IJBPAS, February, 2017, 6(2): 263-277

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

EFFECT OF DIETARY SUPPLEMENTATION BY CINNAMON AND GARLIC POWDER ON GROWTH PERFORMANCE, INTERLEUKIN-6 AND SERUM BIOCHEMISTRY IN ALBINO RAT DIETS

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Received 4th Sept. 2016; Revised 10thOct. 2016; Accepted 7th Dec. 2016; Available online 1st Feb.2017

ABSTRACT

Aim: The current study aims to examine the effect of dietary supplementation with cinnamon and garlic powder as growth promoter agents on growth performance, immune response, and biochemical parameters in rats.

Materials and Methods: A total of 45 adult rats (118-127gm)were randomly assigned to three treatments for 30 days feeding period; group I (control group) received normal commercial basal diet, group II (Cinnamon group) fed with basal diet contained 5 % cinnamon powder, and group III (Garlic group) fed with basal diet contained 5 % garlic powder. Growth performance, serum triglycerides, total cholesterol, HDL (High density lipoprotein), LDL (Low density lipoprotein), malondialdehyde (MDA), total proteins,

albumin and total globulins were determined. In addition to IL-6 (Interleukin-6) titre was estimated in rat serum by using ELISA.

Results: Our results revealed that dietary supplementation with 5% garlic significantly increased the final body weight, weight gain and feed conversion ratio followed by group fed 5% cinnamon compared with control group fed basal diet only ($P< 0.05$). Serum biochemical analysis showed that triglycerides, total cholesterol, LDL and MDA in cinnamon and garlic groups recorded a significant variance in comparison with control. Moreover, cinnamon and garlic groups significantly increased serum total globulins. Also, data revealed a significant decrease in inflammatory cytokines IL-6 level in cinnamon and garlic groups, in comparison with control group.

Conclusion: Application of Cinnamon and garlic powder in the diet proved to have positive influence on growth performance, immune response, serum lipid profile and oxidative stress.

Keywords: Cinnamon, Garlic, Interleukin-6, Lipid profile, MDA, growth performance

INTRODUCTION

Antimicrobials at subtherapeutic doses have been broadly used in animal diets as growth promoters to enhance animal growth performance and production. In the presence of low levels of antimicrobials, resistant cells survive and grow producing an antimicrobials resistant population in the final products. So, the utilization of antimicrobials as growth promoters in the animal feed has been banned in the European Union since January 2006. As a consequence of this boycott in European Union and increasing animal production in the world, alternative substances and strategies for animal growth promotion and disease prevention are being explored, among which phytogenic and herbal products have gained expanded consideration since they have obtained more acceptability among consumers as a natural additive **[1].** Beneficial effects of bioactive plant substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement of endogenous digestive enzyme secretion, activation of immune response and antibacterial, antiviral and antioxidant actions **[2, 3]**. Cinnamon is one of the most common spices used worldwide as flavouring agents, preservatives, and pharmacological agents **[4].** Dietary inclusion of Cinnamon powder improves growth performance, feed efficiency and have positive influence on carcass abdominal fat and serum triglyceride concentration at slaughter age of broiler

chickens **[3, 5, 6].** Cinnamon protects protein and lipids against oxidation **[7].** Procyanidins extracted from cinnamon possess antioxidant activities **[8,9].**On the other hand, Garlic is used as flavouring agent and traditional medicine for healing. Recently, many medicinal properties attributed to garlic and garlic supplement **[10].**Growth performance and feed efficiency enhancement effects of garlic powder have been reported in broiler chickens **[11,12].** Hypolipidemic, hypocholesterolemic, antiatherosclerotic, antioxidant, antitumor and immune-modulatory effects of garlic were recorded **[13,14**]. Despite its inhibition of IL-2 transcript, cinnamon enhanced IL-2 secretion. Also, Cinnamon treatment caused a reduction in the sub-G1 phase, accompanied by an increased ratio of apoptotic cells to necrotic cells and was able to down-regulate IFN-γ expression in activated T cells without altering IL-2 production **[15].**Low dose of cinnamon (10mg/kg) produced only an increase in serum immunoglobulins levels while the high dose of cinnamon bark (100mg/kg) decreased *Pasteurellamultocida*-induced mortality by 17%, increased the phagocytic index, increased neutrophil adhesion, increased serum immunoglobulin levels and antibody titre values **[16].**Cinnamon extract Lower plasma concentrations of IL-1β, IL-6 and TNF-α and decrease the liver concentrations of IL-1β, IL-6, and TNF-α **[17].** On the other hand**,** Garlic enhance the functioning of the immune system by stimulating certain cell types, such as macrophages, lymphocytes, natural killer (NK) cells, dendritic cells and eosinophils, by mechanisms including modulation of cytokine secretion, immunoglobulin production, phagocytosis, and macrophage activation **[18].** The present study aims to study the effect of cinnamon and garlic powder on growth performance, immune response and serum lipid profile in rat.

