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Dietary inclusion of Ashwagandha (*Withania somnifera*) root powder on growth performance and metabolizability in broilers

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Abstract
A total of 300, one day-old commercial broiler chicks were procured and randomly distributed into 30 subgroups means six dietary treatments with five replicates per treatment and each replicate has ten birds. Feeding trial was conducted for 42 days. The control group (T_1) was offered maize- soybean meal based diet which was formulated as per BIS (2007) [7] to fulfill the metabolizable energy (ME) and crude protein requirements of broilers. The first group was kept as a control (T_1) and given the basal diet without antibiotic while second (T_2) basal diet with antibiotic, third (T_3), fourth (T_4), fifth (T_5) and sixth (T_6) groups were supplemented with Ashwagandha root powder @ 0.25, 0.5, 0.75 and 1%, respectively in the diet. Feed intake (g/bird) and body weight gain (g/b) showed significant (P<0.05) increase as the level of Ashwagansha root powder inclusion increases. Over all the feed intake and body weight gain was found significantly (P<0.05) highest in 1.0% (T_6) Ashwagandha supplemented group followed by 0.75% (T_5), 0.50% (T_4) Ashwagandha supplemented groups as compared to 0.25% (T_3), antibiotic (T_2) supplemented group and control group. Feed conversion ratio was found significantly lowest in 0.75% and 1% Ashwagandha supplemented groups as compared to control group. The feed conversion efficiency was improved as level of Ashwagandha root powder increased. Dietary supplementation at the rate of 0.75% and 1% Ashwagandha powder results in significantly (P<0.05) higher DM metabolizability, nitrogen metabolizability and gross energy metabolizability as compared to control group. Thus, it may be concluded that average body weight gain, feed conversion ratio, DM metabolizability, Nitrogen metabolizability and GE metabolizability was improved on feeding 0.75% and 1.0% Ashwagandha root powder as herbal feed supplement.

Keywords: Ashwagandha, broilers, feed conversion ratio, gross energy and dry matter metabolizability

Introduction

Materials and methods

The animal experiment was conducted in accordance with guidelines approved by the Institutional Animal Ethics Committee (IAEC), 235/CPCSEA dated 1-8-2000 in the Department of Animal Nutrition, LUVAS. Three hundred, one day old broiler chicks, were purchased from a local commercial hatchery. The chicks were individually weighed, wing banded and randomly distributed into 30 subgroups means six dietary treatments with five replicates per treatment and each replicate has ten birds. Basal ration was formulated as per BIS (2007) [7] to fulfill the metabolizable energy (ME) and crude protein requirements of birds. Ingredient compositions of experimental diets during different phases of growth are presented in Table 1. The first group was kept as a control (T_1) and given the basal diet without antibiotic while second (T_2) basal diet with antibiotic, third (T_3), fourth (T_4), fifth (T_5) and sixth (T_6) groups were supplemented with Ashwagandha root powder @ 0.25, 0.5, 0.75 and 1%, respectively in the diet. Birds were vaccinated against F_1 strain of Ranikhet disease on 3rd day and IBD on 14th day.

The chicks were kept hygienically on floor litter system in separate pens. The chicks were brooded at 35 ^{o}C during the first week. The birds were vaccinated against prevailing diseases adopting a standard protocol. The weekly record of the feed offered and residual amount was maintained for each replicate to calculate the feed consumption per bird. The birds were weighed individually at weekly intervals and the body weights were recorded to calculate body weight gain up to 6 weeks of age. Feed Conversion Ratio (FCR) for each replicate was calculated as follows:

FCR=Total feed consumed (g)/Total body weight gain (g).

A metabolism trial was conducted at the end of growth period. One bird from each replicate was randomly selected; preliminary period of three days was given for adaptation to the birds to new system of housing and management, followed by a collection period of three days. A representative sample of excreta from each replication was collected daily in same plastic bottles and bottles were again kept in deep freeze to determine moisture and nitrogen contents. Feed offered and weigh back records were maintained on daily basis during the trial period. The availability of nutrients for each replicate was calculated by dividing the amount of retained nutrients (ingested nutrients – excreted nutrients) with the amount of ingested nutrients.

