The Bioscan 15(1): 101-105, 2020
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF SUPPLEMENTATION OF OREGANO (*ORIGANUM VULGARE*) ESSENTIAL OIL WITH PROBIOTICS ON ECONOMICS AND GROWTH PERFORMANCE OF BROILER CHICKENS

HARSHAL NILKANTH REWATKAR[1], VIPIN[2]*, KUNDAN KUMAR[2], PRAMOD KUMAR SONI[2] AND JAI PRAKASH[2]
[1]Department of Animal Nutrition, Post Graduate Institute of Veterinary & Animal Sciences, Akola - 444 104, INDIA
[2]ICAR-Indian Veterinary Research Institute, Izatnagar - 243122 (U.P), INDIA
e-mail: vipinsingh729@gmail.com

KEYWORDS
Broiler performance
Economics
Essential oil
Probiotic

Received on :
29.10.2019

Accepted on :
18.01.2020

***Corresponding author**

ABSTRACT
This study was conducted to evaluate the efficacy of oregano essential oil (OEO) (*Origanum vulgare* L.) individually or in combination with probiotics as a dietary supplement in broiler chicken for 42 days. A total of 240 straight run "Ven-Cobb 400Y" strain commercial day-old broiler chicks were randomly assigned to 4 treatments with 4 replications each (15 birds per replicate): T_0 (standard broiler diet as per BIS, 2007), T_1 (Standard broiler chicken diet as per BIS, 2007 + oregano essential oil @ 0.15 gm/kg diet) T_2 (Standard broiler chicken diet *as per* BIS, 2007+ probiotic (encapsulated *Saccharomyces cerevisiae*) @ 200 gm/tones) T_3 (Standard broiler chicken diet as per BIS, 2007 + oregano essential oil @ 0.15 gm/kg diet + probiotic (encapsulated *Saccharomyces cerevisiae*) @ 200 gm/tones). Improved Cumulative body weight gain and feed efficiency ($P<.05$) were found in (T_3) being 1163.96 gm and 1.22 respectively, followed by (T_2) having 1128.18 gm and 1.22 while (T_1) 1106.83 gm and 1.29 and T_0 (control) 1063.1 gm and1.32. It can be concluded that oregano oil at the levels of 0.15 gm/kg when fed along with probiotics (*Saccharomyces cerevisiae*) appears as a promising alternative to antibiotic growth promoters for augmented performance in broiler chickens.

INTRODUCTION

Antibiotics used as growth promoters in poultry feed has been banned out of concerns for the emergence of bio-resistance and hazards to public health (Hong *et al.*, 2012). Herbs spices and plant extracts have received increasing attention as potentially safe, and naturally compatible possible antibiotics alternatives in recent times (Cunzhen *et al.*, 2019). Essential oils (EOs) documented as natural antibacterial substance also show myriad of properties like growth-promotion (Kansal *et al.,* 2017) and protective functions like antioxidant function, anti-inflammatory, anti-carcinogenic activity, digestion enhancing, and lipophobic functions (Gomathi *et al.*, 2017). Oregano Oil contains carvacrol and thymol as the principal compounds, along with lutein and β-carotene, and its use as a feed additive has emerged as one of the most popular nutritional manipulations in broiler production with several studies recommended it as a growth promoter, natural antibiotic, improver of beneficial bacteria in the digestive tract (Ghazi *et al.*, 2015; Silva-V´azquez *et al.*, 2015; Peng *et al.*, 2016; Skoufos *et al.*, 2016; M´endez-Zamora *et al.*, 2017; Reyer *et al.*, 2017). Probiotics exert their beneficial effect in host animal by manipulation of gut balance (Ren *et al.,* 2019). They create gut conditions that suppress harmful microorganisms and favours beneficial ones (Ramlucken *et al.,* 2020) reducing the risk of diseases, possibly through a reduction in proliferation of pathogenic species (Dafade *et al.,* 2019). However, the response of broiler chickens towards the use of natural essential oils like oregano and other herbal supplements is often unpredictable and depends upon various factors like; variety and raw substrate (Lee *et al.*,2003; Halle *et al.*,2004; Kapica *et al.*,2006), amount of additive (Giannenas *et al.*,2004; Ertas *et al.*,2005) environmental and *in situ* effects (challenged vs. unchallenged), the diet fed to birds (Jamroz *et al.*,2005), various interaction among other components used such as probiotics, prebiotics, organic acids (El-Hakim, 2009). The proposed hypothesis adjudges Oregano oil-fed along with probiotic has the potential to play the role of nutraceutical additive in commercial broiler production (Gopi *et al.*, 2014). This study aimed to investigate the individual and combined effects of two dietary additives, oregano (*Origanum vulgare* L.) and probiotic (encapsulated *Saccharomyces cerevisiae*) on growth performance and thus economics of broiler production.

