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Effect of supplementation of different levels of phytogenic mixture on growth performance and carcass characteristics of broiler chickens

Pooja Singh*, Neeraj*, Ramesh Pandey* and Amit Kumar Singh◆**

*Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagaraj-211007, Uttar Pradesh, India

**Subject Matter Specialist (Animal Husbandry), ICAR-Krishi Vigyan Kendra, Amihit, Jaunpur-222142, Uttar Pradesh, India

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Abstract

This experiment was performed to investigate the impact of dietary supplementation of phytogenic mixture on feed intake, growth, feed efficiency and carcass characteristics of Vencobb 400 broiler chickens. A total of 48 day-old broiler chicks were divided randomly into 3 comparable treatment groups consisting 16 chicks in each group with 4 replicates in each treatment. The control group T_1 was fed basal diet which was devoid of any phytogenic supplementation while T_2 and T_3 were supplemented with phytogenic mixture that contained garlic (*A. sativum*), tulsi (*O. sanctum*) leaves and black cumin (*N. sativa*) seed powder in equal ratio @ 0.25% and 0.50% in the broiler diets, respectively. Results of the study revealed that there was significant ($p<0.05$) improvement in the final live body weight, weekly body weight gain ($p<0.05$) and feed efficiency (FCR and FCE) ($p<0.05$) of the broilers in the treatment groups T_2 and T_3 supplemented with phytogenic mixture as compared to that of control group T_1 while T_2 and T_3 groups did not differ significantly ($p>0.05$). However, feed intake and the carcass characteristics, *i.e.*, dressing% and (relative weight of head, neck, breast, thighs, drumsticks, wings, heart, liver, gizzard, pancreas, intestinal weight and spleen with respect to live body weight of broiler) did not differ significantly ($p>0.05$) in the phytogenic supplemented groups T_2 and T_3 as compared to control T_1. Nonetheless, the abdominal fat percentage was found to be significantly ($p<0.05$) reduced in the phytogenic supplemented groups when compared with control. It was concluded from this experiment that phytogenic supplementation with combinations of garlic (*A. sativum*), tulsi (*O. sanctum*) leaves and black cumin (*N. sativa*) seed powder (1:1:1 ratio) @ 0.25% of the broilers diet significantly improved the growth performance and reduced the abdominal fat percentage without negatively affecting the carcass characteristics of the broiler chicken.

1. Introduction

At present poultry industry is one of the fastest growing subsectors of animal husbandry in India. Indian broiler industry is growing at the rate of 7-8% (BAHS, 2018). The total population of poultry in the country is 851.81M in the year 2019, which has increased by around 16.8% as compared to the year 2012 (BAHS, 2019). Poultry meat provides good quality protein, minerals and vitamins to the diet person consuming it. Also, rearing of poultry birds involves low investment cost, less land and less risk as compared to other enterprises and produces quick return with good FCE and protein source (Bhagat *et al.,* 2016; Singh *et al.,* 2022; Singh *et al.,* 2023).

Various growth promoters or feed additives have been used for decades to increase the growth rate and performance of the poultry birds across the world. Amongst them, antibiotic growth promoter (AGP) is most frequently used for this purpose (Luqmanad and Kumar, 2012; Sikka *et al.,* 2012; Islam and Sheikh, 2021; Patel *et al.,* 2020). However, long time use of antibiotics has adverse effect on the health of birds and also residual effect and carcinogenic effect in humans (Butaye *et al.,* 2003). In view of this, the use of antibiotic growth promoter in animal feed industry has been banned by the European Union Commission in 2006 (Sorwar *et al.,* 2016). Phytogenic feed additives or phytobiotics or phytochemicals are defined as plant derivatives incorporated into the animal feed to enhance livestock productivity through the improvement of digestibility, nutrient absorption and elimination of pathogens residents in the animal gut and also improving the quality of food derived from those animals (Kamel, 2001; Balunas and Kinghorn, 2005; Windisch *et al.,* 2008). Phytogenic feed additives are considered as cost effective, environmental friendly, less toxic and do not produce residual effect as they do not have any drug resistant problem associated with them when supplemented in the animal feed (Yadav *et al.,* 2021). Use of phytobiotics in poultry feeding improves palatability and sensory quality of feed ingredients (Mountzouris *et al.,* 2009), acts as antimicrobial, antistress and improves immune function (Chattopadhyay *et al.,* 2005), antibacterial, analgesic, insecticidal, anticoccidial (Amin *et al.,* 2019), antifungal (Hardy, 2002), improve digestibility, acts as growth promoter, improves feed conversion efficiency and carcass traits (Mountzouris *et al.,* 2009), lower blood cholesterol level (Kumari *et al.,* 2020) acts as antioxidant and improves gut health (Hashemi *et al.,* 2009). Studies showed that *N. sativa* individually or in combination of other herbs improved the final body weights and feed conversion efficiency of broilers and similar results were

