



Effect of garlic (*Allium sativum*) and nilavembu (*Andrographis paniculata*) on growth performance and cost effectiveness of broiler chicken

TORYALI ARIFY¹, S EZHIL VALAVAN², A VARUN³, A SUNDARESAN⁴ and K MANIMARAN⁵

Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu 600 051 India

Received: 28 September 2018; Accepted: 4 April 2019

ABSTRACT

The biological experiment was conducted to study the effect of feeding garlic (*Allium sativum*) and nilavembu (*Andrographis paniculata*) in broiler chicken (Vencobb 400) for a period of 6 weeks on various parameters, viz. bi-weekly body weight, gain in body weight, feed conversion ratio, livability and the cost effectiveness of feeding garlic and nilavembu. A total of 300 day-old, unsexed, broiler chicken were utilized for this study. The treatment groups were fed with diets containing garlic and nilavembu at different levels, such as control (T₁), 5 g garlic + 1 g nilavembu (T₂), 10 g garlic + 1 g nilavembu (T₃), 5 g garlic + 2 g nilavembu (T₄) and 10 g garlic + 2 g nilavembu (T₅), respectively. Biological experiment revealed that there was highly significant ($P < 0.01$) difference in body weight and body weight gain and feed conversion ratio. No significant difference was observed in feed consumption and livability. The cost effectiveness of the broiler chicken fed with various levels of garlic and nilavembu showed increased net profit per kg live weight in the group fed with 10 g garlic and 2 g nilavembu (T₅).

Key words: Broiler, Cost effectiveness, Garlic, Growth performance, Nilavembu

Feed additives are commonly added in poultry feed to improve nutritive value of ingredients and to enhance broiler performance by increasing growth rate and improving feed conversion efficiency. Presently a need has arisen to completely avoid usage of antibiotics in poultry feeding due to increasing consumer concern for poultry drug residues in meat and egg. Phytogetic substances are supposed to increase performance of birds by stimulating secretion of digestive enzymes, leading to enhanced digestion and absorption (Recoquilly 2006). Furthermore, the presence of active ingredients and phenolic compounds can reduce number of intestinal pathogens, thus minimizing nutrient loss. Garlic is a proven herbal medicine and has an anti-bacterial, anti-viral, anti-fungal, anti-cancer, anti-oxidant, immunomodulatory, anti-inflammatory, hypoglycemic and hypo-cholesteremic effect. Nilavembu (*Andrographis paniculata*) is known in North–Eastern India as Maha – tikta literally meaning “king of bitters”. The herb and its isolates are reported to possess anti-viral, anti-inflammatory, hepato-protective, astringent and anti-pyretic properties.

The phytochemical screening of garlic revealed presence of chemical compounds such as saponin, tannin,

carbohydrates, cardio glycoside, alkaloids, flavonoid, phlobatannin and glycoside (Pavni *et al.* 2011) whereas nilavembu had steroids, alkaloids, flavonoids, triterpenoids, tannins, saponin, quinone, coumarin, protein, sugar and gum (Salna *et al.* 2011). The effect of garlic and nilavembu has been studied separately in a few researches. But the phytochemical screening of garlic and nilavembu revealed the presence of many similar phytochemical compounds which are common to each other. Hence, the present experiment was conducted to study the combined effect of garlic and nilavembu on broiler performance the cost effectiveness of feeding garlic and nilavembu.

MATERIALS AND METHODS

The present experiment was conducted at the Poultry Research Station, Tamil Nadu Veterinary and Animal Sciences University, Chennai for a period of 6 weeks. A total of 300 day old, unsexed, broiler chickens were wing banded, weighed and randomly allotted into 5 treatment groups and reared under standard uniform management conditions. All the treatment had three replicates and each consisted of 20 chicks. Garlic and nilavembu was incorporated into basal diet and different treatment groups were formed is shown in Table 1.