MATERIALS AND METHODS

Ethical approval

All institutional and national guidelines for the care and use of laboratory animals were followed

This study was carried out in strict accordance with the recommendations in the Guide for the Care and Use of Laboratory Animals of the National Institutes of Health. The protocol was approved by the Committee on the Ethics of Animal Experiments of the University of Hail.

Animals and Experimental Design

Adult male albino rats were purchased from the animal house in King Saud University; Riyadh, Saudi Arabia weighing about(118-127gm) and the rats were acclimatized in ventilated, clean,

sterile, plastic cage with wood shavings under conventional conditions. The animal room was well ventilated with a 12 hrLight/12 hrdark cycle throughout the experimental period (30 days). Then the rats were randomly divided into three experimental groups, with three replicates in each group and each replicate contained 5 rats (i.e. per group: 5×3=15 rats) and the rats had free access to feed and water and the amount of feed consumed was determined. Group I (control group) rats received normal commercial basal diet (table 1). Group II (Cinnamon group) rats fed with basal diet contained 5 % Cinnamon powder (5gm / 100gm basal diet). Group III (Garlic group) rats fed with basal diet contained 5 % Garlic powder (5gm / 100gm basal diet).

Growth performance parameters

Weights of rats from each replicate per group were recorded at the beginning of experiment and at the end of the experimental period and also the feed consumed to estimate the growth performance using the following formulae: weight gain (WG; g/rat) $=W_f-W_0$; feed conversion ratio(FCR) = FI/ (W_f-W_0), where W_f and W_0were the final and of the rats per group, respectively; and FI is feed intake.

Serum chemistry

Serum triglycerides and total cholesterol were determined according to method of **[19, 20]** respectively; high density lipoprotein (HDL) was measured **[21]** then low density lipoprotein (LDL) was calculated. Serum malonaldehyde (MDA) was determined according to method of **[22]**. Totalprotein and albumin were measured by method of **[23,24]** respectively then globulins were calculated.

Determination of IL-6 in rat serum samples

IL-6 levels were measured in collected serum by using ENZO® life sciences ELISA kits; the generated colour was read at 450nm. The measured optical density is directly proportional to the concentration of IL-6 in either standards or samples **[25].**

Statistical Analysis

All values are given as means ± S.E. Statistical analyses were performed by using SPSS VERSION 22 using one-way ANOVA test for multiple groups' comparison. Differences among means were analysed using Duncan's test, with $p < 0.05$ considered as significant.

RESULTS AND DISCUSSION

Dietary supplementation effects of Cinnamon and garlic powder on growth performance and feed conversion ratio

The data in Table (2) shown that there were significant different between treatments (cinnamon and garlic 5%) when compared with control (untreated group) on final body weight, body gain, feed intake and feed conversion ratio, where the group fed diet supplemented with garlic 5% has highest final body weight and body gain followed by cinnamon 5% group than control group (215.30, 197.0, 188.37 and 93.07, 74.87, 68.73 respectively). However, untreated group (control) has highest results of feed intake and feed conversion ratio followed by garlic 5% group than cinnamon 5% (110.9, 96.90, 90.10 and 1.62, 1.05, 1.21 respectively).

In the present study according to the results in Table 2 and Figure 1, the dietary supplementation with 5% garlic and 5% cinnamon for 30 days in rat diets significantly increased the final body weight, body gain and feed conversion ratio values in comparison to Control group fed on basal diet. Recently, dietary inclusion of 1% garlic **[26]** significantly increased the growth performance and feed efficiency in broiler chicken. The use of cinnamon powder had a great role in enhancing the growth performance, hematological and blood biochemical variables and reproductive performance **[27]** and these changes due to addition of cinnamon could be attributed to the presence of cinnamaldehydes which give cinnamon its aroma and bio-antioxidant properties and our results regarding the growth performance agreed with those**.**

Effect of cinnamon and garlic on serum triglycerides, total cholesterol, HDL, LDL and MDA

The feeding administration of garlic and cinnamon 5% to rat showed significantly changes in serum triglyceride, total cholesterol, HDL, LDL and MDA. Regarding the results in Table (3), it was observed that the triglyceride and total cholesterol contents were highest in untreated group (control) followed by cinnamon and garlic 5% (57.73, 34.03, 39.68 and 86.74, 69.35, 66.08,mg/dl respectively).

The cinnamon and garlic 5% marked a significant increase in HDL content when compared with untreated group (35.63, 35.45 and 34.28 mg/dl respectively). However, obtained data showed decrease in LDL content after feeding with garlic and cinnamon 5% when compared with control (23.42, 28.59 and 40.80 mg/dl respectively).

On the other hand, MDA are the end products of lipid oxidation and the obtained data revealed that there were significant decrease in MDA serum content when treated with garlic and cinnamon 5%

when compared with control (3.5, 4.60 and 6.28 respectively).