Corresponding author: Dr. Amit Kumar Singh
Subject Matter Specialist (Animal Husbandry), ICAR- Krishi Vigyan Kendra, Amihit, Jaunpur-222142, Uttar Pradesh, India
E-mail: amitkumarsingh5496@gmail.com
Tel.: +91-8178921505

observed in case of *A. sativum* and *O. sanctum* in broilers when supplemented individually or in combination with other herbs (Bihari *et al.,* 2010; Abu-Al-Basal, 2011; Palani *et al.,* 2014; Puvaca *et al.,* 2015; Prajapat *et al.,* 2018). Furthermore, earlier studies showed that synergistically improved performance may be achieved in broiler performances through combination of suitable herbs into a phytogenic mixture (Ali *et al.,* 2014; Amsathkumar *et al.,* 2019).

These three have the potential to act as a growth and heath promoters for broilers providing quick and much safe poultry meat source for human consumption. Most of the studies have been performed on individual herbal feed additive and some on combination of the either of these two herbal feed additives. However, no study has been done to see the dietary supplementation effects of the combined powder of black cumin, garlic and tulsi to observe feed consumption, live weight, feed conversion ratio, and feed conversion efficiency and carcass characteristics of broilers. The objectives of present study was to investigate the effect of phytogenic feed mixture on feed consumption, live weight, feed conversion ratio, feed conversion efficiency and carcass characteristics of broiler chickens.

2. Materials and Methods

2.1 Site of the study

The present experiment was carried out in small animal laboratory of the Department of Animal Husbandry and Dairying, SHUATS, Prayagraj, Uttar Pradesh, India.

2.2 Pre-experimental activities

Before bringing the chicks to the broiler cages, the shed area under the building was thoroughly cleaned and disinfected using suitable disinfectants, followed by fumigation with formalin and potassium permanganate ($KMnO_4$). All the equipments were also thoroughly cleaned and disinfected and sterilized before use. The feeders and waterers were sanitized with 0.02% $KMnO_4$ solution on each day. Lime powder was made available round the clock before the entrance of poultry house. Strict biosecurity measures were followed during the conduct of trial period.

2.3 Preparation of phytogenic mixture

Garlic (cloves), tulsi (leaves) and black cumin (seeds) were purchased from the local market. The garlic was peeled, cut into small pieces, fresh tulsi leaves were washed with clean water and seeds of black cumin were taken together and dried at 40°C for 24 h in hot air oven. Dried samples were converted to powder using electric blender and then transferred to separate and labelled air tight containers, and stored in a cool dry place until use.

2.4 Experimental animals and management

A total of 48 day-old Vencobb 400 broiler chicks were purchased from a commercial hatchery. All chicks were then administered antistress (sugared solution and multivitamins) after their arrival and were distributed according to the treatment groups and identified individually by means of marking on the forehead. The birds were reared in battery type cages under standard managemental practices providing 0.75 sq. ft/bird space from day-old to four weeks of age. Fresh feed and clean, cool water were served *ad libitum*. Birds were reared under the same environmental conditions. Initially, the temperature of 35°C was maintained throughout the first week, followed by lowering the temperature by 3°C in each progressive week until it reached room temperature of 25 ± 1°C. One bulb of 100 watt was provided in each cage for light and to maintain the temperature in the room. The study continued for 28 days from early February 2022 to second week of March 2022.

Experimental design and treatments

The birds were assigned into three comparable treatment groups. Each treatment group had randomly assigned 16 birds comprising 4 replicates in each group with 4 birds per replicate in a complete randomized design. Each group was fed with corresponding experimental diet-

T_0: Chicks were provided with standard ration as per NRC, 2007 standards, without any supplement.

T_1: Standard ration supplemented with 0.25% of phytogenic mixture per kg of feed.