Similarly, dry matter retention was also calculated. Protein efficiency ratio was calculated as: Body weight gain (g)/ Total protein intake (g) × 100. Energy efficiency ratio was calculated as:Body weight gain/ Total ME intake (Kcal/kg) × 100. The gross energy of oven dried feed; weigh back and excreta samples were determined by standard procedure using Bomb Calorimeter. The gross heat of combustion in calories per gram of the material was computed by substituting values in the following equation:

Gross heat of combustion (Cal/g) = t×w - (C1+C2+C3)/M

Where, t (Rise in temperature), w (Water equivalent), M (Weight of sample), C1(Correction in calories for heat of formation of acid), C2 (Correction in calories for heat of combustion of fuse wire), C3 (Correction in calories for heat of combustion of thread, 27.73 cal/20 cm.). From gross energy values of feed weigh back and excreta, the metabolizable energy (ME) was worked out by using the equation given by Hill and Anderson (1958) [9] ME = E diet – E excreta - N×8.22. Gross energy metabolizability (%) was calculated as follows: Nitrogen corrected metabolizable energy (Kcal/kg)/ Gross energy of dry feed (Kcal/kg) ×100. The data were analyzed using general linear model procedure of statistical package for social sciences 20th version (SPSS) [22] and comparison of means tested using Duncan's multiple range test (DMRT) [8] and significance was considered at $P<0.05$.

Table 1: Ingredient composition of experimental diets during different phases of growth

Ingredient (kg /100 of feed)	0-4 wk	4-6 wk
Maize	58	60
Soybean meal	30	25
Fish meal	7	7
Vegetable oil	3	6
Mineral mixture	2	2
Feed additives (g/100 kg feed)		
Spectromix[1]	10	10
Spectromix BE[2]	20	20
Veldot[3]	50	50
Choline chloride[4]	50	50
Lysine[5]	50	50
DL-methionine[6]	150	150

1. **Spectromix:** Powder (Ranbaxy Animal Health, New Delhi). Each g. contained Vitamin A- 82,500 IU, Vit D3- 12000 IU, Vit B2-50 mg and Vit.K-10 mg. Mixing rate: 10 g/100 kg of feed.
2. **Spectromix BE:** Powder (Ranbaxy Animal Health, New Delhi). Each g contained Vit.B1- 8 mg, Vit.B6- 16 mg, Vit.B12- 80 mg, niacin-120mg, calcium pentothenate-80 mg, Vit. E-160 mg, Lysine hydrochloride-10 mg, DL-methionine-10 mg and calcium 260 mg. Mixing rate: 20g/100 kg of feed.
3. **Veldot:** Venkeys- Dinitro-O-Toluamide (Coccidiostat). Mixing rate: 50 g/100 kg of feed.
4. **Choline chloride:** Contain 60 percent choline. Mixing rate: 50 g/100 kg of feed.
5. **Lysine:** Contained 98% lysine. Mixing rate: 50 g/100 kg of feed.
6. **DL-methionine:** Contained 98% methionine. Mixing rate: 150 g/100 kg of feed.