MATERIAL AND METHODS

Birds housing and management

The present study was conducted to evaluate the effect of feeding oregano (*Origanum vulgare*) oil as phytobiotic growth promoter with probiotic on growth performance of broiler chicken with the approval by the Institutional Ethics Committee. Two hundred forty straight run "Ven-Cobb 400Y" strain commercial day-old broiler chicks were equally and randomly distributed into four groups. Each treatment was subjected to four replicates with fifteen chicks. Prior to experimental trial, the experimental broiler shed, its premises and the equipments were thoroughly cleaned and disinfected. The experimental chicks were offered feed and freshwater ad-

libitum. The experimental chicks were housed in 16 different pens. Each pen was accommodating 15 birds. The experimental birds were vaccinated against Ranikhet disease through intraocular route on 7th day with B1 strain, Infectious bursal disease (IBD) on 14th day of age by the intraocular route and booster vaccination of Infectious bursal disease (IBD) Invasive intermediate strain (B2K) was carried out on 21st day and vaccination of Ranikhet disease with Lasota strain on 28th day through drinking water.

Procurement of feed ingredients

The good quality feed ingredients were procured from local market for preparation of experimental diets. Oregano essential oil was procured from karma essential oil pharmaceuticals. The probiotic (encapsulated *Saccharomyces cerevisiae*) was sponsored by Venkateshwara Pvt. Ltd was subjected to chemical analysis in the laboratory at the Department of Animal Nutrition, PGIVAS, and Akola. The diets were formulated for prestarter, starter and finisher chickens with standard BIS 2007 (Table 1) and details of dietary treatment are given in Table 2.

Growth studies

The initial body weight (IBW; g) was determined at the beginning of the experiment. Weekly (7, 14, 21, 28, 35, and 40 days) measurement of parameters body weight gain, feed intake was done These variables were used to estimate weekly body weight gain (WBWG; g ($BW_{current}$-$BW_{previous}$)/day), feed conversion ratio (FCR; FI/WBWG) (Coronado *et al.*, 2019; Aviagen, 2018) were determined at the same periods along with cumulative feed consumption and feed efficiency of birds for different weeks of the experiment. Offered and rejected feed weights were recorded to estimate these variables.

$$\text{Weekly body weight gain} = \frac{\text{Current body weight (gm)} - \text{Previous body weight (gm)}}{\text{Number of days}}$$

$$\text{Feed efficiency} = \frac{\text{Gain in body weight (gm) during the week}}{\text{Feed consumed (gm) during the week}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Feed consumed (gm) during the week}}{\text{Gain in body weight (gm) during the week}}$$

Economics of production

The economics of supplementation of feeding oregano (*Origanum vulgare*) oil with probiotic as phytobiotic growth promoter in broiler chicken was studied at the end of experiment. All other cost components of production i.e. cost of chick, medicines, vaccines and other overhead were taken as constant for all the treatment groups. Oregano essential oil and probiotics cost were considered as per respective treatment groups and gross profit per bird was calculated by subtracting the cost of production per bird from the price fetched per bird after selling it in the local market on live weight basis.