T_2: Standard ration supplemented with 0.50% of phytogenic mixture per kg of feed.

Phytogenic mixture contained garlic, tulsi and black cumin mixed in equal proportion 1:1:1 and then supplemented in the desired amount in respective treatment groups. The basal starter diet (Table 1) (first three weeks of age) contained of 23% crude protein (CP) with 3,000 ME kcal/kg; however, the finisher diet (3rd to 4th week of age) with 20% CP and 3,150 ME kcal/kg, as per the recommendations of NRC. The first group (control) was provided with a basal diet devoid of herbal supplements whereas the treatment group diets were made by thoroughly mixing the basal diet with 0.25% and 0.50 % of phytogenic mixture, respectively.

Table 1: Ingredient and nutrient composition of experimental diet (%DM)

Ingredients (%)	Starter (0-21 day)	Finisher (22-28 days)
Corn	53.53	59.58
Soybean meal (44 %CP)	38.95	33.33
Monodibasic phosphate	1.44	1.22
Limestone	1.34	1.37
Vegetable oil	3.85	3.53
Salt	0.40	0.41
DL-methionine	0.208	0.215
L-lysine-HCL	0.128	0.196
Choline HCL (60%)	0.06	0.05
Mineral-vitamins premix	0.01	0.01
Total	**100**	**100**
Calculated nutrients		
Crude protein %	22	20
ME, kcal/kg	3000	3,150
Calcium %	0.91	0.88
Available phosphorus %	0.40	0.36
Sodium %	0.21	0.22
Chloride %	0.26	0.28
Digestible Lys. %	1.17	1.08
Digestible Met. %	0.48	0.49
Digestible Met + Cys %	0.82	0.78
Digestible Thr, %	0.79	0.73
Choline, mg/kg	1,422	1,312

2.5 Collection of data

Initial weight of each chick was recorded on arrival and then body weight at 7th, 14th, 21th and 28th day was taken to obtain the weekly body weight and body weight gain. The feed consumption was also recorded on weekly basis to determine the feed conversion ratio (FCR) and feed conversion efficiency (FCE). At the end of treatment, blood samples were collected from the wing vein of each bird using disposable plastic syringe and needle with anticoagulant. After slaughter of the birds, dressing percentages and weight of different offal was taken. Daily mortality and each management practice were strictly monitored during whole experimental period.

2.6 Parameters studied during the experiment

2.6.1 Feed consumption on weekly basis

Feed intake by each broiler was determined on the basis of differences between the quantity of feed provided and the feed left over during 24 h period. Daily feed intake record was added together for consecutive seven days of the week to obtain the weekly feed consumption. This process was continued for 4 weeks, from first day of the experiment until 28th day.

Feed intake=Weight of the feed offered (g)–Weight of the feed left (g)

2.6.2 Weekly body weight and body weight gain

The growth rate of the birds is reflected through the weekly live weight gain. Body weight of each bird from all the groups was recorded on weekly basis to obtain the weekly body weight including the day old chicks. The birds were weighted during morning hour before feeding. Weight gain of the birds was determined by subtracting the initial live weight from the final live weight.

Average of each and every bird's weekly gain was estimated separately by subtracting the previous week average live weight of birds from the average live weight of birds in the present week of that particular group.

Weight gain = Initial weight of the bird (g) – Final weight (g)

2.6.3 Feed conversion ratio (FCR)

Feed conversion ratio was obtained by dividing the average feed intake by average body weight gain.

Feed conversion ratio = Amount of feed consumed (g)/ Weight gain (g)

2.6.4 Feed conversion efficiency (FCE)

Feed conversion efficiency was obtained by dividing the average body weight gain by average feed intake multiplied by hundred.

Feed conversion efficiency= Weight gain (g)/Amount of feed consumed (g)

2.6.5 Carcass characteristics

Birds were slaughtered for the carcass parameters at the end of the experimental trial. The birds were fasted overnight and pre-slaughter weights were recorded. The dressed weight of each group was obtained separately after complete bleeding and removal of feathers, skin, viscera, head and legs calculated as percent of pre-slaughter weight. The neck, wing, kidney, drumstick, thigh, intestine and breast meat were weighed separately and divided by pre-slaughter weight to determine relative weight and expressed as percentage. Fat around the abdominal wall was removed, weighed and calculated as percentage of pre-slaughter weight. The edible visceral organs heart, liver and gizzard were weighed individually after separating from viscera.

