



E-ISSN: 2320-7078

P-ISSN: 2349-6800

JEZS 2019; 7(5): 1407-1413

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Received: 21-07-2019

Accepted: 23-08-2019

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Effect of oregano essential oil with multi-enzyme in protein reduced diet on broiler performance

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Abstract

The present study was conducted to evaluate effect of oregano essential oil with multi-enzyme in protein reduced diet in broilers. Randomly the day old broilers chicks were equally distributed into eight treatment groups. There were three replicates of 20 chicks each under each treatment. The control group (A) received with basal diet as per BIS (2007). Group B received diet with 2% reduction in Crude Protein (CP). Groups C and D received basal diet supplemented with oregano essential oil and with multi-enzyme @ 400g/tonne, respectively. Group E received basal diet supplemented with oregano essential oil and multi-enzyme. Group F and G received diet with 2% reduction in CP supplemented with oregano essential oil and with multi-enzyme respectively. Group H received diet with 2% reduction in CP supplemented with oregano essential oil and multi-enzyme. The result showed that, broilers supplemented with oregano essential oil along with multi-enzyme alone or in combination recorded significantly higher ($P<0.01$) body weight. The feed intake was higher in all treatment groups. Furthermore, the feed conversion ratio was improved in all treatment groups. The lower mortality % was recorded in treatment groups. In conclusion, the broiler diet supplemented with oregano essential oil @ 200 mg/kg of feed along with multi-enzymes @ 400gm/tonne resulted higher body weight gain, improved FCR and reduced mortality.

Keywords: Oregano essential oil, multi-enzyme, protein reduced diet, broiler performance

Introduction

Poultry meat and its products in last decade years are becoming more important and popular food choice for most of the non-vegetarian population. In India, poultry industry is transform from backyard farming into a full-fledged agro based industry [1]. Herbs have been known for their various degrees of antimicrobial activity from the ancient time which is due to essential oil (Eos) in volatile oils from present in different plants and herbs [2]. Antibiotics growth promoter used for improving growth performance in poultry. Recently restrictions on use of antibiotics, due to its antibiotic residual effect. Essential oils have antimicrobial, antiparasitic, antioxidant, anti-inflammatory, immunomodulatory and antifungal properties [3]. Most of the essential oils which are phenolic in nature act on bacterial cell by increasing cell permeability which leads to cell death due to water imbalance and hence show antibacterial action. Antibacterial activities of essential oils were also well documented [4]. Oregano essential oil (OEO) is mainly composed of natural and volatile aromatic compound which are have antimicrobial and antioxidative activities [5]. Essential oils also promotes feed intake, digestive enzyme production and destroy pathogens in poultry [6].

The feed constitute 70% of the total cost of production. It necessitates that efficient utilization of feed ingredient for cost effective poultry production [7]. Major focus of modern poultry industry is to reduce the cost of feed. Maize and soy meal forms major portion of the poultry feed in which maize contributing 55-65% and out of total feed volume soy meal forming 25-30%. Protein is one of the major parts which can affect all production parameter in broiler chickens [8]. Lowering % of dietary protein may be decreased the cost of diet and it is possible to have significant cost saving. Application of feed enzymes is widely adopted in poultry industry. Enzymes can increase the utilization of energy, protein, calcium and phosphorus and also may reduce microbial proliferation in the hindgut due to improvement in nutrient utilization in the foregut [9]. Most of the conventional and non-conventional feed ingredients contain anti-nutritional factors (ANF) like phytate, NSP, protease inhibitors, etc. which leads to decreased digestibility and bioavailability of the nutrient. Dietary supplementation of the

exogenous enzymes such as β -glucanase, xylanase, amylase, α -galactosidase, protease, lipase, phytase etc. to improve the digestion of ANF, increase nutrient utilization and performance of poultry [10]. Addition of enzyme in poultry diet increase the energy value of feed along with increase in protein, carbohydrates, fat and phytin phosphorus utilization from the plant material [11]. Keeping these facts in view the present investigation had planned to study the effect of supplementation of oregano essential oil (OEO) with multi-enzyme in protein reduced diet on broiler growth performance.