Owing to our data in Table 3, Figure 2 which revealed a significant decrease of triglycerides, cholesterol and LDL by adding cinnamon (5%) and garlic (5%) to the diet of rats come in accordance with **[28-31]** who mentioned that cinnamon and garlic lower blood triglycerides and cholesterol. Cinnamon contain mevalonic acid derivatives **[32,33]**, Inhibition of cholesterol biosynthesis by some mevalonic acid derivatives was reported **[34].** On the other hand, garlic inhibit cholesterol synthesis **[35,36]** and the suppress LDL oxidation **[37].** Our result data in Table 3 showed that cinnamon (5%) and garlic (5%) supplementation to rat significant decrease and highly significant decrease MDA respectively which concomitant with **[29,38,39].** Cinnamon oil potentially exhibits superoxide-dismutase- (SOD) like activity. Also, isolated flavonoids of cinnamon have antioxidant properties with free-radical-scavenging activities **[40].** Garlic extract exhibits antioxidant activities by scavenging the free radicals generated in rat kidney **[39].**

Effect of cinnamon and garlic on serum total proteins, albumin, and total globulins

The serum proteins and useful parameters to indicate impairment in the functional capacity of the liver and kidney. In this study no alteration in the levels of total proteins, albumin was found (Table 4, Figure 3). However, Total globulin content was significantly different from the control group after the cinnamon and garlic 5% treatment (1.77, 2.33 and 2.35 g/dl respectively).

Concerning the result of serum total proteins, albumin, total globulins in table 4, there was a significant increase of total globulins with cinnamon and garlic groups, meanwhile no significant change of total proteins and albumin in comparison with control group.

Concerning to the data in Table 4 which revealed that cinnamon (5%) and garlic (5%) significantly increased serum total globulins. These results come in accordance with **[41]** who mentioned that cinnamon (0.5%) increased α1 and α2 and γ-globulins. Also **[42]** stated that garlic powder (3%) increased serum γ-globulins in broiler chicks, immuno-stimulant effect of garlic supplementation may be due to its component **[43].** Moreover, this increasing in globulins may be attributed to their antioxidant activity which is cleared by our result of decreased MDA.

Effect of cinnamon and garlic on level of IL-6 in rat serum

The obtained data revealed that, there was a significant decrease in

inflammatory cytokines IL-6 level with cinnamon and garlic (5%) groups, in comparison with control group, as shown in Figure 4.

The primary finding was that there were significant falls in IL-6 level, in the cinnamon group (P<0.05) and these findings were consistent with the data from the randomized controlled trials, which showed a reduction in an acute-phase inflammatory response, and pain, after daily intake of cinnamon **[44].**Garlic extract induced a variety of Immunomodulatory activities on leukocyte cytokine production. Leukocyte and inflammatory cytokine production was reduced significantly in the presence of garlic extract, revealing a potential therapeutic use in inflammatory conditions. Garlic derivatives have both a stimulatory **[45]** and inhibitory **[46]** effect on lymphocyte proliferation and lipopolysaccharides induced TNF-α generation. Our results suggest that garlic has an overall inhibitory effect on IL-6 production (P<0.05), these result agreed with **[47]** who mentioned that garlic-derived compounds inhibit the transcription of several cytokine genes involved in proinflammatory responses, such as IL-6.

Table 1: Commercial basal diet used and its composition

Ingredients	Concentrations (g kg^{-1})
Alfalfa pellets	350
Maize Broken	150
Barley	150
Wheat	100
White Sorghum	100
Sunflower white	50
Sunflower black	50
Safflower	50
Total	1000
Calculated analysis*	
Crude protein (%)	17%
Metabolizable energy (Kcal/kg)	2415

*calculated according to feed stuffs ingredient analysis Table 2012 edition

Table 2: Dietary supplementation effects of cinnamon and garlic on growth performance and feed conversion ratio of rats

	Control	Cinnamon	Garlic	F-Ratio; P-Value
Initial Body weight (g/rat)	119.63±1.10	122.13±2.38	122.23±2.32	F=0.529;P=0.614
Final body weight (g/rat)	188.37±1.5^{c}	197.0±1.88^{b}	215.30±3.45^{a}	F=32.073; P=0.001
Body Gain (g/rat)	68.73 ±2.19^{b}	74.87 ±3.02^{b}	93.07 ±5.74^{a}	F=10.24; P=0.012
Feed intake (g/rat)	110.93 ±1.00^{a}	90.10 ±0.87^{c}	96.90 ±3.10^{b}	F=29.67; P=0.001
Feed conversion ratio	1.62 ±0.04^{a}	1.21 ±0.04^{b}	1.05 ±0.03^{c}	F=66.49; P=0.0001

Values in the same row with different superscript letters are significantly different (P <0.05). Values are presented as mean ± SE (n = 15rats in each group).