Statistical analysis

The data were analyzed by using Statistical Package for the Social Sciences (SPSS) Version 17.0. The differences between means were subjected to ANOVA by univariate analysis using the General Linear Model.

RESULTS AND DISCUSSION

Cumulative weight gain

The cumulative body weight gain from 1st to 6th week of the period on different dietary treatment was calculated and presented in Table 3. Significant ($P < 0.05$) influence on cumulative weight gain was observed. The analysis of variance showed that the treatment had a significant effect on cumulative weekly body weight gain at starter and finisher period. Moreover, the interaction effect of treatment and week was found to be significant. The highest cumulative body weight gain was recorded at the 6th week as 2392.02 ± 49.41 gm for T_3 followed by T_2, T_1 and T_0. Treatment group T_3 had maintained the highest cumulative weekly body weight gain from 1st to 6th week as compared to other treatment groups. The results of the present study are in agreement with the previous studies that observed benefits of probiotic supplementation on broiler performance and increased feed efficiency improved the broilers feed conversion ratio, indicating an improved weight gain (Manafi *et al.*, 2016). Bai *et al.* (2013) with probiotic blend *L. fermentum* and *S. cerevisiae* and Dafade *et al.* (2019) with oregano essential oil along with multi-enzyme reported Significantly improved ($P<0.01$) average daily weight gain and feed efficiency in chickens. Notwithstanding the previous results Botsoglou *et al.* (2002), Basmacýoðlu *et al.* (2004) studied supplementation of oregano essential oil at levels of 50 or 100; 150 and Cross *et al.* (2007) studying oregano essential oil feeding @ 300 and 1000 mg/kg in broilers reported to have no beneficial effect of these nutritional manipulations on growth performance. The inconsistent result of essential oils in broiler diets can be attributed to factor like the dietary levels of feed additives along with the prevalent environmental condition. Experimental conditions with healthy chicks kept under best of managemental practices often fail to show a marked response to growth-promoting supplements giving little scope for their use. (Botsoglou *et al.*, 2004).

Cumulative feed consumption

As given in Table 4 the data from 1st, 2nd and 3rd week were significant while other weeks were non- significantly varied. The highest cumulative feed consumption (g) at the end of the starter phase was observed in T_1 group that is 942.85 ± 26.39 (g) whereas for finisher end phase (T1) 3675.36 ± 76.86 (g) recorded the highest feed consumption. The result of present study with respect to weekly feed consumption corroborates with Hernandez (2004) who reported no differences for feed intake in broilers fed essential oil blend @200 ppm along with 5,000 ppm Labiatae extract (LE). The similar result was reported by (Halle *et al.*, 2004) when using, graded supplementation of oregano essential oils in broiler chicken. However contrary to our findings Khattak *et al.* (2014) observed the feed intake was affected when using a natural blend of 7 essential oils along with Oregano. Giannenas *et al.* (2016) in his studies reported that feeding 25 mg/kg oregano essential oil singly or

Table 1: BIS (2007) Standard for broilers

	BIS (2007) Pre starter	Starter	Finisher
CP (%)	23	22	20
ME (kcal/kg)	3000	3100	3200

Table 2: Dietary treatments used for experimental birds in the study

Dietary treatments	No. of replicate	No. of birds
T0 Standard broiler chicken diet as per BIS, 2007.	4	60
T1 Standard broiler chicken diet as per BIS, 2007+ oregano essential oil @ 0.15 gm/kg diet	4	60
T2 Standard broiler chicken diet as per BIS, 2007 + probiotic (encapsulated *Saccharomyces cerevisiae*) @ 200 gm/ tones)	4	60
T3 Standard broiler chicken diet as per BIS, 2007+oregano essential oil @ 0.15 gm/kg diet+probiotic (encapsulated *Saccharomyces cerevisiae*) @ 200 gm/ tonnes T_1)	4	60
Total birds	16	240

Table 3: Weekly cumulative body weight gain (gram) of broilers for different dietary treatments