Materials and Methods

The experiment was carried out on 480, commercial straight run day old broiler chicks of Cobb 400 for a period of 42 days. The experimental broilers chicks were allotted to 8 treatment groups viz. A, B, C, D, E, F, G and H. Each treatment group had 3 replicates of 20 birds each. The dietary treatment groups were A Control - Basal Diet as per BIS (2007), B - Diet with 2% reduction in CP, C - Basal Diet as per BIS (2007) + oregano essential oil @ 200 mg/kg, D - Basal Diet as per BIS (2007) + Multi-enzyme, E - Basal Diet as per BIS (2007) + oregano essential oil @ 200 mg/kg + Multi-enzyme, F - Diet with 2% reduction in CP + oregano essential oil @ 200 mg/kg, G - Diet with 2% reduction in CP + Multi-enzyme and H - Diet with 2% reduction in CP + oregano essential oil @ 200 mg/kg + Multi-enzyme. Broiler chick were reared on deep litter system up to 6 weeks. *Ad-lib* feed was provided as per the treatment along with water. Broiler fed on pre-starter up to 7 days, followed by starter (2 - 3 weeks) and finisher (4-6 weeks). Managemental practices were uniform throughout the experimental period for all the treatments groups. Immediately after arrival birds from each group were weighed individually and then after at weekly intervals. Mean live body weight gain (g/ b) was computed on weekly basis. The difference between the feed offered and balanced feed was worked out to know the actual

feed consumed by each group during each week. The feed consumption was calculated and expressed as g/b/d. On the basis of weekly live weights and weekly feed consumption, the values of FCR of each group were calculated. The data obtained on various parameters studied during this experimental trial were subjected to statistical analysis as described by Snedecor and Cochran [12].

Results and Discussion

Weekly Live Body Weight

The average weekly live body weights of broilers from day old to 6 weeks of age in all dietary treatments are presented in Table 1. The results of the current experiment indicated that the weekly live body weights under all different treatment groups differed significantly ($P<0.01$) except at 1st week. At 2nd week, the significantly higher ($P<0.01$) weekly live body weight was observed in treatment groups fed multi-enzyme and oregano essential oil alone or in combination as compared to control and group B. During 3rd and 4th week of age broiler in all treatment groups were showed significantly ($P<0.01$) better live body weights than the control and group B. During 5th week of age the broiler fed with oregano essential oil, multi-enzyme or its combination showed significantly ($P<0.01$) higher body weight than group B and control group. At the end of 6th week, the broiler supplemented with oregano essential oil along with multi-enzyme alone or in combination recorded significantly higher ($P<0.01$) body weight. The birds in groups F, G and H supplemented with protein reduced diet along with either oregano essential oil, multi-enzyme or combination of both recorded higher live body weights than control and group B though the differences are statistically non-significant. Throughout the experiment, the highest weekly body weight was observed in treatment group E fed with control diet supplemented oregano essential oil along with multi-enzyme than other treatment groups.

Table 1: Weekly live body weight (g/b) of broilers fed oregano essential oil with multienzyme in protein reduced diet