Results and discussion

Average feed intake

Results showing mean values of average feed intake (g/b) from 0-42 days are presented in Table 2 and Fig 1. Average feed intake during 0-14 days ranged from 398.00 (T_2) to 405.60 (T_3) and intake did not differ significantly in Ashwagandha supplemented group as compared to control. Feed intake (g/b) during 15-28 days ranged from 1104.40 (T_3) to 1259.20 (T_6) and intake was increased in Ashwagandha supplemented group as compared to control (T_1) and significantly higher feed intake was found in 0.50%, 0.75% and 1% Ashwagandha supplemented group as well as antibiotic supplemented group as compared to control group. Average feed intake (g/b) during 29-42 days ranged from 1658.00 (T_3) to 1855.80 (T_6). Feed intake was significantly higher at 1% Ashwagandha supplemented as compared to other groups and lowest was found in 0.25% (T_3) Ashwagandha supplemented group, antibiotic supplemented group (T_2) and control (T_1) group. There was an increase in feed intake as the level of Ashwagandha root powder inclusion increases. Over all feed intake (g/b) ranged between 3166.80 (T_3) to 3506.20 (T_6) and highest was found in 1% (T_6) followed by 0.75% (T_3) and 0.50% (T_4) Ashwagandha supplemented group and this differ significantly as compared to control. There were significant ($P<0.05$) differences in feed intake among groups fed with higher levels of Ashwagandha root powder as compared to control. In resemblance to our result findings, Bhardwaj and Gangwar (2011) [6] found that cumulative feed intake (g/b) for 8- 23 weeks feeding period was significantly ($P<0.05$) higher in T_1 and lower in the entire Ashwagandha treated groups. Several researchers also reported that with the increasing body weight gain there is significant increase in feed intake in different Ashwagandha fed groups (Singh *et al*., 2010 [21]; Ansari *et al*., 2008 [5]). Vasanthakumar *et al.* (2015) [23] reported that the feed intake (g) was significantly ($P<0.05$) more in 1% Ashwagandha root powder in T_2 (4580.64±94.86) and 0.15% root extract in T_3 (4423.52±76.23) supplemented groups as compared to the T_1 (3954.22±83.24) control group. In consistent with our results Shisodiya *et al*. (2008) [20] observed no significant difference in feed intake between treatment groups of broilers fed *Withania somnifera* root powder as herbal feed supplement. However, Joshi *et al.* (2015) [10] found that supplementation of Ashwagandha at 1% and 2% level of the feed has no significant difference on the overall feed intake.

Table 2: Average feed intake (g/bird) during different growth periods under different dietary treatments

Treatments	0 to 14 d	15 to 28 d	29 to 42 d	0 to 42 d
T_1	404.60±0.01	1121.40^{a}±0.01	1673.20^{a}±0.02	3199.2^{a}±0.02
T_2	398.00±0.01	1182.20^{b}±0.04	1667.80^{ab}±0.08	3248.00^{b}±0.09
T_3	405.60±0.01	1104.40^{a}±0.25	1658.00^{ab}±0.09	3166.80^{a}±0.34
T_4	399.20±0.02	1207.40^{bc}±0.04	1683.00^{b}±0.05	3289.60^{b}±0.09
T_5	399.00±0.04	1234.40^{cd}±0.02	1769.40^{c}±0.05	3402.80^{c}±0.11
T_6	402.40±0.05	1259.20^{d}±0.06	1855.80^{d}±0.10	3506.20^{d}±0.13

^{a,b,c,d} Means bearing different superscripts in a column differ significantly (P<0.05)