Treat.	Weeks W_1	W_2	W_3	W_4	W_5	W_6	Overall mean
T_0	$93.05^{a}\pm0.49$	$337.45^{a}\pm6.34$	$730.77^{a}\pm10.58$	$1317.87^{a}\pm21.78$	$1769.43^{a}\pm35.7$	$2130.04^{a}\pm29.8$	$1063.1^{a}\pm154.37$
T_1	$95.73^{b}\pm0.33$	$346.13^{ab}\pm3.09$	$729.79^{a}\pm17.11$	$1403.69^{ab}\pm37.54$	$1770.08^{a}\pm28.59$	$2295.53^{b}\pm30.16$	$1106.83^{b}\pm163.62$
T_2	$104.9^{d}\pm0.3$	$355.25^{bc}\pm3.99$	$791.1^{b}\pm16.13$	$1422.2^{b}\pm44.73$	$1812^{a}\pm46.56$	$2283.63^{b}\pm33.71$	$1128.18^{b}\pm162.94$
T_3	$100.6^{c}\pm0.96$	$359.83^{c}\pm1.58$	$818.18^{b}\pm6.58$	$1471.97^{b}\pm6.43$	$1841.13^{a}\pm35.18$	$2392.02^{b}\pm49.41$	$1163.96^{c}\pm169.61$
Overall mean	98.57 ±1.2	349.67 ±2.89	767.46 ±11.56	1403.93 ±20.06	1798.16 ± 18.32	2275.31 ± 29.25	1115.52 ±80.16

Treatment mean end in a column bearing common superscripts does not differ significantly (P>0.05)

Table 4: Cumulative feed consumption per bird for different dietary treatments

Treat.	Weeks W_1	W_2	W_3	W_4	W_5	W_6	Overall mean
T_0	$97.89^{a}\pm1.42$	$375.87^{a}\pm9.79$	$922.44^{ab}\pm22.31$	$1765.22^{a}\pm29.57$	$2613.63^{a}\pm74.43$	$3519.26^{a}\pm82.45$	1549.05 ± 255.07
T_1	$109.74^{c}\pm1.67$	$374.24^{a}\pm5.88$	$942.85^{b}\pm26.39$	$1825.28^{a}\pm65.49$	$2542.28^{a}\pm108.88$	$3675.36^{a}\pm76.86$	1578.29 ± 261.91
T_2	$98.66^{a}\pm0.43$	$371.62^{a}\pm8.97$	$849.49^{a}\pm29.9$	$1781.59^{a}\pm65.35$	$2442.64^{a}\pm69.92$	$3612.94^{a}\pm85.97$	1526.16 ± 257.37
T_3	$104.2^{b}\pm0.61$	$374.16^{a}\pm3.45$	$932.02^{b}\pm18.39$	$1808.24^{a}\pm25.21$	$2461.16^{a}\pm61.12$	$3645.46^{a}\pm98.87$	1554.21 ± 258
Overall mean	102.63 ± 1.34	373.97 ± 3.36	911.7 ± 14.52	1795.08 ± 23.23	2514.93 ± 40.14	3613.25 ± 41.5	1551.93 ± 127.01

Treatment mean end in a column bearing common superscripts does not differ significantly (P>0.05)