Treatment groups	Age (Weeks)						
	Day-old	1 st	2 nd	3 rd	4 th	5 th	6 th
A - Basal diet	40.46±0.45	175.93±2.16	400.85 ^{cd} ±5.47	769.41 ^c ±10.54	1301.47 ^b ±20.32	1756.36 ^c ±31.35	2244.82 ^c ±41.06
B - 2% Reduced CP diet	39.10±0.70	176.27±2.04	392.08 ^d ±5.44	719.08 ^d ±11.15	1225.47 ^c ±20.34	1672.00 ^d ±28.39	2233.61 ^c ±29.17
C - Basal diet + OEO @ 200 mg/kg	39.26±0.56	171.23±2.17	421.90 ^{ab} ±6.63	844.08 ^b ±13.94	1416.67 ^a ±15.96	1836.18 ^{ab} ±21.24	2396.81 ^{ab} ±29.55
D - Basal diet + Multi enzyme @ 400 /T	39.01±0.62	176.53±2.68	435.59 ^a ±6.79	861.48 ^{ab} ±16.07	1435.05 ^a ±30.49	1874.63 ^{ab} ±34.91	2385.91 ^{ab} ±46.98
E - Basal diet Basal diet + OEO + Multienzyme	39.19±0.53	174.33±2.02	432.37 ^a ±5.37	883.43 ^a ±9.55	1418.02 ^a ±17.96	1893.89 ^a ±22.16	2447.56 ^a ±43.59
F - 2% Reduced CP diet + OEO @ 200 mg/kg	40.06±0.59	174.17±2.37	421.78 ^{ab} ±5.21	858.27 ^{ab} ±9.46	1407.75 ^a ±16.71	1874.28 ^{ab} ±23.27	2310.26 ^{bc} ±44.80
G - 2% Reduced CP diet + Multienzyme @ 400g/T	39.02±0.59	172.85±2.81	414.3 ^{bc} ±5.53	844.55 ^b ±11.03	1375.21 ^a ±21.32	1803.09 ^{bc} ±30.51	2285.33 ^{bc} ±44.11
H - 2% Reduced CP diet + OEO + Multienzyme	39.48±0.53	175.42±2.46	426.20 ^{ab} ±6.24	864.62 ^{ab} ±13.23	1414.71 ^a ±22.91	1835.82 ^{ab} ±27.86	2327.09 ^{bc} ±41.96
CD	NS	NS	21.35**	44.31**	77.75**	102.23**	153.41**
CV %	11.306	9.882	10.859	11.250	11.930	11.854	13.530

Means bearing different superscripts differ significantly within a column. ** $P<0.01$, NS-Non-significant

At the end of experiment, there was 8.45% increase in live body weight in group E supplemented with combination of oregano essential oil with multi-enzyme over control birds. Moreover, this improvement in live body weight was 3.56% in group H supplemented with protein reduced diet along with oregano essential oil and multi-enzyme over the control. In

line with our study Peng *et al.* [13] observed that inclusion of oregano oil @ 300 and 600 mg/kg of diet increased final body weight by 8.3% and 10.7%, respectively, in broilers. The findings of present study are in accordance with Giannenas *et al.* [14] fed basal diet plus 25 mg/kg oregano essential oil, 2.5 mg/kg laurel essential oil or their combination resulted in

higher body weights of broilers. Cazares-Gallegos *et al.* [15] observed positive result in body weight when fed with Mexican oregano essential oil in broilers. Bozkurt *et al.* [16] noted increased body weights in chickens, when fed with mannan oligosaccharide with oregano essential oil. The improvement in final body weight in groups supplemented protein reduced diet suggesting that improvement in nutrient utilization brought about by enzymes or oregano essential oil supplementation which compensated for reduced protein content of diet. Multi-enzyme reduces microbial proliferation in the hindgut due to the improvement in the nutrient utilization in the foregut also eliminate effect of anti-nutritional factors and improves the utilization of dietary energy and amino acid result in improved performance of broiler chicken [17]. This may due to low digestive enzyme secretion ability in early age as evident in study conducted by Noy and Sklan [18].

The results showed weekly live body weights oregano essential oil @ 200 mg/kg combination with multi-enzyme @ 400gm/tonne was found most beneficial among all the different treatments considered in the present experiment. Moreover, multi-enzymes and oregano essential oil supplementation in protein reduced of diet also found beneficial in terms of improved live body weight in broilers.

Cumulative Body Weight Gain

The average cumulative body weight gain of broiler from 1st to 6th weeks of age in all treatment groups were presented in Table 2. At 3rd week of the age broilers in all treatment's groups showed significantly ($P < 0.01$) higher cumulative weight gain than control and group B. Similarly, broilers in Group B showed significantly lower gain in weight. The parallel trend as noticed for gain in weight at 3rd week of age was also seen during 4th week.