3. Statistical analysis

Each parameter was statistically analyzed by using MS-Excel 2007 version and SPSS software (version 22.0), IBM. One way ANOVA was used for analysis of data. Graphical representations were done using MS-Excel software. Means were considered significantly different when $p<0.05$.Duncan Multiple Range Test was conducted for differentiating among different groups significantly.

4. Results

4.1 Feed intake (g) of broilers

The data of average feed consumed by the broilers of control (T_0) and two different treatments (T_1, T_2) groups is presented in Figure 1. On stringent analysis of data, it was observed that at first week, the highest feed intake was observed in T_2 (275.94 g), followed by T_0 (273.00 g) and T_1 (267.62 g) groups. At second week, the highest feed intake was investigated in T_0(573.44 g), followed by T_2 (546.50 g) and T_1 (526.00 g). At third week, the highest average feed intake of broilers was recorded in T_2 (603.38 g), followed by T_0 (596.25 g) and T_1 (565.81 g) groups. At fourth week, the highest feed intake was found in T_2 (813.44 g), followed by T_0 (810.88 g) and T_1 (774.25 g) groups. The mean feed intake per broiler in T_0, T_1 and T_2 was 550.89 g, 533.42 g and 559.81 g, respectively. It was observed that there was no significant effect of treatments on feed intake in broilers ($p>0.05$).

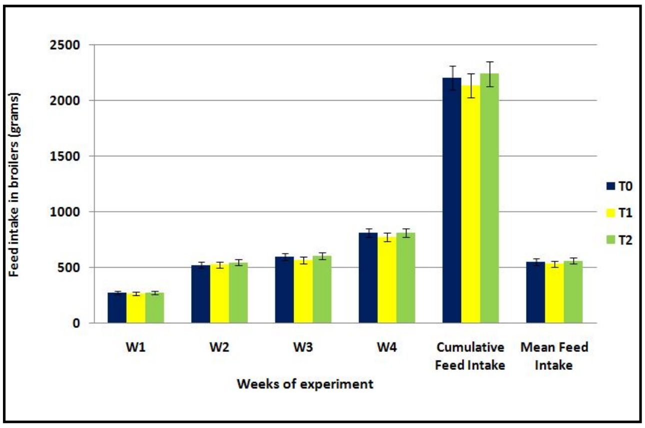

Figure 1: Feed intakes in broilers in different groups in different weeks.

4.2 Body weight of broilers

The data of average body weight of the broilers of control (T_0) and two different treatments (T_1 and T_2) groups is presented in Figure 2 and body weight gain in Figure 3. Statistical analysis of data showed that at first week, the highest body weight was observed in T_2 (236.81 g), followed by T_1 (233.63 g) and lowest being T_0 (230.25 g). At second week, the highest body weight was investigated in T_2 (609.25 g), followed by T_1 (595.06 g) and lowest being T_0 (654.44 g). At third week, the highest average body weight of broilers was recorded in T_2 (1046.88 g), followed by T_1 (1006.50 g) and lowest being T_0 (957.81 g). At fourth week, the highest body weight was found in T_2 (1630.25 g), followed by T_1 (1557.00 g) and lowest being T_0 (1495.12 g). The overall mean body weights of broiler were 811.91 g, 848.05 g and 880.78 g in T_0, T_1 and T_2, respectively. Initial body weights of broiler chicks of each group were significantly non-different (p>0.05). Results reflected a significantly increased (p<0.001) overall live weights in treatment groups T_1 and T_2 than control group birds. Whereas, live weight of T_1 and T_2 differed non-significantly (p>0.05).