Table 5: Cumulative feed efficiency per bird for different dietary treatments

Treat.	Weeks W_1	W_2	W_3	W_4	W_5	W_6	Overall mean
T_0	$1.05^{a}\pm0.01$	$1.11^{b}\pm0.02$	$1.26^{bc}\pm0.01$	$1.34^{b}\pm0$	$1.48^{b}\pm0.01$	$1.65^{c}\pm0.02$	$1.32^{b}\pm0.04$
T_1	$1.05^{a}\pm0.02$	$1.08^{ab}\pm0.01$	$1.3^{c}\pm0.06$	$1.3^{ab}\pm0.04$	$1.44^{a}\pm0.06$	$1.6^{bc}\pm0.02$	$1.29^{b}\pm0.04$
T_2	$1.03^{a}\pm0.01$	$1.05^{a}\pm0.02$	$1.08^{a}\pm0.05$	$1.25^{a}\pm0.03$	$1.35^{a}\pm0.03$	$1.58^{ab}\pm0.02$	$1.22^{a}\pm0.04$
T_3	$1.04^{a}\pm0.01$	$1.04^{a}\pm0.01$	$1.14^{ab}\pm0.02$	$1.23^{a}\pm0.01$	$1.34^{a}\pm0.02$	$1.52^{a}\pm0.03$	$1.22^{a}\pm0.04$
Overall mean	1.04 ± 0.01	1.07 ± 0.01	1.19 ± 0.03	1.28 ± 0.02	1.45 ± 0.02	1.59 ± 0.02	1.26 ± 0.02

Treatment mean end in a column bearing common superscripts does not differ significantly (P>0.05)

in combination with 2.5 mg/kg laurel essential oil enhanced feed consumption in broilers.

Cumulative feed efficiency

At the end of starter phase better, feed conversion ratio (FCR) was observed in treatment the group T_2 that is 1.08 ± 0.05 followed by T_3 (1.14 ± 0.02) and T_0 (1.26 ± 0.01) treatment groups while change in trend was observed in the 6th week of age i.e. finisher, in that the group T_3 had best FCR that is 1.52 ± 0.03 followed by T_2 (1.58 ± 0.02) and T1 (1.6 ± 0.02) treatment groups. Whereas, statistically analysis of variance showed that the significant differences are there between each week. The results of the present study are in accordance with the Yalçýn *et al.* (2013) who found that the supplementation of Mexican oregano oil has beneficial effects on feed effciency, in grower phase of broilers. A similar result was found by Giannenas *et al.* (2016) on supplementation of 25 mg/kg oregano essential oil with 2.5 mg/kg laurel essential oil. Dafade *et al.* (2019) also noticed improved FCR, with oregano essential oil and multi-enzyme supplementation of broilers diet. In agreement with our study Cho *et al.* (2014), reported improved feed efficiency when the herbal blend of (250 mg/kg; oregano and yucca extract,) were fed to broilers. The possible reason for the myriad of benefits by the use of essential oil could be due to stimulatory effects on digestive enzyme secretion, blood circulation, antioxidant and antimicrobial properties, and the immunopotentiation activity (Sugiharto, 2016). El-Ghany and Ismail (2013) also showed that Phytobiotics positively influence growth in broiler chickens.

Economics of broiler production

The economics of broiler production in the trial was worked out by considering the prices of input prevalent at the time of experiment in the market. Input considered was the cost of

Table 6: Economics of broiler production

Particulars	Treatments			
	T0	T1	T2	T3
Chick cost Rs/bird	44.00	44.00	44.00	44.00
Feed intake, g/bird	3.97	4.28	4.18	4.17
Feed cost, Rs/kg	30.04	31	31.4	33.2
Feed cost, Rs/ bird	119.39	132.62	131.18	138.37
Miscellaneous cost, Rs/bird*	15.00	15.00	15.00	15.00
Net cost, Rs/bird	178.39	191.62	190.18	197.37
Bodyweight at the end of 6th wk (kg)	2.17	2.34	2.33	2.44
Return of sale on live weight @Rs. 86/kg Live BW	187.01	201.31	200.15	209.86
Net profit Rs/bird	8.63	9.69	9.97	12.49
Net Rs/ kg	3.97	4.14	4.29	5.12