Table 3: Effect of cinnamon and garlic on serum triglycerides, total cholesterol, HDL, LDL and MDA

	Triglycerides (mg/dl)	Total cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	MDA (nmol/ml)
Control	57.73± 2.98[a]	86.74± 2.35[a]	34.28±2.28	40.80±1.14[a]	6.28±0.28[a]
Cinnamon	34.03±1.43[b]	69.35±2.50[b]	35.63± 1.89	28.59± 1.60[b]	4.60±0.23[b]
Garlic	39.68±2.48[b]	66.08±2.41[b]	35.45± 2.08	23.42±1.20[c]	3.56± 0.23[c]
F-Ratio;	F=26.95	F=21.019	F=0.123	F=45.100	F=30.71
P-Value	P=0.001	P=0.002	P=0.887	P=0.0001	P=0.001

The groups which have different superscript letters in the same column are significantly different where the high significant group which has superscript a followed by b then c. (P<0.05)

Table 4: Effect of cinnamon and garlic on serum total proteins, albumin, and total globulins

	Total proteins(g/dl)	Albumin (g/dl)	Total globulins (g/dl)
Control	5.49± 0.04	3.64±0.12	1.77±0.06[b]
Cinnamon	5.71±0.45	3.84±0.16	2.23± 0.03[a]
Garlic	5.69±0.17	3.52±0.10	2.35± 0.04[a]
F-Ratio;	F=3.48	F=1.66	F=179.2
P-Value	P=0.099	P=0.267	P=0.0001

The groups which have different superscript letters in the same column are significantly different where the high significant group which has superscript a followed by b then c. (P<0.05).