The basal experimental diet was prepared as per BIS 2007 broiler standard with similar nutrient composition for all the treatments. Fresh garlic was purchased from local market and pure nilavembu powder was obtained from the Government Siddha Medical College, Chennai. All the experimental feeds were prepared at the Central Feed

Present address: ^{1,3}PG Scholar (toryali.arify@gmail.com, varunsivagangai92@gmail.com), Department of Poultry Science, MVC, Chennai. ²Professor (vetezhil2015@gmail.com), Livestock Farm Complex; ⁴Assistant Professor (drsundaresan2009@gmail.com), Directorate of Centre for Animal Production Studies; ⁵Assistant Professor (maranvet@yahoo.com), Central University Laboratory, Directorate of Centre for Animal Health Studies.

Table 1. Experimental design

Treatment	Experimental design	No. of birds			
		R ₁	R ₂	R ₃	Total
T ₁	Control group – Basal feed	20	20	20	60
T ₂	Basal diet + 5 g of Garlic + 1 g of Nilavembu / kg of feed	20	20	20	60
T ₃	Basal diet + 10 g of Garlic + 1 g of Nilavembu / kg of feed	20	20	20	60
T ₄	Basal diet + 5 g of Garlic + 2 g of Nilavembu / kg of feed	20	20	20	60
T ₅	Basal diet + 10 g Garlic + 2 g of Nilavembu / kg of feed	20	20	20	60
	Total	100	100	100	300

Technology Unit, Kattupakkam, Tamil Nadu Veterinary and Animal Sciences University, as shown in Table 2. All the diets were iso-caloric and iso-nitrogenous. The experimental birds were fed *ad lib.* throughout the experimental period. The birds were fed with broiler pre-starter (0–7 days), starter (8–21 days) and finisher (22–42 days), respectively.

Feed consumption and livability were recorded daily and the body weight was recorded in every week. Feed conversion ratio and livability were also calculated. The economics of feeding various levels of garlic and nilavembu

were calculated by taking in to account prevailing cost of different feed ingredients including garlic and nilavembu, total feed consumed, total weight gain and market price of broiler chicken that prevailed during the period of study. The feed cost per kg live weight gain was calculated as follows:

$$\text{Feed cost/kg live weight gain} = \frac{\text{Cost/kg} \times \text{Total feed consumed}}{\text{Total body gain}}$$

The recorded data were used to calculate the gain in body weight, feed efficiency and per cent livability. The data was subjected to statistical analysis as per Snedecor and Cochran (1989).

Table 2. Ingredient and nutrient composition of the experimental broiler diet

Ingredient (kg)	Broiler feed formula		
	Pre-starter	Starter	Finisher
Maize	50.50	53.50	54.00
Cumbu/Bajra	7.00	6.25	8.00
Soya bean meal	29.75	26.00	22.00
Dry fish	9.00	9.00	9.00
Mineral Mixture	1.50	1.50	1.50
Oil	1.75	3.25	5.00
Salt	0.50	0.50	0.50
Total	100.00	100.00	100.00
Supplements (g)			
Vitamin AB ₂ D ₃ K ¹	10.00	10.00	10.00
B-complex vitamins ²	25.00	25.00	25.00
Trace minerals ³	50.00	50.00	50.00
Nutrient composition			
Crude Protein (%)	22.51	21.04	19.53
ME (kcal / kg)	3000	3124	3252
Crude Fibre (%)	3.75	3.52	3.40
Ether extract (%)	5.27	6.75	8.47
Calcium (%)	0.99	0.96	0.90
Available Phosphorus (%)	0.45	0.44	0.43
Lysine (%)	1.33	1.22	1.12
Methionine (%)	0.63	0.61	0.59
Linoleic acid (%)	1.50	1.91	2.36

¹One gram of Vitamin AB₂D₃K supplement contained 8,2,500 IU of vitamin A, 50 mg of vitamin B₂, 12,000 IU of vitamin D₃ and 10 mg of vitamin K. ²One gram of B-Complex supplement contained 8 mg of vitamin B₁, 16 mg of vitamin B₆, 80 mg of vitamin B₁₂, 80 mg of vitamin E, 120 mg of niacin, 8 mg of folic acid, 80 mg of calcium pantothenate, 120 mg of calcium and 300 mg of phosphate. ³One gram of trace minerals contained 54 mg of manganese, 52 mg of zinc, 20 mg of iron, 2 mg of iodine and 1 mg of cobalt.