Table 2: Cumulative weekly weight gain (g/b) of broilers fed oregano essential oil with multi-enzyme in protein reduced diet

Treatments	Age (weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
A - Basal diet	135.47±4.51	360.39 ^{cd} ±5.07	728.95 ^b ±9.21	1261.01 ^b ±13.68	1715.90 ^c ±17.11	2204.36 ^d ±39.65
B - 2% Reduced CP diet	137.17±3.26	352.98 ^d ±6.63	679.98 ^c ±1.51	1186.37 ^c ±3.18	1632.90 ^d ±17.49	2194.51 ^d ±30.13
C - Basal diet + OEO @ 200 mg/kg	131.98±2.13	382.64 ^{ab} ±8.50	804.83 ^a ±12.20	1377.41 ^a ±9.71	1796.92 ^{ab} ±24.94	2357.55 ^{ab} ±49.53
D - Basal diet + Multi enzyme @ 400 g/T	137.53±5.60	396.58 ^a ±5.68	822.47 ^a ±34.22	1396.05 ^a ±26.28	1835.62 ^{ab} ±27.21	2346.90 ^{abc} ±30.06
E - Basal diet Basal diet + OEO + Multienzyme	135.14±3.25	393.18 ^{ab} ±6.99	844.24 ^a ±10.60	1378.83 ^a ±34.50	1854.70 ^a ±18.43	2408.37 ^a ±20.20
F - 2% Reduced CP diet + OEO @ 200 mg/kg	134.11±4.54	381.73 ^{ab} ±9.02	818.21 ^a ±8.98	1367.69 ^a ±25.44	1834.22 ^{ab} ±14.33	2270.20 ^{bcd} ±39.96
G - 2% Reduced CP diet + Multienzyme @ 400g/T	133.82±3.55	375.27 ^{bc} ±7.15	805.53 ^a ±16.52	1336.19 ^a ±36.05	1764.06 ^{bc} ±37.75	2246.31 ^{cd} ±14.20
H - 2% Reduced CP diet + OEO + Multienzyme	135.94±1.03	386.73 ^{ab} ±2.18	825.15 ^a ±9.89	1375.23 ^a ±20.18	1796.34 ^{ab} ±38.51	2287.61 ^{bcd} ±45.63
CD	NS	27.721**	64.833**	98.261**	107.461**	146.964**
CV %	4.787	3.069	3.436	3.086	2.533	2.691

Means bearing different superscripts differ significantly within a column. ** $P < 0.01$, NS-Non-significant.

At 6th week, broilers in Group E offered feed having oregano essential oil with multi-enzyme gained significantly ($P < 0.01$) higher cumulative weight gain than all other treatments, control and group B. The highest cumulative body weight gain was observed in group E followed by group C, D, H, F, G, A and B. In the present study, dietary inclusion of oregano essential oil alone or in combination with multi-enzyme either in control or protein reduced diet improved gain in weight in broilers over the birds in control group and group B. The increase in weight gain compare to control in group E was 6.44% and Group H was 3.77%, respectively. Narasimha *et al.* [19] noted higher weight gain of 7.48% in broilers supplemented with different feed additives (NSP enzymes, synbiotics and phytase) compared to broilers fed basal diet. Cao *et al.* [20] reported that the addition of a combination of enzyme (350g/T of feed) and the essential oils (100g/T of feed) increased ileal and overall energy and protein digestibility resulted significant benefits in terms of nutrient utilization. Broiler producers commonly used enzymes as feed additives. Bravo *et al.* [21] reported that dietary energy was reduced by 2% compared to optimal levels it was shown that supplementation essential oils in diets compensated performance of broilers. Khattak *et al.* [22] observed increased in weight gain ($P < 0.05$) in broilers fed with natural blend of essential oils from basil, caraway, laurel, lemon, oregano, sage, tea, and thyme. Bozkurt *et al.* [16] studied the effect of oregano of the essential oil on the performance of broilers and observed significantly improved body weight gain. Similarly,

Ghazi *et al.* [23] reported that broilers fed diet containing oregano essential oil at the rate of 250 mg/ kg of feed increased body gain compared with the control.