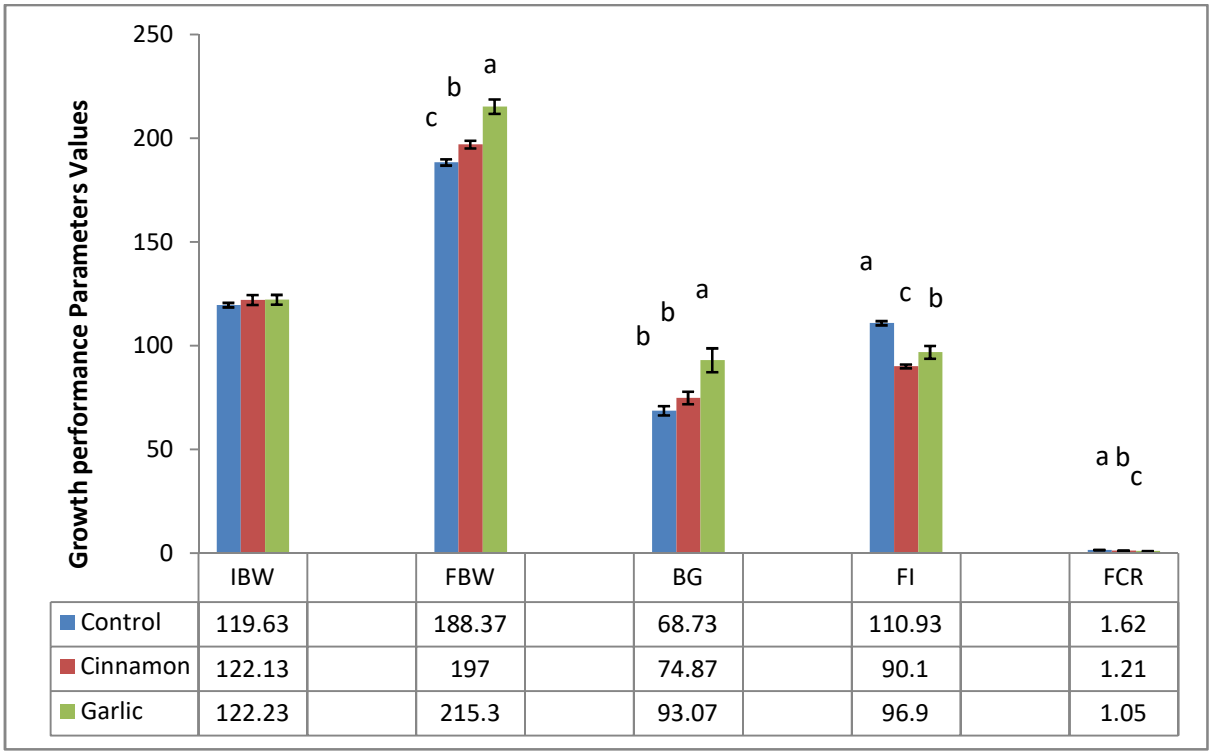
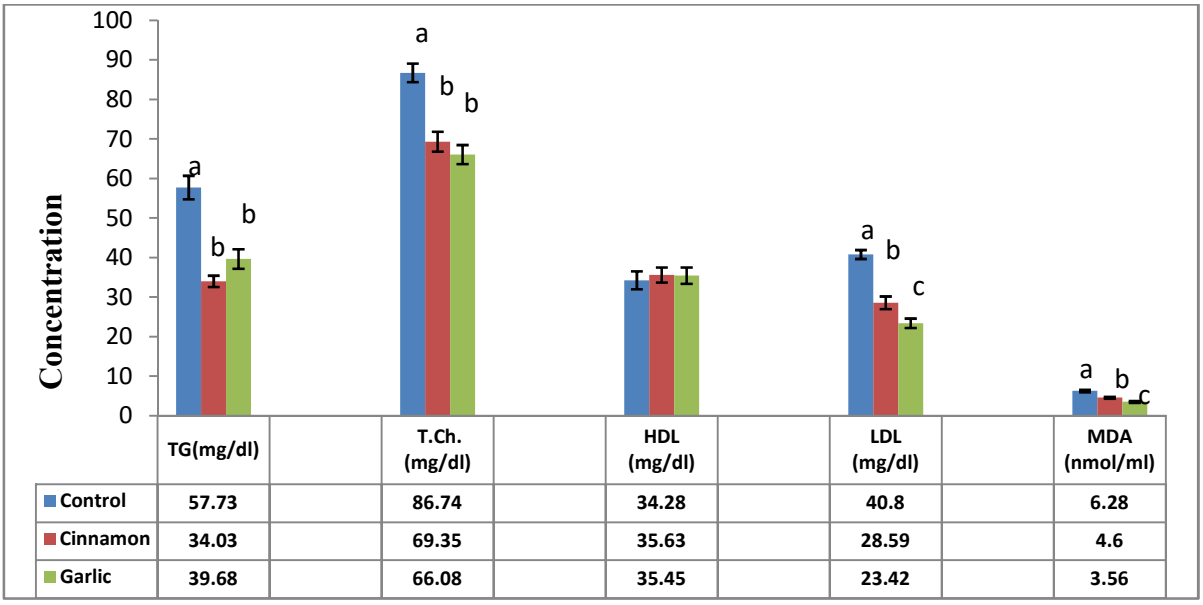
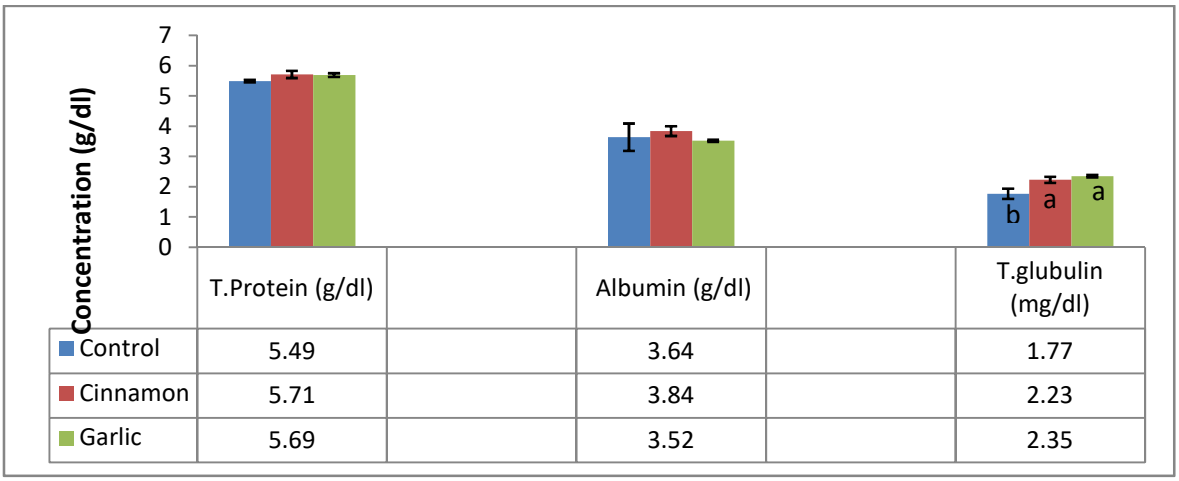


Figure 1: Dietary supplementation effects of cinnamon and garlic on growth performance and feed conversion ratio of rats.