RESULTS AND DISCUSSION

Data pertaining to body weight, weight gain, feed conversion ratio and economics are presented in Table 3 and 4, respectively. There was highly significant ($P < 0.01$) difference between treatment groups in body weight due to dietary supplementation of garlic and nilavembu throughout the study period. At the end of experimental period, i.e. at 6 weeks of age, dietary inclusion of 10 g garlic and 2 g nilavembu (T₅) had significantly ($P < 0.01$) higher body weight than other treatment groups. The control group (T₁) had lower body weight among all treatment groups. Based on statistical analysis, highly significant difference ($P < 0.01$) in body weight gain of commercial broiler chicken was observed in the birds receiving 10 g garlic and 2 g nilavembu (T₅) during the entire experimental period than other treatment groups and control group. At end of 6th week, dietary supplementation of 10 g of garlic and 2 g of nilavembu (T₅) recorded significantly ($P < 0.01$) higher body weight gain followed by T₄, T₃, T₂ and control group. These findings are in accordance with Eltazi (2014) and Makwana *et al.* (2015) who observed that supplementation of garlic had significantly improved body weight and body weight gain and this may be due to allicin in garlic which promotes the performance of the intestinal flora and inhibits the growth of pathogenic bacteria by interfering with bacterial cell metabolism and thus enhances the activity of pancreatic enzymes. On the contrary, Anvar *et al.* (2012) and Milosevic *et al.* (2013) reported that inclusion of garlic did not improved body weight and body weight gain in broilers. Malahubban *et al.* (2013)

Table 3. Effect of supplementation of garlic and nilavembu on cumulative body weight (g/bird), cumulative body weight gain (g/bird), cumulative feed consumption and cumulative feed conversion ratio (Mean $\pm$ SE) of commercial broiler chicken