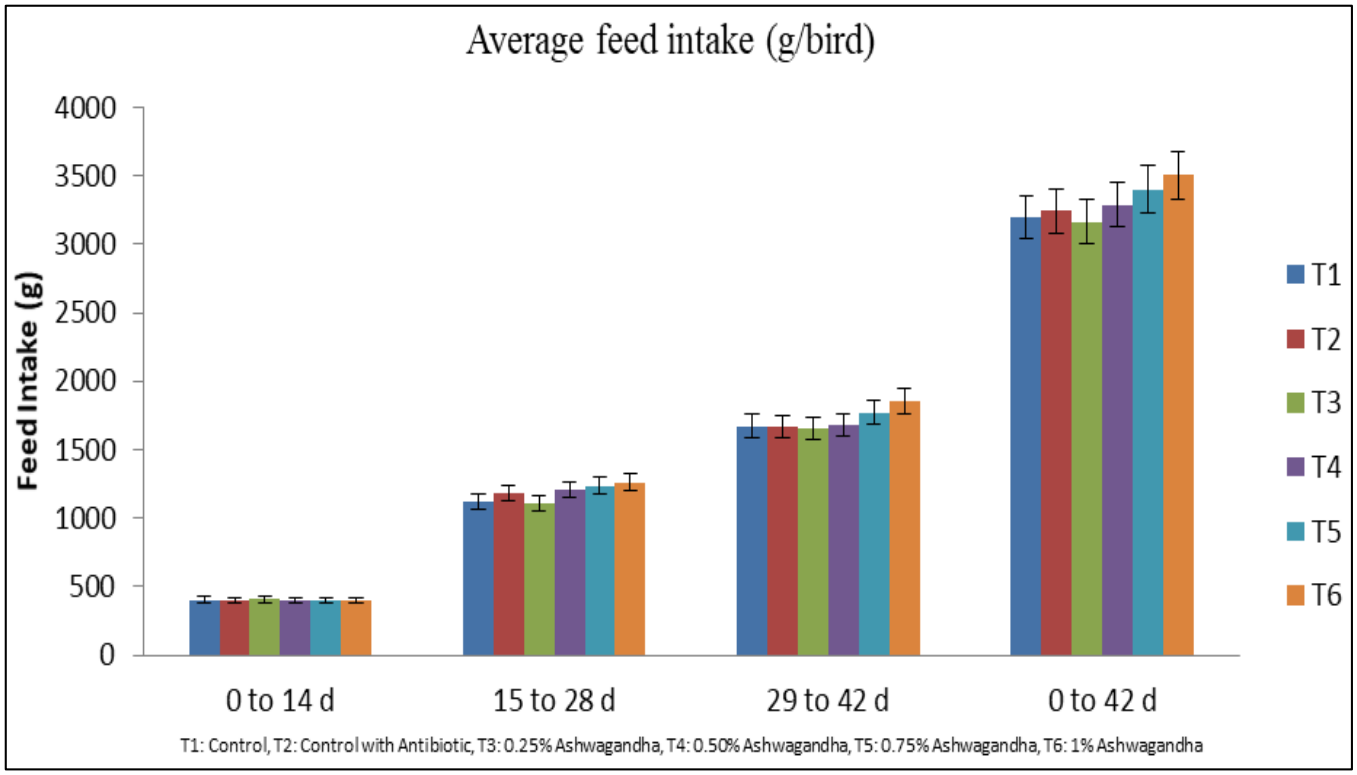

Fig 1: Average feed intake (g/bird) during different growth periods under different dietary treatments