*Miscellaneous cost (Rs/bird) including vaccine, medication, electricity

day-old chicks, feeds, vaccines, medicines and other miscellaneous expenditures which were also considered as a uniform for all the treatment groups. It was observed that higher profit per kg of broiler was in treatment group T_3 diet containing standard broiler chicken diet as per BIS, 2007, oregano essential oil at the dose 0.15 gm/kg diet and probiotic (encapsulated *Saccharomyces cerevisiae*) at the dose 200 gm/ tones)as Rs. 5.12 /-followed by treatment group T_2 diet containing probiotics (encapsulated *Saccharomyces cerevisiae*) as Rs. 4.29/-, group T_1 diet containing oregano essential oil at the dose 0.15 gm/kg diet as Rs. 4.14/-, and lower in control group *i.e.* T_0 as Rs.3.97/-. The economic assessment of the present study was in line with Borazjanizadeh *et al.* (2011) who used the clove and oregano on broiler chickens' diets @ 0.5 and 1% of the diet and showed a profit in the calculated cost of broiler meat per kg of feed ($P<0.05$). Anjum *et al.* (2005) in his studies on broiler supplementation with protexin (multistrain probiotic) reported it to be beneficial for economic efficiency in broiler chickens.

CONCLUSIONS

It may be concluded that commercial broiler chickens fed with Oregano (*Origanum vulgare*) Oil @ 0.15 gm/kg and Probiotic (encapsulated *Saccharomyces cerevisiae*) showed a positive impact on growth and feed conversion ratio and can be recommended as beneficial supplementation to broiler diets.

REFERENCES

Anjum, M. I., Khan, A. G., Azim, A. and Afzal, M. 2005. Effect of dietary supplementation of multi-strain probiotic on broiler growth performance. *Pak. Vet. J.* **25(1):** 25-29.

Aviagen, 2014. Ross broiler management handbook.

AOAC. 2012. Association of Official Analytical Chemist, official Method of Analysis of AOAC international, 19th Edn. Washington D.C., U.S.A.

Bai, S. P., Wu, A. M., Ding, X. M., Lei, Y., Bai, J., Zhang, K. Y. and Chio, J. S. 2013. Effects of probiotic-supplemented diets on growth performance and intestinal immune characteristics of broiler chickens. *Poult. Sci.* **92(3):** 663-670.

BIS. 2007. Nutrient Requirements of Poultry. Bureau of Indian Standards, 5th revision. New Delhi, India.

Borazjanizadeh, M., Eslami, M., Bojarpour, M., Chaji, M. and Fayazi, J. 2011. The effect of clove and oregano on economic value of broiler chickens' diet under hot weather of Khuzesta. *J. Anim. Vet. Adv.* **10(2):**169-173.

Basmacýoðlu, H., Tokuþoðlu, Ö., Ergül, M. 2004. The effect of oregano and rosemary essential oils and alpha tocopheryl acetate on performance and lipid oxidation of meat enriched with n-3 PUFA's in broilers. *S. Afr. J. Anim. Sci.* **34**: 197-210.

Botsoglou, N.A., Florou-Paneri, P., Christaki, E., Fletouris, D. J., Spais, A. B. 2002. Effect of dietary oregano essential oil on performance of chickens and on iron-induced lipid oxidation of breast, thigh and abdominal fat tissues. *Br. Poult. Sci.* **43**: 223-230.

Chai, S. J., Cole, D., Nisler, A. and Mahon, B. E. 2017. Poultry: The most common food in outbreaks with known pathogens, United States, 1998-2012. *Epidemiol. Infect.* **145(2):** 316-325.

Cunzhen, D., Yan, Z. and Haifeng, X. 2019. Research on market status of broiler industry under avian influenza crisis-based on internet big data and ms-var model. *Chinese J. Agric. Resou. Reg. Planning.* **7:** 15.

Cross, D. E., McDevitt, R. M., Hillman, K., Acamovic, T. 2007. The effects of herbs and their associated essential oils on performance, dietary digestibility and gut microflora in chickens from 7 to 28 days of age. *Br. Poult. Sci.* **48:** 496-506.

Cho, J. H., Kim, I. H. and Kim, I. J. 2014. Effects of phytogenic feed additive on growth performance, digestibility, blood metabolites, intestinal microbiota, meat color and relative organ weight after oral challenge with *clostridium perfringens* in broilers. *Livest. Sci.* **160:** 82-88.