Treatment	1 st week**	2 nd week**	3 rd week**	4 th week**	5 th week**	6 th week**
<i>Body Weight</i>						
T ₁ (control)	111.26 ^c $\pm$ 0.07	276.54 ^c $\pm$ 2.84	637.26 ^d $\pm$ 9.10	841.02 ^c $\pm$ 12.32	1275.75 ^d $\pm$ 15.16	1976.57 ^d $\pm$ 19.98
T ₂ (G-5 g + N-1 g)	110.95 ^c $\pm$ 0.28	277.78 ^c $\pm$ 4.50	685.54 ^c $\pm$ 6.98	1059.79 ^b $\pm$ 15.31	1416.64 ^c $\pm$ 18.77	2016.76 ^{cd} $\pm$ 19.99
T ₃ (G-10 g + N-1 g)	113.44 ^b $\pm$ 0.07	279.19 ^{bc} $\pm$ 9.79	706.51 ^{bc} $\pm$ 7.75	1107.39 ^{ab} $\pm$ 08.92	1456.22 ^c $\pm$ 12.03	2029.24 ^{bc} $\pm$ 16.44
T ₄ (G-5 g + N-2 g)	113.59 ^b $\pm$ 0.09	299.26 ^b $\pm$ 5.73	719.49 ^b $\pm$ 6.87	1110.51 ^{ab} $\pm$ 13.41	1538.09 ^b $\pm$ 12.31	2068.22 ^b $\pm$ 12.99
T ₅ (G-10 g + N-2 g)	115.36 ^a $\pm$ 0.26	328.60 ^a $\pm$ 6.97	778.13 ^a $\pm$ 4.23	1154.90 ^a $\pm$ 12.36	1629.44 ^a $\pm$ 14.05	2151.79 ^a $\pm$ 13.43
<i>Cumulative body weight gain</i>						
	1 st week**	2 nd week**	3 rd week**	4 th week**	5 th week**	6 th week**
T ₁ (control)	67.82 ^{cd} $\pm$ 0.56	234.29 ^c $\pm$ 4.64	593.77 ^d $\pm$ 8.89	797.53 ^c $\pm$ 12.01	1232.26 ^d $\pm$ 15.33	1935.07 ^d $\pm$ 20.16
T ₂ (G-5 g + N-1 g)	67.42 ^d $\pm$ 0.94	233.19 ^c $\pm$ 2.47	642.18 ^c $\pm$ 7.08	1016.43 ^b $\pm$ 15.36	1373.28 ^c $\pm$ 18.43	1973.40 ^{cd} $\pm$ 19.77
T ₃ (G-10 g + N-1 g)	69.78 ^{bc} $\pm$ 0.13	235.39 ^c $\pm$ 9.29	662.71 ^{bc} $\pm$ 7.16	1063.59 ^{ab} $\pm$ 09.34	1412.42 ^c $\pm$ 12.39	1985.44 ^{bc} $\pm$ 15.81
T ₄ (G-5 g + N-2 g)	70.75 ^{ab} $\pm$ 1.76	256.07 ^b $\pm$ 4.59	676.31 ^b $\pm$ 7.08	1067.33 ^{ab} $\pm$ 13.43	1494.90 ^b $\pm$ 12.52	2025.03 ^b $\pm$ 12.22
T ₅ (G-10 g + N-2 g)	72.39 ^a $\pm$ 0.39	285.26 ^a $\pm$ 7.09	734.77 ^a $\pm$ 4.39	1111.55 ^a $\pm$ 12.11	1586.09 ^a $\pm$ 14.20	2108.44 ^a $\pm$ 13.27
<i>Cumulative feed conversion ratio</i>						
	1 st week ^{NS}	2 nd week ^{NS}	3 rd week ^{NS}	4 th week**	5 th week**	6 th week**
T ₁ (control)	1.42 $\pm$ 0.02	1.38 $\pm$ 0.06	1.36 $\pm$ 0.02	2.17 ^b $\pm$ 0.07	2.25 ^d $\pm$ 0.04	1.83 ^c $\pm$ 0.02
T ₂ (G-5 g + N-1 g)	1.42 $\pm$ 0.08	1.38 $\pm$ 0.20	1.34 ^a $\pm$ 0.02	1.73 ^a $\pm$ 0.11	2.07 ^{cd} $\pm$ 0.03	1.81 ^c $\pm$ 0.01
T ₃ (G-10 g + N-1 g)	1.42 $\pm$ 0.05	1.38 $\pm$ 0.01	1.31 $\pm$ 0.04	1.66 ^a $\pm$ 0.05	1.98 ^{bc} $\pm$ 0.07	1.79 ^{bc} $\pm$ 0.02
T ₄ (G-5 g + N-2 g)	1.42 $\pm$ 0.03	1.38 $\pm$ 0.22	1.28 $\pm$ 0.01	1.62 ^a $\pm$ 0.07	1.86 ^{ab} $\pm$ 0.04	1.74 ^b $\pm$ 0.01
T ₅ (G-10 g + N-2 g)	1.42 $\pm$ 0.03	1.38 $\pm$ 0.02	1.29 $\pm$ 0.01	1.58 ^a $\pm$ 0.06	1.75 ^a $\pm$ 0.02	1.69 ^a $\pm$ 0.02

Means bearing different superscripts within the same column differ significantly; NS, Non significant; **, Highly significant (P<0.01); G, Garlic; N, Nilavembu.

Table 4. Effect of supplementation of garlic and nilavembu on cost effectiveness (Economics) of commercial broiler chicken

Treatment	Body weight (kg)	Chick cost (₹)	Total feed consumed (kg)	Cost of feed including cost of garlic (₹)	Total feed cost per bird (₹)	Total cost of production per bird (₹)	Total cost of production kg per live weight (₹)	Total income per bird (₹)	Net profit per bird (₹)	Net profit (₹) per kg live weight
	a	b	c	d	e = (c $\times$ d)	f = (b+e+A)	g = f / a	h = a $\times$ B	i = h - f	j = B - g
T ₁ (control)	1.97	35	3.71	28.54	105.88	146.88	74.56	157.60	10.72	5.44
T ₂ (G-5 g + N-1 g)	2.02	35	3.68	29.04	106.87	147.87	73.20	161.60	13.73	6.80
T ₃ (G-10 g + N-1 g)	2.03	35	3.60	29.56	106.42	147.42	72.62	162.40	14.98	7.38
T ₄ (G-5 g + N-2 g)	2.09	35	3.55	29.04	103.09	144.09	68.94	167.20	23.11	11.06
T ₅ (G-10 g + N-2 g)	2.15	35	3.57	29.56	105.53	146.53	68.15	172.00	25.47	11.85

A, Miscellaneous cost: ₹ 6 per bird; B, Price of one kg live weight: ₹ 80 per bird; G, Garlic; N, Nilavembu.

and Laing *et al.* (2013) reported that supplementation of *Andrographis paniculata* to broilers resulted in better body weight and weight gain. Supplementation of nilavembu causes reduced pH and decreased the intestinal thickness. The combination of garlic and nilavembu had provided an environment for better absorption of nutrients and had enhanced the utilization of energy and there by increased the growth rate of chicken.