Average body weight gain

Mean body weight gain (g) at the age of 0 -14 days ranged from 220.86 (T_1) to 233.07 (T_5) and significantly (P<0.05) higher body weight gain was found in Ashwagandha supplemented group as compared to control as shown in Table 3. Body weight gain (g) at age 15 -28 days ranged from 592.91 (T_3) to 725.04 (T_6) and significantly higher body weight gain was found in Ashwagandha and antibiotic supplemented group as compared to control. Mean body weight gain (g) from day 29 to 42 ranged from 886.29 (T_3) to 1043.56 (T_6) and significantly (P<0.05) higher was found in 0.75% and 1% Ashwagandha supplemented group followed by 0.50% (T_4) as compared to 0.25% Ashwagandha supplemented group, antibiotic supplemented and control group. Body weight gain (g) from day 0 to 42 ranged 1607.78 (T_3) to 1997.42 (T_6) and significantly higher body weight gain was found in 1.0% (T_6) Ashwagandha supplemented group followed by 0.75% (T_5), 0.50% (T_4) Ashwagandha supplemented groups as compared to 0.25% (T_3), antibiotic (T_2) supplemented group and control group. This increase in the body weight gain of the broilers in the present study could be correlated to the increase in feed intake of the Ashwagandha supplemented groups. These observations are in close agreement with Kale *et al.* (2016) [11] found that broiler chicks fed *Withania somnifera* root powder at the rate of 2.5% and 5% of feed attained significantly (P<0.05) higher body weight in T_1 (567.00 g) and T_2 (581.67 g) as compared to those in T0 (424.17 g) in six week of age. Similarly, Narayanswamy *et al.* (2004) [15] and Shisodiya *et al.* (2008) [20] who reported that feeding of *Withania somnifera* root powder as herbal feed supplement significantly improved weight of broiler chicks. The improved performance in broilers fed the WSR might be due to the improved nutrient digestibility as observed by Lilija (1983) [14], which were associated with the development of digestive tract and digestive organs. Ansari *et al.* (2008) [5] conducted a study with six medicinal plants fed at the rat of 4g/kg of the feed and found that maximum weight gain at 6 weeks age in T No.6 *Withania somnifera* (1.819 kg) followed by T No.1 *Nigella sativa* (1.805 kg), T No.5 *Azadirachta indica* (1.800 kg), T No.3 *Corylus avellena* (1.645 kg), T No.7 control (1.537 kg), T No.4 *Ipomea digitata* (1.428 kg) and T No.2 *Boerhavia diffusa* (1.416 kg). Ansari *et al.* (2013) [4] reported that at 28 and 42 days of age, birds fed diets supplemented with 2.5% or 5.0% WSR had greater BW than those fed diets with 1.25% WSR and negative control. The improvement in body weight and FCR may be related to main active constituent withanine and withanolide of *Withania somnifera* root powder that could act not only as antibacterials and antioxidants but as a stimulant of digestive enzymes in the intestinal mucosa and pancreas that improve the digestion of dietary nutrients and feed efficiency, subsequently increasing the growth rate (Ali, 2011) [3].

Table 3: Average body weight gain (g) under different dietary treatments.

Treatments	0 to 14 d	15 to 28 d	29 to 42 d	0 to 42 d
T_1	220.86^{a}±1.20	608.12^{a}±4.50	889.19^{a}±2.34	1718.17^{a}±4.16
T_2	221.33^{a}±2.43	645.35^{b}±3.00	904.29^{b}±3.04	1770.97^{b}±5.23
T_3	228.57^{b}±2.25	592.91^{a}±10.90	886.29^{a}±3.75	1707.76^{a}±12.53
T_4	230.92^{b}±1.14	656.73^{b}±2.87	910.34^{b}±3.54	1798.00^{c}±6.09
T_5	233.07^{b}±2.38	719.20^{c}±1.50	1013.56^{c}±7.26	1965.82^{d}±7.88
T_6	228.82^{b}±1.54	725.04^{c}±4.24	1043.56^{d}±6.98	1997.42^{e}±8.44

^{a,b,c,d,e} Means bearing different superscripts in a column differ significantly (P<0.05)