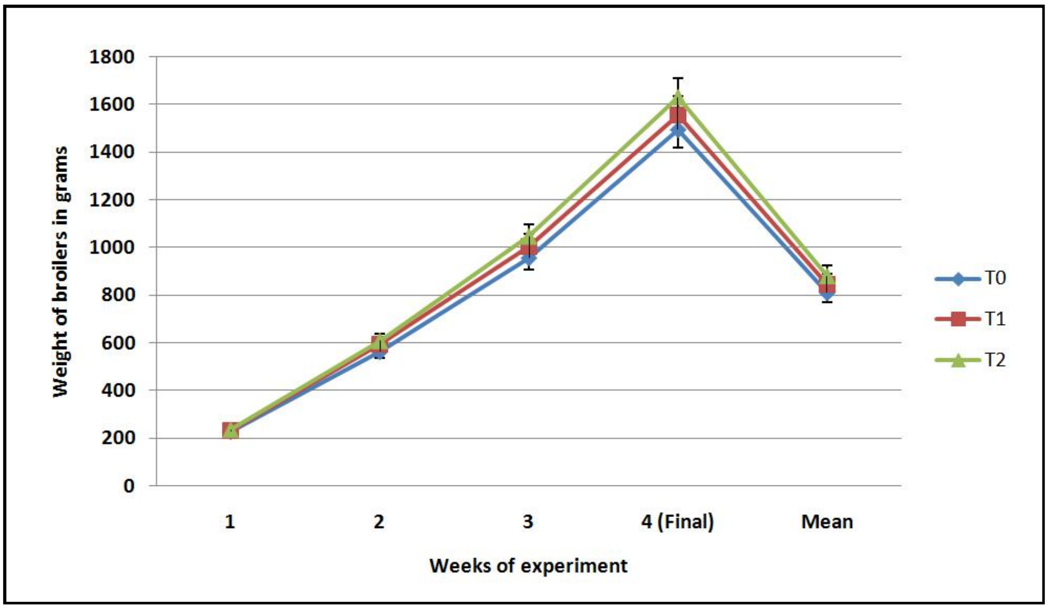

Figure 2: Body weight of broilers of different groups in different weeks.

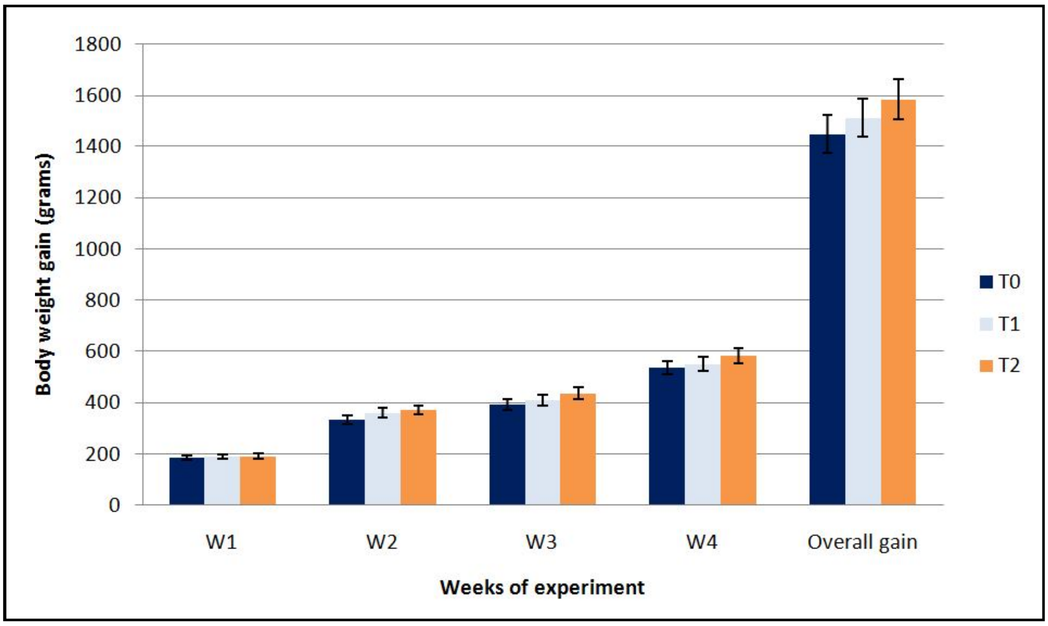

Figure 3: Body weight gains in broilers in different groups in different weeks.

4.3 Feed efficiency of broilers

Effect of different levels of phytogenic mixture on FCR and FCE is depicted in the Table 2. Investigations of present study indicated significantly higher (p<0.001) FCR and FCE in supplemented broilers as compared to control groups. However, no significant (p>0.05) difference was observed between T_1 and T_2 groups. In addition to this, overall FCE was found significantly higher (p<0.001) in T_1 and T_2 than control groups but, T_1 and T_2 groups had no significant differences.