Rewatkar *et al.* [24] observed an increased cumulative body weight gain in broiler chicken when feed with effect of oregano (*origanum vulgare*) oil as phyto-biotic growth promoter with probiotic. Essential oils help protein digestibility by alleviating pepsin and HCl secretion [25]. Addition of multienzyme oregano essential oil in a corn/soya-based protein reduced diet improved nutrient utilization and in consequence increased weight gain of broilers. Thus, it may be possible to compensate for probable undesirable effects of reduced protein levels via the application of certain feed additives such essential oils and enzymes. Bedford and Classen, [26] observed that dietary supplementation of enzymes can increase the utilization of nutrients such as energy, protein, calcium and phosphorus as a consequence improve the broilers performance. Kocher *et al.* [27] fed low energy diet supplemented with cocktail enzyme reported improvement in performance of broilers. Abudabos *et al.* [28] reported improvement in body weight gain of broilers which had fed enzyme supplemented diet in energy and protein reduced diet could be ascribed to the increase nutrient retention especially protein.

Cumulative feed consumption

The average cumulative feed consumption per bird was calculated for all the dietary treatments from 1st to 6th week

of age is presented in Table 3. The cumulative weekly feed consumption among different treatment groups differed significantly at 3rd, 4th and 5th week of age. At 3rd week of age significantly higher ($P<0.01$) cumulative feed consumption was observed in treatment groups supplemented with oregano essential oil with multi-enzyme (group E) compared to all other treatments and group A and Group B. At 4th week of age significantly higher ($P<0.01$) cumulative feed consumption was observed in all treatment groups compared to group A and group B. Same trend as that of 4th week was noted in 5th week for cumulative weekly feed consumption indifferent treatment groups. The numerically highest cumulative feed consumption was reported in group E supplemented with oregano essential oil with multi-enzyme compared to all other treatments.

The results was in accordance with Cazares-Gallegos *et al.* [15] who observed increased feed intake when fed with Mexican

oregano essential oil (MOO) in broilers. Moreover, Giannenas *et al.* [14] also found that, supplementation of 25 mg/kg oregano essential oil, 2.5 mg/kg laurel essential oil or their combination in basal diet increased feed consumption. Pournazari *et al.* [29] also noted, increase feed consumption in broilers fed with thyme oil in diet as compared to control. Adibnehad *et al.* [30] found that feed intake was improved in broiler chicken supplemented with 1% of peppermint and 0.5% of thyme powder in broiler diet. Cifci *et al.* [31] reported that broiler group received cinnamon essential oil @ 500 ppm has highest feed consumption. Al-Kassie *et al.* [32] observed higher feed consumption when broiler fed with 200 ppm of essential oil i.e. thyme and cinnamon though diet. Researchers found that essential oil in broiler diets significantly increases feed consumption. They attributed this effect to active principle in plants which are considered as digestion stimulating factors [33].

Table 3: Cumulative weekly feed consumption (g/b) of broilers fed oregano essential oil with multi-enzyme in protein reduced diet

Treatments	Age (weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
A - Basal diet	147.23±5.83	453.11±8.65	987.20 ^c ±5.95	1797.45 ^b ±15.82	2738.05 ^{bc} ±17.45	3828.19 ±33.03
B - 2% Reduced CP diet	152.52±4.69	457.84±10.49	946.99 ^d ±19.34	1664.95 ^c ±34.24	2647.65 ^c ±32.97	3841.05 ±46.29
C - Basal diet + OEO @ 200 mg/kg	153.05±5.21	463.20±16.30	1054.93 ^b ±14.21	1930.51 ^a ±35.66	2801.81 ^{ab} ±68.90	3992.47±103.27
D - Basal diet + Multi enzyme @ 400 g/T	142.62±2.42	468.63 ±2.80	1063.43 ^{ab} ±19.42	1953.80 ^a ±36.96	2862.51 ^a ±27.42	3954.65 ±29.45
E - Basal diet Basal diet + OEO + Multienzyme	145.72±1.47	461.25±16.84	1094.65 ^a ±12.14	1923.68 ^a ±44.20	2870.81 ^a ±19.02	4020.00 ±30.00
F - 2% Reduced CP diet + OEO @ 200 mg/kg	147.73±2.57	465.94 ±3.61	1077.40 ^{ab} ±3.10	1938.45 ^a ±52.04	2868.54 ^a ±34.98	3841.99 ±51.17
G - 2% Reduced CP diet + Multienzyme @ 400g/T	147.18±5.13	448.89 ±3.57	1048.51 ^b ±6.10	1924.99 ^a ±10.19	2809.37 ^{ab} ±11.74	3883.48 ±13.64
H - 2% Reduced CP diet + OEO + Multienzyme	148.83±1.32	464.85±11.98	1079.63 ^{ab} ±10.49	1945.16 ^a ±28.53	2839.86 ^{ab} ±71.58	3924.54 ±68.19
CD	NS	NS	52.503**	143.402**	124.240*	NS
CV %	4.639	4.014	2.108	3.190	2.559	2.381