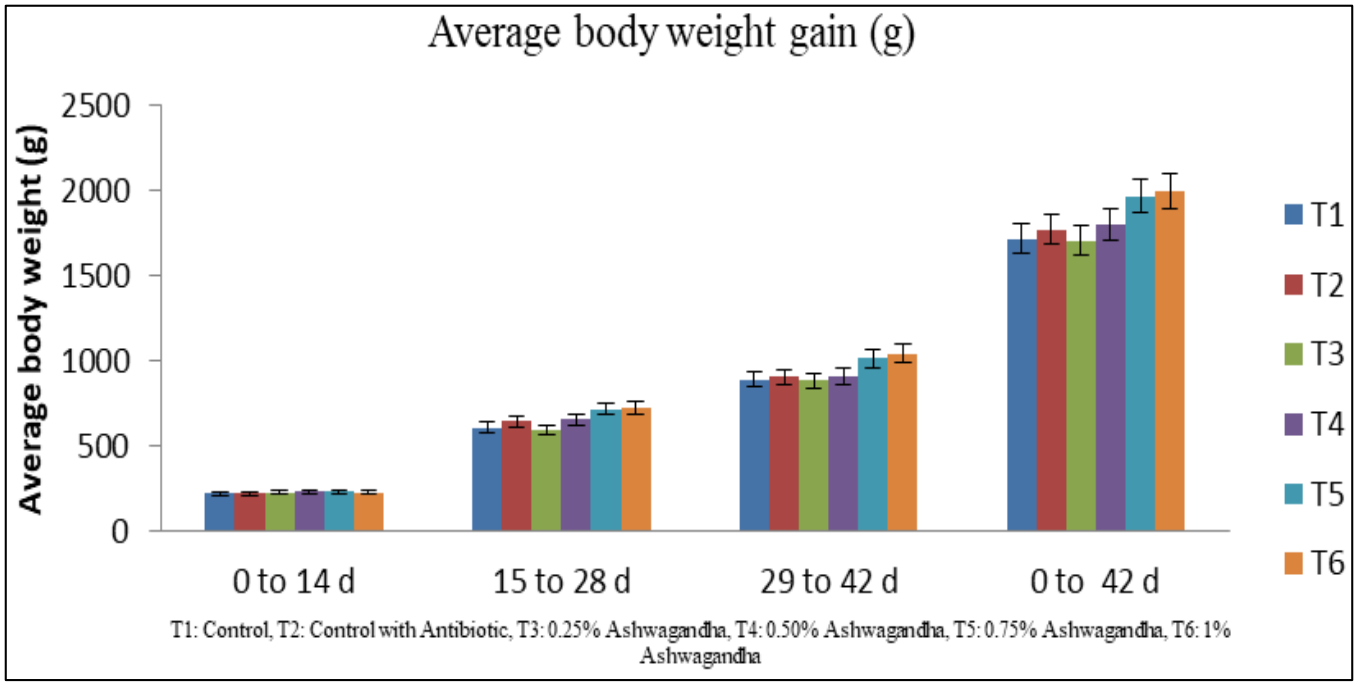

Fig 2: Average body weight gain (g) under different dietary treatments

Feed conversion ratio

Feed Conversion Ratio during 0-14 days of the experiment was higher in T_1(control) and lowest FCR was obtained in T_5 and T_6 groups and significantly differ from antibiotic supplemented and control group as presented in Table 4. FCR during 15 to 28 days was obtained lowest in T_5 and T_6 and was significantly (P<0.05) different than other groups. During 29 to 42 days growth period, FCR of 0.75% and 1% Ashwagandha supplemented group was observed significantly better from control, 0.25%, 0.50% Ashwagandha supplemented and antibiotic supplemented group. At the age of 6 weeks, T_1 (basal diet) showed the highest FCR and difference was significantly higher in comparison to Ashwagandha supplemented groups at higher level and significantly (P<0.05) lowest FCR was found in 0.75% and 1% Ashwagandha supplemented groups. This beneficial effect of treatment on feed conversion ratio was in agreement with Samarth *et al.* (2002) [19] and Akotkar *et al.* (2007) [2] who used herbal feed supplement *Withania somnifera* root powder at the rate of 0.5 and 1 per cent respectively. Kale *et al.* (2016) [11] concluded that the broilers in group T_1 and T_2 fed with *Withania somnifera* root powder at the rate of 0.25 and 0.5 per cent respectively, showed significantly (P<0.05) better FCR than T_0 indicating better utilization of feed. Bhardwaj and Gangwar (2011) [6] found that FCR (feed intake/egg mass) and net FCR were significantly (P<0.05) poorer in T1 group than other groups supplemented group. Ansari *et al.* (2013) [4] observed that feed efficiency (weight gain/feed intake) was influenced by the 2.5% and 5% level of *Withania somnifera* root used at both 28 and 42 days of age, improving the feed efficiency compared with the diets at lower(1.25%) level of *Withania somnifera* roots and control. The improvement in BW and FCR in the present study may be related to main active constituent withanine, withanolide 1, and withanolide 2 of WSR that could act not only as antibacterials and antioxidants but as stimulant of digestive enzymes in the intestinal mucosa and pancreas that improve the digestion of dietary nutrients and feed efficiency, subsequently increasing the growth rate (Abou-Douh, 2002) [1].