4.4 Carcass traits

From the perusal of statistically analyzed data (Table 3), non-significant difference (p>0.05) was observed in carcass traits such as (relative to live body weight of broilers) dressing%, head%, neck%, breast%, thighs%, drumsticks%, wings%, heart%, liver%, gizzard%, pancreas%, intestinal weight%, spleen%. However, interestingly it was found that abdominal fat% was found significantly (p<0.001) less in treatment groups T_1 and T_2 birds than control group T_0 in this experiment. However, T_1 and T_2 groups differed non-significantly (p<0.05) for abdominal fat%.

Table 2: Feed efficiencies and liveability of broilers under different groups

Treatments	W1	W2	W3	W4	Overall
FCR					
T0	1.475^a	1.573^a	1.536^a	1.532^a	1.529^a
T1	1.408^c	1.456^c	1.392^b	1.415^b	1.418^b
T2	1.435^b	1.477^b	1.399^b	1.421^b	1.433^b
FCE (%)					
T0	68.481^a	64.006^a	66.113^a	66.293^a	66.223^a
T1	71.069^c	69.109^b	72.815^b	71.364^b	71.089^b
T2	69.962^b	68.340^b	73.039^b	71.690^b	70.758^b
Liveability %					
T0	100^a	100^a	100^a	100^a	100^a
T1	100^a	100^a	100^a	100^a	100^a
T2	100^a	100^a	100^a	100^a	100^a

Least square means bearing different superscripts differ significantly (p<0.05) row-wise in same column.

Table 3: Least square means of carcass traits of broilers in different groups

Parameters expressed in %	T0	T1	T2	SEM	Statistical significance
Dressing	65.20	65.29	66.22	0.21	NS; p = 0.112
Head	3.80	3.83	3.91	0.04	NS; p = 0.542
Neck	3.38	3.40	3.39	0.03	NS; p = 0.969
Breast	24.75	25.98	25.47	0.34	NS; p = 0.330
Thigh	9.89	9.39	9.51	0.12	NS; p = 0.203
Drumsticks	9.68	9.78	9.83	0.08	NS; p = 0.706
Wings	7.85	7.97	8.00	0.06	NS; p = 0.588
Heart	0.70	0.71	0.69	0.01	NS; p = 0.663
Liver	2.22	2.26	2.28	0.03	NS; p = 0.694
Gizzard	1.69	1.73	1.74	0.02	NS; p = 0.508
Pancreas	0.24	0. 25	0.26	0.005	NS; p = 0.560
Intestinal weight	6.10	6.14	6.25	0.04	NS; p = 0.340
Spleen	0.14	0.14	0.16	0.005	NS; p = 0.494
Abdominal fat	1.52^a	1.27^b	1.28^b	0.03	S; p = 0.001

NS: Non-significant; S:Significant

Least square means bearing different superscripts differ significantly (p<0.05) column-wise in same row.

5. Discussion

5.1 Feed intake and growth of broilers

Statistical analysis of data showed that our investigations are similarly corroborated with earlier researches those also found no change in feed consumption in herbal supplemented broilers (Amad *et al.*, 2011; Amad *et al.*, 2013; Asli and Rashti, 2017). The biological phenomenon of the enhanced live weights in broilers of herbal fed groups might be attributed to enhances digestive activities, nutrient absorption and assimilation, free radicals scavenging activity and anti pathogenic activity of herbal ingredients (Puvaca *et al.*, 2015; Prajapat *et al.*, 2018; Amsathkumar *et al.*, 2019; Nagar *et al.*, 2020; Nagar *et al.*, 2021; Ayalew *et al.*, 2022).