Means bearing different superscripts differ significantly within a column. ** $P<0.01$, * $P<0.05$, NS-Non-significant.

In the present study the weekly feed consumptions broilers received diet with 2% reduction in crude protein showed higher feed consumption at 6th weeks similar observation is noted by Sterling *et al.* [34] reported increased feed consumption in broilers fed low CP diet supplemented with lysine in which may be to meet the protein requirement of broiler. Alaeldein *et al.* [35] observed that feed consumption was non-significant among different treatment groups along with supplementation of blend of essential oil. Al-Mashhadani *et al.* [36] reported that inclusion of 0.5% and 1% coriander oil significantly improved feed intake during summer months. Suresh Kumar *et al.* [37] reported improvement in feed consumption when broiler diet was supplemented with enzyme. Elangvan *et al.* [38] reported improvement in feed consumption with enzyme in broiler chicken.

Overall, the feed intake was higher in all treatment groups. Though, at the end of experiment numerically increased feed consumption due oregano essential oil with multi-enzyme supplementation in basal or protein reduced diet was evident which is suggesting beneficial effects of oregano essential oil with multi-enzyme supplementation in broiler growth performance in terms of feed intake.

Cumulative Feed Conversion Ratio

Cumulative feed conversion ratio for different dietary treatment groups from 1st to 6th weeks of age are presented in

Table 4. The addition of essential oil and multi enzyme either alone or in combination in basal diet or protein reduced diet in broilers also improved the cumulative weekly feed conversion ratio during 4th to 6th week of age. However, the extent of the effect was statistically non-significant. The numerically better cumulative FCR was observed in group E (diet supplemented with oregano essential oil @ 200 mg/kg with multi-enzyme 400 gm/tonne) at 6th week, followed by group F (negative control diet with oregano essential oil @ 200 mg/kg and group C (control diet with oregano essential oil @ 200 mg/kg) compare to control.

The percent improvement in FCR at 6thweek in broilers fed oregano essential oil with multi-enzyme was 4.02% over the control. The birds supplemented with essential oil and multi enzyme either alone or in combination in basal diet or protein reduced diet showed better cumulative feed conversion ratio compare to control. The average percent improvement in FCR is 0.5- 2.8% in treatment groups over control. This may be attributed to the fact that the birds fed essential oils and multi-enzyme utilized the nutrients more efficiently than the birds in control group. In the current experiment result observed that the dietary group supplemented with oregano essential oil with or with-out multi-enzyme showed slightly improved cumulative FCR (Table 4). Similar result was obtained by Chalhouni *et al.* [39] noted that FCR was numerically better in broilers supplemented with essential oil blend in the diet.