Statistical analysis revealed that no significant difference was observed in feed consumption between treatment groups throughout the study period. This might be due to iso-caloric and iso-nitrogenous diets fed throughout the experimental period. The present finding was in agreement with earlier report of Anvar *et al.* (2012), Malahubban *et al.* (2013) and Eltazi *et al.* (2014) who had stated that there was no significant difference in feed consumption due to garlic and nilavembu supplementation.

Data on feed conversion ratio revealed highly significant

(P<0.01) difference between treatment groups throughout the experimental period except at the age of 1 to 3 weeks. At sixth week of age, the group supplemented with 10 g of garlic and 2 g of nilavembu (T₅) recorded significantly (P<0.01) better feed conversion ratio (1.69 $\pm$ 0.02) than other treatment and control group (1.83 $\pm$ 0.02). Though feed consumption remains same in all treatment groups, the alteration in feed conversion ratio by the group fed with 10 g of garlic and 2 g of nilavembu (T₅) is due to the significant difference in body weight than other treatment groups. The result of this study was in agreement with Makwana *et al.* (2015) and Karangiya *et al.* (2016) who stated that supplementation of garlic improved the feed efficiency in chicken. Better feed conversion ratio in garlic supplemented group might be due to decreased growth and colonization of various pathogenic microorganism in the gut resulting in enhanced efficiency of feed utilization. Malahubban *et al.* (2013) and Laing *et al.* (2013) who

supplemented *Andrographis paniculata* at different levels to broiler resulted in significantly ($P < 0.05$) improved feed conversion ratio when compared to control group. The combination of garlic and nilavembu had resulted in a positive additive effect on better feed conversion ratio in broilers.

There was no mortality among the birds belonging to various treatment groups during the entire experimental period and this substantiates the earlier reports of Milosevic *et al.* (2013) and Eltazi *et al.* (2014), who had observed non-significance difference in livability of chicken while feeding garlic. Moreover, Eid and Iraqi (2014), Puvaca *et al.* (2014) showed that supplementation of garlic had significantly ($P < 0.05$) decreased mortality rate compared to control group. In the present study, better livability was observed due to combined effect of garlic and nilavembu.

The total feed cost per bird was highest in group T₂ (₹ 106.87) followed by group T₃ (₹ 106.42) and control (₹ 105.88) group. Similar trend was observed for total cost of production per bird. The income per bird ranged from ₹ 157.60 to ₹ 172.00. The net profit per bird was highest in T₅ group (₹ 25.47) and the lowest in T₁ group (₹ 10.72). In this study, the cost effectiveness of broiler chicken fed with various level of garlic and nilavembu showed increased net profit per kg live weight in T₅ (₹ 11.85) group. This may be due to increased body weight gain of the birds, which received 10 g of garlic and 2 g of nilavembu. The present findings were in agreement with the findings of Makwana *et al.* (2015) and Singh *et al.* (2015) who reported that supplementation of garlic had better profitability per broiler and benefit cost ratio when compared to control group. Similarly, supplementation of nilavembu along with garlic showed better net profit per bird. The present result was in agreement with Laing *et al.* (2013) who showed that the economic benefit returns on salable bird from feed cost showed higher in *Andrographis paniculata* and *Zingiber cassumunar* mixture treated groups, when compared with the control group.

In this study, the cost effectiveness of broiler chicken fed with various level of garlic and nilavembu showed increased net profit per kg live weight in T₅ (₹ 11.85) group. This may be due to increased body weight gain of the birds, which received 10 g garlic and 2 g nilavembu. Lowered cost of production in garlic and nilavembu supplemented group is mainly because of better feed conversion ratio due to garlic and nilavembu growth promoting effects.