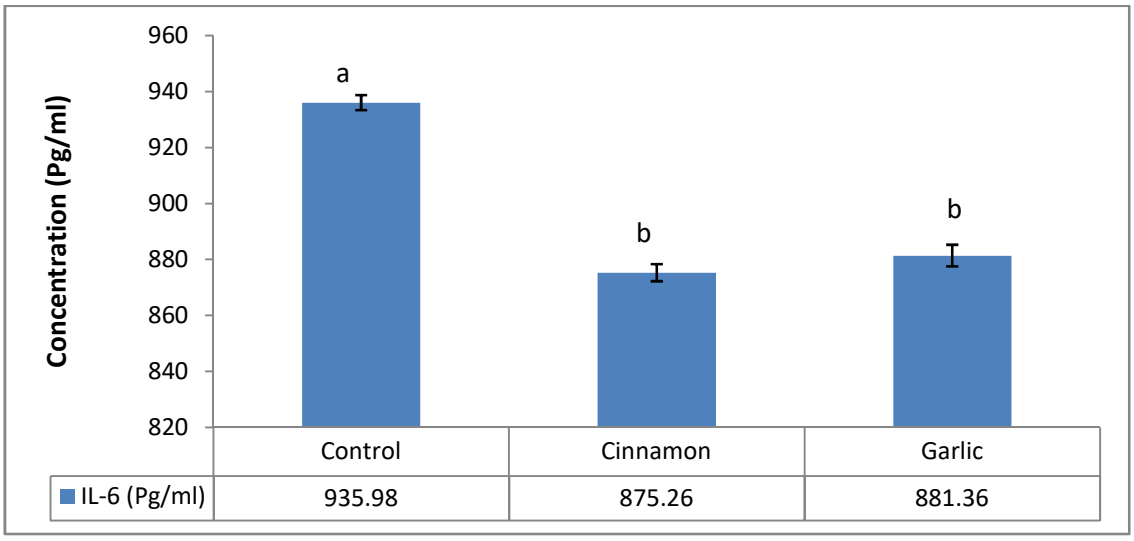
	TG(mg/dl)		T.Ch. (mg/dl)		HDL (mg/dl)		LDL (mg/dl)		MDA (nmol/ml)
Control	57.73		86.74		34.28		40.8		6.28
Cinnamon	34.03		69.35		35.63		28.59		4.6
Garlic	39.68		66.08		35.45		23.42		3.56

Figure 2: Effect of cinnamon and garlic on serum triglycerides, total cholesterol, HDL, LDL and MDA



	T.Protein (g/dl)		Albumin (g/dl)		T.glubulin (mg/dl)
Control	5.49		3.64		1.77
Cinnamon	5.71		3.84		2.23
Garlic	5.69		3.52		2.35

Figure3: Effect of cinnamon and garlic on serum total proteins, albumin, and total globulins



	Control	Cinnamon	Garlic
IL-6 (Pg/ml)	935.98	875.26	881.36

Figure 4: Dietary supplementation effect of cinnamon and garlic on amount of serum IL6.

CONCLUSION

According to the obtained results, it was found that supplementation of cinnamon and garlic powder by 5 percent to the rat diet led to improve the growth performance parameters, antioxidant status and increase serum total globulins could also reduce the serum levels of anti-inflammatory IL-6 and lipid profile. In general, the medicinal plants and their seeds could be used as a growth promoter to replace antibiotics in animal diets.

Authors' Contributions

This work was carried out in collaboration between all authors. SAAE, EAS and SYAA designed the study. Authors OFT and SYAA collected and processed the samples while SAAE, SYAA, EAS and OFT did the analysis of growth performance, serum immunological and biochemical parameters respectively. OFT and SYAA carried out the experimental work, laboratory analysis, While SAAE, EAS did data analysis. All authors wrote the first and final drafts of the manuscript. All authors read and approved the final manuscript.

Competing Interests

The authors declare that they have no competing interests.

REFERENCES

[1] 1.Nouzarian, R., Tabeidian, S., Toghyani, M., Ghalamkari, G., Toghyani, M., 2011. Effect of turmeric powder on performance, carcass traits, humoral immune responses, and serum metabolites in broiler chickens. Journal of Animal and Feed Sciences663, 127.

[2] Gopi, M., Karthik, K., Manjunathachar,.H.V., Tamilmahan , P., Kesavan, M., Dashprakash, M., Balaraju, B.L., Purushothaman, M., 2014. Essential oils as a feed additive in poultry nutrition. Adv. Anim. Vet. Sci. 2, 1-7.

[3] Toghyani, M., Toghyani, M., Gheisari, A., Ghalamkari, G., Eghbalsaied, S., 2011. Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical and haematologi -cal parameters in broiler chicks. Livestock Science138, 167-173.

[4] Bolin et al 2010: Cinnamon: Potential Role in the Prevention of Insulin Resistance, Metabolic Syndrome, and Type 2 Diabetes Bolin Qin, M.D., Ph.D.,1,2 Kiran S. Panickar,1 and Richard A. Anderson, Ph.D., C.N.S.1 Journal of Diabetes Science and Technology Volume 4, Issue 3, May 2010 © Diabetes Technology Society.

[5] Park, B.-S., 2008. Effect of dietary cinnamon powder on savor and quality of chicken meat in broiler chickens. Journal of the Korean Society of Food Science and Nutrition37, 618-624.

[6] Torki, M., Akbari, M., Kaviani, K., 2015. Single and combined effects of zinc and cinnamon essential oil in diet on productive performance, egg quality traits, and blood parameters of laying hens reared under cold stress condition. Int. Journal of Biometeorol., 59, 1169-1177.

[7] Roussel AM, Hininger I, Benaraba R, Ziegenfuss TN, Anderson RA. 2009. Antioxidant effects of a cinnamon extract in people with impaired fasting glucose that are overweight or obese. J Am CollNutr. 28(1):16-21.