Table 4: Feed conversion ratio under different dietary treatments

Treatments	0 to 14 d	15 to 28 d	29 to 42 d	0 to 42 d
T_1	1.83^{c}±0.01	1.85^{b}±0.01	1.88^{d}±0.01	1.86^{d}±0.00
T_2	1.80^{bc}±0.02	1.83^{b}±0.01	1.84^{c}±0.01	1.83^{c}±0.01
T_3	1.77^{b}±0.01	1.86^{b}±0.02	1.87^{d}±0.01	1.85^{d}±0.01
T_4	1.73^{a}±0.01	1.84^{b}±0.01	1.85^{c}±0.01	1.83^{c}±0.00
T_5	1.71^{a}±0.01	1.72^{a}±0.01	1.75^{a}±0.01	1.73^{a}±0.00
T_6	1.71^{a}±0.01	1.74^{a}±0.01	1.78^{b}±0.00	1.76^{b}±0.00

^{a,b,c,d} Means bearing different superscripts in a column differ significantly (P<0.05)

Metabolizability of Nutrients

Results depicted in Table 5 and Fig. 2., shows that supplementation at the rate of 0.75% and 1% Ashwagandha powder results in significantly (P<0.05) higher DM metabolizability among all different dietary treatments. Nitrogen retention was significantly higher in 0.75% Ashwagandha supplemented group as compared to control and antibiotic supplemented group. Other treatments also showed significantly improved nitrogen metabolizability as compared to control. Gross energy metabolizability in different dietary treatments ranged between 68.00% (T_3) to 71.29% (T_5). Group supplemented with 0.75% Ashwagandha root powder has significantly (P<0.05) higher gross energy metabolizability followed by 1% (T_6), 0.50% (T_4) Ashwagandha supplemented groups as compared to antibiotic, 0.25% (T_3) Ashwagandha supplemented and control group. Rutkowaski *et al.* (2016) [17] concluded that the apparent nitrogen retention, total digestibility of fat and the nitrogen corrected apparent metabolizability value of lupine seeds determined in young chicken show a significant beneficial effect of extrusion of yellow lupine. Also significantly better ileal digestibility of protein and some amino acids from extruded seeds was found in comparison to raw lupine seeds. A similar beneficial effect of extrusion in terms of protein digestibility in rats was reported by Leontowicz *et al.* (2001) [13]. The results of study are consistent with the findings of Saini *et al.* (2017) [18] who observed that dry matter digestibility of broiler ration increased with increase in level of *Withania somnifera* up to 1.0% and thereafter decreased. Further, he also suggested that inclusion of *Withania somnifera* as feed additive @ 1.0% in broiler ration, exerted maximum nitrogen retention and thereafter at 0.5% level of inclusion. Similarly, Raghavan *et al.* (2011) [16] who observed significant effect on nitrogen balance due to supplementation of herbs. Kavitha *et al*. (2004) [12] and Wang *et al.* (2008) [24] also recorded significantly improved nitrogen retention in broilers supplemented with enzyme as compared to non supplemented groups.