Table 4: Cumulative weekly feed conversion ratio of broilers fed oregano essential oil with multi-enzyme in protein reduced diet

Treatments	Age (weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
A - Basal diet	1.09±0.06	1.26±0.04	1.35±0.02	1.43±0.02	1.60±0.01	1.74±0.02
B - 2% Reduced CP diet	1.11±0.06	1.30±0.02	1.39±0.02	1.40±0.03	1.62±0.003	1.75±0.03
C - Basal diet + OEO @ 200 mg/kg	1.16±0.05	1.21±0.04	1.31±0.03	1.40±0.02	1.56±0.02	1.69±0.01
D - Basal diet + Multi enzyme @ 400 g/T	1.04±0.04	1.18±0.01	1.30±0.03	1.40±0.01	1.56±0.01	1.69±0.01
E - Basal diet Basal diet + OEO + Multienzyme	1.08±0.03	1.18±0.06	1.30±0.03	1.40±0.003	1.55±0.02	1.67±0.02
F - 2% Reduced CP diet + OEO @ 200 mg/kg	1.10±0.02	1.22±0.02	1.32±0.02	1.42±0.01	1.56±0.01	1.69±0.02
G - 2% Reduced CP diet + Multienzyme @ 400g/T	1.10±0.07	1.20±0.03	1.30±0.03	1.44±0.04	1.59±0.04	1.73±0.02
H - 2% Reduced CP diet + OEO + Multienzyme	1.10±0.02	1.20±0.03	1.31±0.01	1.41±0.003	1.58±0.01	1.72±0.01
CD	NS	NS	NS	NS	NS	NS
CV %	7.291	4.920	3.262	2.374	2.215	1.847

NS-Non-significant.

In addition, essential oils can upgrade enzymes and enhance digestion. Lee *et al.* [40] found that carvacrol and thymol, improved feed conversion rate in broiler chickens. In accordance to current results the better results with respect to FCR have also been observed by the researchers. Maziar Mohiti-Asli *et al.* [41] concluded that combination of essential oils did not significantly affect feed conversion ratio (FCR) of broiler. Mansoub *et al.* [42] reported that oregano essential oil may improve the growth performance as well as FCR in broilers. Cazares-Gallegos *et al.* [15] investigated the effect of Mexican oregano essential oil in broiler chicken and recorded better FCR and performance in broilers supplemented diet with Mexican oregano essential oil. Vendrell *et al.* [43] pointed that the active principle of herbs having significant role in maintaining epithelial lining membrane of the organs and systems the n increases their effectiveness thereby improving

the feed intake and FCR.

Thus, positive effect of oregano essential oils with multi-enzyme in terms of improved overall FCR is also noted in broilers.

Mortality

The percent mortality during the whole experimental period in all treatment groups were presented in Table 5. The overall mortality among the different groups was similar so dietary supplementation of oregano essential oil and enzymes did not found any adverse effect on mortality percentage. The mortality percentage is lower in treatment groups as compare to control. In the present experiment the mortality was decreased in all the treatments groups. Hence, treatments found beneficial to improve livability in broiler production which is also evident in literatures.

Table 5: Mortality (%) in broilers fed oregano essential oil with multi-enzyme in protein reduced diet

Treatment groups	No. of birds	No. of birds died	Mortality (%)
A - Basal diet	60	4	6.66
B - 2% Reduced CP diet	60	4	6.66
C - Basal diet + OEO @ 200 mg/kg	60	3	5
D - Basal diet + Multi enzyme @ 400 g/T	60	3	5
E - Basal diet Basal diet + OEO + Multienzyme	60	3	5
F - 2% Reduced CP diet + OEO @ 200 mg/kg	60	3	5
G - 2% Reduced CP diet + Multienzyme @ 400 g/T	60	3	5
H - 2% Reduced CP diet + OEO + Multienzyme	60	4	6.66

Conclusions

The present study confirmed the benefits of use of oregano essential oil and multi-enzymes in broiler production. Moreover, supplementing oregano essential oil and enzyme has exerted synergistic effects on improvement in live body weight and weight gain, better feed conversion ratio, enhanced immune response with more economic benefits in broiler production. Furthermore, this synergism is also observed in terms of improved overall performance of broilers supplemented with oregano essential oil and multi-enzymes in protein reduced diet. Thus it can be concluded that, the broiler diet supplemented with oregano essential oil @ 200 mg/kg of feed along with multi-enzymes @ 400gm/tonne resulted higher body weight gain, improved FCR and reduced mortality.

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