[8] Peng, X., K.W.Cheng, J. Maetal., 2008. Cinnamon bark pro anthocyanidins as reactive carbonyl scavengers to prevent the formation of advanced glycation end products, ”Journal of Agricultural and Food Chemistry, vol. 56, no.6, pp.1907–1911.

[9] K. R. M¨ a¨att¨a-Riihinen, M. P. K¨ahk¨onen, A. R. T¨orr¨onen, and I. M. Heinonen, 2005. Catechins and procyanidins in berries of vaccinium species and their antioxidant activity,” Journal of Agricultural and Food Chemistry, vol.53, no.22, pp. 8485–8491.

[10] Shirzad H, Taji F, Rafieian-Kopaei M. 2011.Correlation between antioxidant activity of garlic extracts And WEHI-164. Fibro sarcoma tumor growth in BALB/c mice. J Med Food; 14: 969-74.

[11] Brzóska, F., Śliwiński, B., Michalik-Rutkowska, O., Śliwa, J., 2015. The Effect of Garlic (Allium Sativum L.) on Growth Performance, Mortality Rate, Meat and Blood Parameters in Broilers. Annals of Animal Science15, 961-975.

[12] El-Katcha, M.I., Soltan, M.A., Essi, M.S., 2016. Effect of Garlic Extract Supplementation on Growth Performance, Nutrient Digestibility and Some Blood Serum Biochemical Changes of Fattening Lambs. Alexandria J. Veterinary Sciences, 48, 124-133.

[13] Schäfer G, Kaschula CH. 2014. The immunomodulation and anti-inflammatory effects of garlic organosulfur compounds in cancer chemoprevention.

Anticancer Agents Med. Chem; 14: 233-241.

[14] Mohammadi A, Oshaghi EA. 2014. Effect of garlic on lipid profile and expression of LXR alpha in intestine and liver of hypercholesterolemic mice. J Diabetes Metab. Disord 13: 20.

[15] Lee BJ, Kim YJ, Cho DH, Sohn NW, Kang.H, 2011. Immunomodu -latory effect of water extract of cinnamon on anti-CD3-induced cytokine responses and p38, JNK, ERK1/2, and STAT4 activation.Immunopharmacol.Imm unotoxicol33(4):714-22.

[16] Samir R.,Mohamed A.,Gowda K. and Pradeep.T. 2009. Immunomod ulatory activity of Cinnamomumzeylanicumbark.Pha rmaceutical Biology 47(12):1168-1173 ·

[17] Eun L. 2015.Effect of Cinnamon Extract on the Inflammatory Response in the LPS-shock Rat. Korean J. Plant Res. 28(3):333-340.

[18] Rodrigo A., Saray Q., RocíoI vetteL., Enrique O., Juan P., Lucrecia C. and Daniel O.2015.Immunomodulation and A ntiInflammatory Effects of Garlic Compounds.J. Immunology Research.13-18.

[19] Knight, T. A.; Anderson, S. and James, M. R. Chemical basis of the sulphovenilim reaction for estimating total serum lipid. J. Clinc. Chem., 1972; 18:199

[20] Fredrickson, D. S.; Levi, R. L. and Less, R. S. 1967. Determination of cholesterol .N. Engl. J. Med., 276: 148-156.

[21] - Lopes-Virella M.F, Stone P, Ellis S, Colwell JA. 1977. Cholesterol Determination in High-Density Lipoproteins Separated by Three Different Methods clinical chemistry, 23(5):882-4.

[22] Ohkawa H, Ohishi N, Yagi K. 1979. Assay for lipid peroxide in animal tissues by thiobarbituric acid reaction. Anal Biochem., 95: 351: 8

[23] Josephson, B. and Gyllensward, C. 1957.The development of the protein fractions and of cholesterol concentration in the serum of normal infants and children. Scandinavian journal of clinical and laboratory investigation, 9(1):29-38.

[24] Drupt, F. 1974. Colorimetric meth -od for determination of albumin. Pharm. Biol., 9: 777-779.

[25] Chard,T., 1990. In "An Intro. To Radioimmunoassay & Related Tech.", 4th Ed., Elsevier, Amsterdam.201.

[26] Motamedi, S.M., Taklimi, S.M.M., 2014. Investigating the effect of fenugreek seed powder and garlic powder in the diet on immune response of commercial laying hens'egg. Indian J. Sci. Res3, 277-283.

[27] El-Kholy, K., El- Damrawy, S., Seleem, T., 2012. Rabbit productivity and reproductivity as affected by cinnamon. (*C. zeylanicum*). Egypt. Poult. Sci. 32, 691-703.

[28] Mohan, B., R. Kadirvel, A. Natarjan and M. Bhaskaran, 1996.Effect of probiotic suppleme ntatio-n on growth, nitrogen utilization and serum cholesterol in broilers. British Poult. Sci., 37: 395-401.