From the results of the present study, it may be concluded that supplementation of garlic and nilavembu at various concentrations tried in this experiment has definitely proven to give better result than control group. However, the higher concentration of garlic and nilavembu (T₅) has obviously moved ahead of the other treatment with regards to body weight, weight gain, feed conversion ratio and better economic viability. The combinations of these two phytobiotics have definitely brought about synergistic effect on the production in broilers.

REFERENCES

- Anvar A B, Dastar J G N, Sung K, Lohakare J and Forghani F. 2012. Effects of garlic and thyme extracts on growth Performance and Carcass Characteristics of broiler chicks. *Journal of Animal Science and Technology* **54**(3): 185–90.
- Bureau of Indian Standard. 2007. Indian Standard. Poultry Feeds-Specification (Fifth revision) IS 1374: 2007, pp 1–30.
- Eid K M and Iraqi M M. 2014. Effect of garlic powder on growth performance and immune response for Newcastle and Avian influenza virus disease in broiler chickens. *2nd International Conference on Biotechnology Application in Agriculture, Benha University, Moshtohor and Hurgada*. pp.8–12.
- Eltazi S M A. 2014. Response of broiler chicks to diets containing different mixture levels of garlic and ginger powder as natural feed additives. *International Journal of Pharmaceutical Research and Allied Sciences* **3**(4): 27–35.
- Karangiya V K, Savsani H H, Shrikant Soma Patil, Garg D D, Murthy K S, Ribadiya N K and Vekariya S J. 2016. Effect of dietary supplementation of garlic, ginger and their combination on feed intake, growth performance and economics in commercial broilers. *Veterinary World* **9**(3): 245–50.
- Laing D, Wongtangtintharn S, Tungjarernkul B, Sirilaophaian S and Khajareern J. 2013. Effects of *Andrographis paniculata* and *Zingiber cassumunar* mixture on productive performance and carcass quality of broiler chickens. *International Conference on Agriculture and Biotechnology* **60**: 7.
- Makwana A, Rinkesh B, Raval P, Haresh, Chauhan D R, Kulkarni C A, Srivastava K, Shekhar R, Bhagwat and Bharat B R. 2015. Effects of garlic (*Allium sativum*) supplementation on growth performance, carcass characteristics and economics of broilers. *Indian Journal of Animal Research* **5**(4): 843–48.
- Malahubban M, Alimon A R, Sazili A Q and Fakurazi S. 2013. Effects of *Andrographis paniculata* and *Orthosiphon stamineus* supplementation in diets on growth performance and carcass characteristics of broiler chickens. *International Journal of Agriculture and Biology* **18**: 14–9596.
- Milosevic N, Stanacev V, Peric L, Dukicstojic M and Velji M. 2013. Effects of different levels of garlic powder in the diet on production parameters and slaughter traits of broiler chickens. *European Poultry Science* **77**: 254–59.
- Pavni K, Esha B, Neha J, Tushar A, Shrey K, Suchit A, Sarita A, Vibha R and Neeraj W. 2011. Phytochemical screening of developing garlic and effect of its aqueous extracts on viability of cardiac cell line. *Journal of Pharmacy Research* **4**(3): 902–04.
- Puvaca N, Kostadinovic L J, Ljubojevic D, Lukac D, Popovic S, Dokmanovic B and Stanacev S V. 2014. Effect of dietary garlic addition on productive performance and blood lipid profile of Broiler Chickens. *Institute for Animal Husbandry, Belgrade-Zwmmun* **30**(4): 669–76.
- Recoquillay F. 2006. Active plant extracts show promise in poultry production. *Poultry International* **28**–30.
- Singh J, Sethi A P S, Sikka S S, Chateli M K and Kumar P. 2015. Effect of sun dried whole bulb garlic powder on growth, carcass characteristics and meat quality of commercial broilers. *Indian Journal of Animal Sciences* **85**(1): 67–71.
- Salna K P, Sreejith K, Uthiralingam M, Mithu A P, John M C and Albin T F. 2011. A comparative study of phytochemicals investigation of *Andrographis paniculata* and *Murraya koenigii*. *International Journal of Pharmacy and Pharmaceutical Sciences* **3**(3): 291–92.
- Snedecor G W and Cochran W C. 1989. *Statistical methods*. 8th edn. The Iowa state University Press, Ames, Iowa USA.