Table 5: DM Metabolizability, Nitrogen Metabolizability and Gross Energy Metabolizability under different dietary treatments

Treatments	Dry Matter Metabolizability (%)	Nitrogen Metabolizability (%)	Gross Energy Metabolizability (%)
T_1	67.79^{ab}±0.08	68.30^{a}±0.08	68.05^{a}±0.18
T_2	68.02^{b}±0.08	68.49^{a}±0.09	68.15^{a}±0.24
T_3	67.47^{a}±0.08	68.52^{a}±0.15	68.00^{a}±0.13
T_4	68.47^{c}±0.15	69.56^{b}±0.10	69.01^{b}±0.23
T_5	71.52^{d}±0.17	72.41^{d}±0.02	71.29^{c}±0.05
T_6	71.25^{d}±0.13	71.05^{c}±0.25	69.29^{b}±0.08

^{a,b,c,d} Means bearing different superscripts in a column differ significantly (P<0.05)

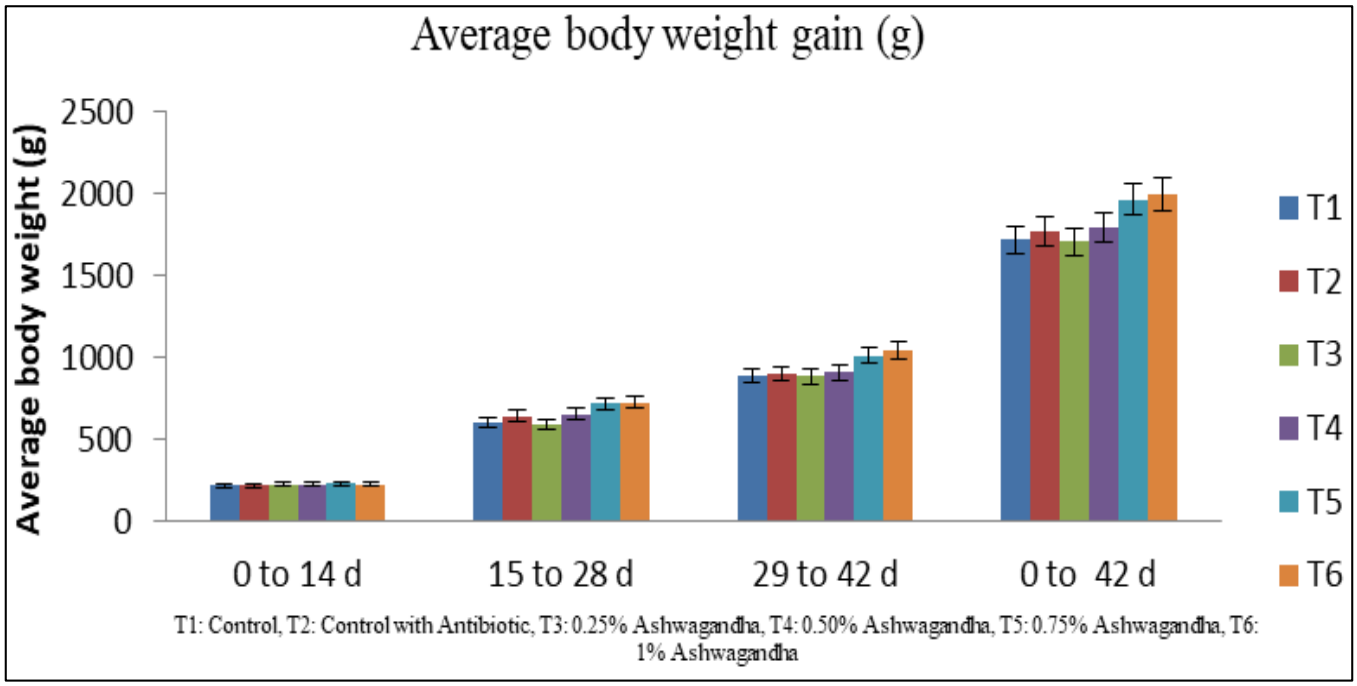

Fig 2: DM Metabolizability, Nitrogen Metabolizability & Gross Energy Metabolizability

Conclusion

The conclusion of present study indicated that dietary inclusion of Ashwagandha root powder as herbal feed supplement @ 0.75% and 1.0% Ashwagandha root powder lead to significant increase in the performance of the broilers in terms of improved body weight gain, feed conversion ratio, Dry matter metabolizability, nitrogen metabolizability and gross energy metabolizability.

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