[29] Durak.I, Kavutcu M, Aytaç B, Av-ci A, Devrim E, Ozbek H, Oztürk HS.2004. Effects of garlic extract consumption on blood lipid and oxidant/antioxidant parameters in humans with high blood cholestero l. J. Nutr. Biochem. Jun; 15(6):373-7.

[30] Kannan, M., R. Karunakaran, V. Balakrishnan and T. G. Prabhakar, 2005. Influence of prebiotics supplementation on lipid profile of broilers. Intern. J. Poult. Sci., 4(12): 994-997.

[31] S.Rahman, H.Begum, Z.Rahman, F. Ara, M.J. Iqbal, and A.K.M.Yousuf, 2013. Effect of cinnamon (*Cinnamom umcassia*) as a lipid lowering age on hypercholesterolemic rats, "Journal of Enam Medical College, vol.3,no.2,pp.94–98.

[32] Jayaprakasha G. K., Jaganmohan Rao L. and Sakariah K.K. 1997. Chemical composition of the volatile oilfrom the fruits of *Cinnamom umzeylanicum Blume Flav*. Fragr. J. 12, 331-333.

[33] Jayaprakasha G. K., Jaganmohan Rao L. and Sakariah K. K. 2000. Chemical composition of the flower oil of *Cinnamomum zeylanicum Blume*. J. Agric. FoodChem. 48, 4294- 4295.

[34] Klimov, A.N., Klimova T. a., Petrova L.A. and Poliakova E.D. 1971. Inhibition of cholesterol biosynthesis by mevalonic acid derivatives. In proceeding of the 4th international symposium on drugs affecting lipid metabolism.

Held in Philadelphia, Sep. 8-11,pp 304.

[35] Yeh YY, Liu L. 2001. Cholesterol-lowering effect of garlic extracts and organosulfur compounds: human and animal studies. J Nutr.; 131: S989–S993.

[36] Singh DK, Porter TD. 2006. Inhibition of sterol 4alpha-methyl oxidase is the principal mechanism by which garlic decreases cholesterol synthesis. J Nutr.; 136:S759–S764.

[37] Lau BH. 2006. Suppression of LDL oxidation by garlic compoun ds is a possible mechanism of cardiovascular health benefit. J.Nutr.; 136: S765–S768.

[38] J.N.Dhuley, 1999. Anti-oxidant effects of cinnamon (*Cinnamom umverum*) bark and greater cardamon (*Amomum subulatum*) seeds in rats fed high fat diet, "Indian Journal of Experimental Biology, vol.37,no.3,pp.238–242.

[39] Zaidi S K, Ansari S A, Ashraf G M, Jafri M A, Tabrez S, Banu N 2015. Reno-protective effect of garlic extract against immobilization stress induced changes in rats Asian Pac J Trop Biomed 2015; 5(5): 364-369.

[40] M. Okawa, J. Kinjo, T. Nohara, and M. Ono, 2001.DPPH (1,1-diphenyl-2-Picrylhydrazyl) radical scavenging activity of flavonoidsobtainedfromsomemedi cinalplants,"Biological and Pharm aceutical Bulletin,Vol.24,no.10,pp. 1202–1205.

[41] Dos Santos WM, de Brito TS, de A Prado S, de Oliveira CG, de Paula AC, de M Hoyos DC, Ribeiro PA. 2016. Cinnamon (*Cinnamomumsp*.) inclusion in diets for Nile tilapia submitted to acute hypoxic stress Fish Shellfish Immunol. Apr 30.pii: S1050-4648(16).30286-8.

[42] Jafari, R A, Razi-Jalali, M. and Kiani, R. 2011.Effect of fresh dietary garlic powder on some of serum biochemical parameters in broiler chicks. Comp Clin. Pathol., 20: 295-297.

[43] Corzo-Martinez M., Corozo,N. And Villamiel, N. 2007.Biological properties of onions and garlic. Trends in Food Science and Technology 18: 609-625.

[44] Tung YT, Chua MT, Wang SY, Chang ST. 2008. Anti-inflammation activities of essential oil and its constituents from indigenous cinnamon (*C.osmophlo*

eum) twigs. Bioresour Technol.; 99: 3908–13.

[45] Salman H, Bergman M, Bessler H, PunskyI, Djaldetti M. 1999. Effect of garlic derivative (alliin) on peripheral blood cell immune responses. *Int J Immuno. pharmacol*; 21: 589–597.

[46] Lee ES, Steiner M, Lin R. 1994. Thioallyl compounds: potent inhibitors of cell proliferation. *Boi chimBiophysActa* ; 1221:73–77.

[47] Ho C. Y. Ho, C. J. Weng, J. J. Jhang, Y. T. Cheng, S. M. Huang, &G. C. Yen, 2014. Diallylsulfide as a potential dietary agent to reduce TNFalpha- and histamine-induced proinflammatory responses in A7r5 cells, "Molecular Nutrition and Food Research, vol. 58, no. 5, pp. 1069–1078.