used in the brooding period in each broiler pen. All the birds were supplemented with a commercially available vitamin supplement through drinking water for the first three days after the placement. The environmental and housing conditions mentioned above were provided according to the Cobb broiler management guidelines (Cobb Vantress, 2021).

Study material

A newly discovered sugarcane extract that originated from sugarcane molasses was used in the experiment. The Product Makers Pvt Ltd (Melbourne, Australia) initially developed the sugarcane extract according to a hydrophobic resin procedure described by Ji *et al.,* (2019). The present study used the sugarcane extract product, which is brown in colour, and in liquid-to-paste form.

Experimental diets

The four treatment diets were prepared by hand mixing graded dietary levels (0, 0.1, 0.2 and 0.3%) of the sugarcane extract with already processed commercial broiler starter and grower diets (anticoccidial drugs containing corn-soybean meal-based diets), separately. Starter diets were fed from d 0 to 18, and grower diets after that. Grower diets were introduced to the birds, gradually replacing starter diets over the 3-d transition period (from d 18 to 21). The starter and grower diets were made in crumble and pellet forms, respectively. The birds were fed according to Cobb 500 Broiler Performance and Nutrition Supplement (Cobb Vantress, 2018), and water was given *ad libitum* throughout the study period.

Data collection

Performance parameters, including feed intake and body weight, were taken on a pen basis at d 7, 14, 21, 28, and 35. Body weight gain and mortality corrected feed: gain ratio were calculated on each weigh-back. Mortality and weights of the carcasses were recorded daily, and a detailed postmortem examination was performed for each dead bird.

Statistical analysis

The experiment was a randomized complete block design with a broiler room used as a block to minimize the environmental effects. Data were analyzed using a one-way analysis of variance of the Proc mixed model using Stata statistical software (SAS 9.4, Carey, N.C. 2008) to evaluate the linear effect of different dietary levels of the sugarcane extract. The significance level was considered as $P \leq 0.05$. Mean separation was completed using the Tukey-Kramer test to analyze the differences between dietary sugarcane extract levels. Data were tested for normality using the Shapiro-Wilk test prior to the variance analysis.

RESULTS

Dietary sugarcane extracts up to the 0.3% inclusion level did not affect body weight gain, feed intake, and feed to gain ratio of broiler chickens in each assessed period and the total trial length (Table 1). Further, the evaluated broiler performance parameters were within the standard levels according to the Cobb 500 performance objectives (Cobb Vantress, 2018).

Performance variable	Dietary sugarcane extract (%)				*P* value	SEM[1]
	0	0.1	0.2	0.3		
0-7 days						
BWG[2]	0.140	0.140	0.144	0.139	0.105	0.0027
FI	0.148	0.143	0.147	0.145	0.646	0.0034
F:G	1.06	1.02	1.02	1.04	0.404	0.0230
8-14 days						
BWG	0.294	0.288	0.273	0.283	0.060	0.0046
FI	0.368	0.367	0.354	0.361	0.102	0.0096
F:G	1.26	1.27	1.30	1.27	0.493	0.0176
15-21 days						
BWG	0.485	0.492	0.476	0.479	0.631	0.0092
FI	0.684	0.694	0.680	0.677	0.640	0.0079
F:G	1.41	1.41	1.43	1.41	0.212	0.0246
22-28 days						
BWG	0.602	0.589	0.582	0.584	0.060	0.0072
FI	0.925	0.921	0.902	0.902	0.213	0.0136
F:G	1.54	1.56	1.55	1.55	0.977	0.0185
29-35 days						
BWG	0.747	0.752	0.767	0.741	0.487	0.0409
FI	1.303	1.292	1.265	1.265	0.319	0.0560
F:G	1.75	1.72	1.65	1.71	0.261	0.0314
0-35 days						
BWG	2.268	2.261	2.242	2.227	0.437	0.0219
FI	3.429	3.417	3.348	3.350	0.245	0.0412
F:G	1.51	1.51	1.49	1.50	0.207	0.0102

[1] SEM – standard error of the mean

[2] BWG – body weight gain; FI – feed intake; F:G – feed to gain ratio

DISCUSSION

There was no effect of the dietary sugarcane extract on broiler performance at any of the assessed periods between d 0 to 35 in the current study when the dietary sugarcane extract levels were 0.1, 0.2 and 0.3%. The effect of sugarcane extract polyphenol on the growth performance of broiler chickens was assessed in very few studies, and the results were inconsistent. Shakeri *et al*. (2020) observed a positive response to a sugarcane molasses extract that is rich in polyphenols in terms of broiler growth performance. The sugarcane extract increased average daily gain and linearly reduced the feed conversion ratio with increasing doses (0, 0.2, 0.4, 0.6, 0.8 and 1%) in the diet from d 21 to 35, and for the overall period (d 0 to 35) in both heat stress condition and thermoneutral environment. Further, a study that used 0.05% dietary sugarcane extract increased body weight gain in broiler chickens (Khambualai *et al*., 2010). In contrast, the 0.1% dietary addition of sugarcane extract did not affect feed intake, body weight gain, and feed conversion in broiler chickens, according to the study completed by Khonyoung *et al*. (2019).

The comparison of performance results among these studies is challenging without knowing the analyzed total polyphenol content since most of the previous research includes the concentration of dietary sugarcane extract level but not the total polyphenol content (Khambualai *et al*., 2010; Khonyoung *et al*., 2019). The assessment of the total polyphenol content is crucial for comparison of the current study with the previous studies, as the total polyphenol content varies in different sugarcane varieties (Kadam *et al*., 2008; Abbas *et al*., 2013). Furthermore, the analysis of the polyphenol profile of the sugarcane extract is important to assess the effect of these polyphenol-containing compounds on broiler production performance, as the different varieties of sugarcane differ in phenolic profile (Coutinho *et al*., 2016), which affects different levels in exerting their properties, including antioxidant potential (De Morais *et al*., 2020). The absence of significant effects of the sugarcane extract on broiler performance in the present study could be attributed to the different total polyphenol content and the phenolic profile of sugarcane extract between the current research and previous research with significant findings (Khambualai *et al*., 2010; Shakeri *et al*., 2020).

The evaluation of higher doses of dietary sugarcane extract on broiler performance and the incorporation of sugarcane extract during feed processing rather than mixing the sugarcane extract at the post-processed stage are suggested in future research related to the current study to evaluate sugarcane extract dietary addition in broiler chickens. The usage of a custom feed by adding the sugarcane extract during feed processing would increase the uniform distribution of polyphenol compounds in the diets, which is crucial for the detailed investigation of the sugarcane extract effects on broiler performance. The analysis of polyphenol content of processed diets is important to confirm the uniform dietary distribution of the sugarcane extract. Further, the analysis of polyphenol content and phenolic and flavonoids profile in the study material just before addition to the experimental diets is also recommended since polyphenols can be deteriorated due to the environmental conditions, including high temperature and humidity. A major limitation of the current research includes the failure to manufacture custom-made experimental diets by adding the sugarcane extract during feed processing, and to analyze total polyphenol content and phenolic profile in the sugarcane extract and the processed experimental diets, that affects effective evaluation of results.

CONCLUSION

The study concluded that broiler performance parameters, including body weight gain, feed intake, and feed to gain ratio, were not affected by adding sugarcane extract to the commercial broiler diets up to 0.3% inclusion level under experimental farm conditions. Future experiments by adding sugarcane extract during the feed processing are recommended to validate the dietary sugarcane extract level on broiler performance, as the usage of a custom feed would facilitate equal dietary distribution of sugarcane extract.

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