The investigations of present research are positively similar to previous researches which indicated significantly higher overall live weights of supplemented broilers (Amsathkumar *et al.*, 2019; Ayalew *et al.*, 2022; Al-Beitawi and El-Ghousein, 2008; Thakur *et al.*, 2020a; Thakur *et al.*, 2020b). On the other hand, few researches indicated no alterations in live weights of supplemented broilers (El-Deek *et al.,* 2002). Notwithstanding the observations of this study, feed intake was improved in supplemented broilers (Kumar and Patra, 2017; Khalaji *et al.,* 2011; Ghasemi *et al.,* 2014). The higher body weight of chicks may be due to better utilization of available nutrients in the body of chicks. The principle compounds, *viz*., *Thymoquinone*, *Allicin* and total phenolic compounds show enhanced free radical scavenging and antimicrobial activities in animal's body (Chaturvedi *et al.,* 2013; Shang *et al.,* 2019). These compounds are known to improve gut health and its proliferation in the animals thereby making better utilization of nutrients (Hasin *et al.,* 2021; Sriranga *et al.,* 2021; Singh *et al.,* 2021; Attalmanan *et al.,* 2013). Furthermore, the report suggests that there is improved secretion of digestive acids and enzymes when such herbal supplementation is done in the animals (Hasin *et al.,* 2021; Srinivasan, 2005). Windisch *et al.* (2008) suggested that herbal supplementation improves the resistive capacity leading to a reduced cortisol levels of animals which in turn leads to enhanced nutrient absorption in the body and hence better gain by the animals. Release of more growth hormones in the system of animals through triggered hypothalamus-pituitary axis under the influence of phytogenic feed supplements have been seen to improve body weight performance of animals (Hasin *et al.,* 2021; Srinivasan, 2005; Graham *et al.,* 2008).

The biological phenomenon of the enhanced live weights in broilers of herbal fed groups might be attributed to enhances digestive activities, nutrient absorption and assimilation, free radicals scavenging activity and anti pathogenic activity of herbal ingredients (Puvaca *et al.,* 2015; Prajapat *et al.* 2018; Amsathkumar *et al.,* 2019; Nagar *et al.,* 2020; Nagar *et al.,* 2021; Ayalew *et al.,* 2022). The investigations of present research are in agreement with previous researches in which enhanced feed conversion efficiencies were observed (Al-Beitawi and El-Ghousein, 2008; Hassan *et al.,* 2015; Hafeez *et al.,* 2016). Notwithstanding this, observations of few researches are different with the findings of present research (Asli and Rashti, 2017; Nagar *et al.,* 2020; Nagar *et al.,* 2021).

5.2 Carcass traits

Significantly non-different carcass traits in treatment group birds show that the supplementation of phytogenic feed had no adverse effect on the normal physiology of birds. More abdominal fat deposition in the broilers is disliked by the consumers from their health point of view (Fouad and El-Senousey, 2014; Pena-Saldarriaga *et al.,* 2020). A similar report of non-significant effect of phytogenic feed on carcass characters was documented (Noman *et al.,* 2015; Patel *et al.,* 2017; Singh and Kumar, 2018; Borgohain *et al.,* 2019; Chitra, 2020). However, there are some studies which reported contrary results of significantly different ($p<0.05$) carcass traits in the supplemented broilers (Guler *et al.,* 2006; Wang *et al.,* 2015; Ukoha and Onunkwo, 2016; Yusuf *et al.,* 2017)**.** The reason behind this may be they used different phytogenic ingredients in their experiment than ours. Those mixtures showed different results in the supplemented birds as different phytogenic ingredients have different intensities and effectiveness in body of birds. Bamidele and Adejumo (2012) also observed significantly reduced cholesterol levels in herbal feed supplemented groups. In connection to that, Singh and Kumar (2018) also reported that there was significantly lower separable fat from carcass of black cumin supplemented groups than non-supplemented group birds. Guler *et al.* (2006) also found similar result of lower abdominal fat in broilers supplemented with *Nigella sativa* seeds than non-supplemented birds. Sugiharto *et al.* (2011) showed that these phytogenic mixture contain bioactive compounds which significantly lowers abdominal fat percent by down-regulating lipo-genesis in liver and increases beta oxidation of fatty acids. However, as per Asai and Miyazawa (2001) clear mechanism of reduced fatty acid deposition in abdominal region is clearly not established.

6. Conclusion

Our study showed that supplementation of phytogenic mixture containing *N. sativa*, *A. sativum* and *O. sanctum* (1:1:1 ratio) @0.25% and 0.050% in broilers feed may enhance live weights, FCR and FCE of broilers. However, feed intakes among broilers of all three groups were statistically non-different. In addition to this, abdominal fat was favourably lowered in treatment groups. Supplementation of phytogenic mixture @0.25% and 0.050% in broilers feed showed similar results. Therefore, based on the findings of this study, it may be concluded that dietary supplementation of phytogenic mixture containing *N. sativa*, *A. sativum* and *O. sanctum* (1:1:1 ratio) @0.25% of broilers feed may improve the performance of broilers.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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