Dafade, S. S., Gole, M. A., Manwar, S. J., Wankhede, S. M., Rathod, P. R. and Sajid, S. 2019. Effect of oregano essential oil with multi-enzyme in protein reduced diet on broiler performance. *J Entomol Zool. Stud.* **7(5):** 1407-1413.

Ertas, O. N., Güler, T., Çiftçi1, M., Dalkihç1, M. and Simsek, U. G. 2005. The effect of an essential oil mix derived from oregano, clove and anise on broiler performance. *Int. J. Poult. Sci.* **4:** 879-884.

El-Ghany, W. A. A. and Ismail, M. 2013. Tackling of experimental colisepticaemia in broiler chickens using phytobiotic essential oils and antibiotic alone or in combination. *Iranian J. Vet. Res.* **15:** 110-115.

El-Hakim, A. S. A., Cherian, G. and Ali, M. N. 2009. Use of organic acid, herbs and their combination to improve the utilization of commercial low protein broiler diets. *Int. J. Poult. Sci.* **8:** 14-20.

Giannenas, I. L., Karamoutsios, A. C., Bartzanas, T. H., Tsinas, A. N., Tzora, A. T., Skoufos, I. O. 2016. Oregano and sage essential oils improve antioxidant status of raw and cooked breast and thigh chicken meat. *Agro Food Industry Hi-Tech.* **27(4):** 10-14.

Giannenas, I. A., Florou-Paneri, P., Papazahariadou, M., Botsoglou, N. A., Christaki, E. and Spais, A. B. 2004. Effect of diet supplementation with ground oregano on performance of broiler chickens challenged with *Eimeria tenella*. *Arch. Geflugelkd.* **68:** 247-252.

Ghazi, S., Amjadian, T. and Norouzi, S. 2015. Single and combined effects of vitamin C and oregano essential oil in diet, on growth performance, and blood parameters of broiler chicks reared under heat stress condition. *Int. J. Biometeorol.* **59:** 1019-1024.

Gomathi G., Senthilkumar, S., Natarajan, A., Amutha, R., Sakthivael, P. C., Gobiraju, S., Ajantha, A. and Purushothaman, M. R. 2017. Utilization of essential oils in poultry diet –A review. *Int. J. Sci. Environment Techno.* **6(3):** 1632-1640.

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

Halle, I., Thomann, R., Bauermann, U., Henning, M. and Köhler, P. 2004. Effects of a graded supplementation of herbs and essential oils in broiler feed on growth and carcass traits. *Landbauforshung Volkenrode*. **54:** 219-229.

Hernandez, F., Madrid, J., Garcia, V., Orengo, J. and Megias, M. D. 2004. Influence of two plant extracts on broilers performance, digestibility and digestive organ size. *Poult. Sci.* **83(2):** 169-174.

Hong, J. C., Steiner, T., Aufy, A. and Lien, T. F. 2012. Effects of supplemental essential oil on growth performance, lipid metabolites and immunity, intestinal characteristics, microbiota and carcass traits in broilers. *Livest. Sci.* **144(3):** 253-262

Ilias, G., Tzora, A., Sarakatsianos, I., Karamoutsios, A., Skoufos, S., Papaioannou, N., Anastasiou, I., and Skoufos, I. 2016. The effectiveness of the use of oregano and laurel essential oils in chicken feeding. *Ann. Anim. Sci*. **16(3):** 779-796.

Jamroz, D., Wiliczkiewicz, A., Wertelecki, T., Orda, J. and Skorupiñska, J. 2005. Use of active substances of plant origin in chicken diets based on maize and locally grown cereals. *Br. Poult. Sci*. **46:**485-493.

Kansal, A., Ali, N., Fahim, M. A., Bharti, K., Chandra, G., Siddiqui, R. A., Singh, R. and Kant, S. 2017. Effect of dietary supplementation of garlic on the haemato-biochemical parameters and performance of broiler chickens. *Int. J. Livest. Res.* **7(10):** 223-230.

Khattak, F., Ronchi, A., Castelli. P. and Sparks, N. 2014. Effects of natural blend of essential oil on growth performance, blood biochemistry, cecal morphology, and carcass quality of broiler chickens. *Poult. Sci*. **93:** 132-137.

Kapica, M., Kwiecien, M., Puzio, I., Bienko, M., Radzki, R. P. and Pawlowska, M. 2006. Influence of some herbs on the activity of digestive enzymes in chickens. *Med. Weter.* **62:** 1048-1050.

Lee, K. W., Everts, H., Kappert, H. J., Yeom, K. H. and Beynen, A. C. 2003. Dietary carvacrol lowers body weight gain but improves feed conversion in female broiler chickens. *J. Appl. Poult. Res.* **12:** 394-399.

Manafi, M., Khalaji, S. and Hedayati, M. 2016. Assessment of a probiotic containing *Bacillus subtilis* on the performance and gut health of laying Japanese quails (*Coturnix coturnix* Japonica). *Braz. J. Poultry Sci.* **18(4):** 599-606.

M´endez-Zamora, G., Dur´an-Mel´endez, L. A., Hume, M. E. and Silva-V´azquez, R. 2017. Performance, blood parameters, and carcass yield of broiler chickens supplemented with Mexican oregano oil. *R. Bras. Zootec.* **46:** 515-520.

Peng, Q. Y., Li, J. D., Li, Z., Duan, Z. Y. and Wu, Y. P. 2016. Effects of dietary supplementation with oregano essential oil on growth performance, carcass traits and jejunal morphology in broiler chickens. *Anim. Feed Sci. Technol*. **214:** 148-153.

Ramlucken, U., Ramchuran, S. O., Moonsamy, G., Lalloo, R., Thantsha, M. S. and van Rensburg, C. J. 2020. A novel Bacillus based multi-strain probiotic improves growth performance and intestinal properties of Clostridium perfringens challenged broilers. *Poult. Sci.* **99(1):** 331-341.

Ren, H., Vahjen, W., Dadi, T., Saliu, E.M., Boroojeni, F. G. and Zentek, J. 2019. Synergistic effects of probiotics and phytobiotics on the intestinal microbiota in young broiler chicken. *Microorganisms*. **7(12):** 684.

Reyer, H., Zentek, J., Manner, K., Youssef, I. M. I, Aum¨uller, T., Weghuber, J., Wimmers, K. and Muller, A. 2017. Possible molecular mechanisms by which an essential oil blend from star anise, rosemary, thyme, and oregano and saponins increase the performance and ileal protein digestibility of growing broilers. *J. Agric. Food Chem*. **65**: 6821-6830.

Sugiharto, S. 2016. Role of nutraceuticals in gut health and growth performance of poultry. *J. Saudi Society Agric. Sci.* **15(2):** 99-111.

Silva-V´azquez, R., Dur´an-Mel´endez, L. A., Santellano-Estrada, E., Rodr´ýguez-Muela, C., Villalobos-Villalobos, G., M´endez-Zamora, G. and Hume, M. E. 2015. Performance of broiler chickens supplemented with Mexican oregano oil (*Lippia berlandieri* Schauer). *R. Bras. Zootec.* **44:** 283-289.

Skoufos, I., Giannenas, I., Tontis, D., Bartzanas, T., Kittas, C. Panagakis, P. and Tzora, A. 2016. Effects of oregano essential oil and attapulgite on growth performance, intestinal microbiota and morphometry in broilers. *S. Afr. J. Anim. Sci.* **46:** 77-88.

Yalçýn, S., Eser, H., Yalçýn, S., Cengiz, S. and Eltan 2013. Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) on performance, carcass and gut characteristics, blood profile, and antibody production to sheep red blood cells in broilers. *J. Appl. Poult. Res.* **22:** 55-61.

Zanini, S. F., Sousa, D. R., Rodrigues, M. R. A., Silva, M. A., Zanini, M. S. and Colnago, G. L. 2013. Oregano essential oil as antimicrobial agent in broilers diet. *Arch. Vet. Sci.* **18(4).**