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Growth Performance of Chicken Broilers Fed Sodium Sulphate and Fish Oil in Fish Meal-Free Ration

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ABSTRACT

Fish meal is an integral part of broiler diet despite having issues like storage and randicity. The prices of fish meal suddenly shot up during COVID pandemic. Taking this problem in mind, the following experiment was carried out to study the growth performance of chicken broilers with Sodium Sulphate and Fish Oil supplementation in an is oproteneic and is oenergetic fish meal free ration. One hundred eighty, one-day-old broiler chicks of Ven-Cobb strain-400 were distributed into 4 treatment groups (T0, T1, T2 and T3) each having 45 chicks which were further divided into 3 replicates of 15 chicks in each replicate. A completely randomized design was followed. Initial body weight, weekly body weight and weekly feed intake were recorded and other production parameters were calculated on the basis of initially recorded readings. The combination of Sodium Sulphate and Fish Oil improved all parameters related to body weight and feed intake of chicken broilers in comparison to the control group. The mean FCR, mean cumulative FCR and mean phase-wise FCR of chicken broilers were better in Sodium Sulphate with the Fish Oil supplemented group. The inclusion of Sodium Sulphate with Fish Oil in ration also improved the performance index, protein efficiency, production number and energy efficiency of broilers. Therefore, combination of Sodium Sulphate and Fish Oil may possibly replace fish meal in the diet of chicken broilers.

Keywords: *Broiler, feed conversion ratio, fish meal, fish oil, performance indices, sodium sulphate*

INTRODUCTION

Currently, the Indian Poultry sector is one of the fastest-growing segments in the agricultural sector as it has transformed itself from age-old backyard farming into a dynamic agri-based industry over past four decades. Among the poultry sector, broilers are one of the fastest-growing components of worldwide meat demand, and India, the world's second-largest developing country, is also witnessing a rapid climb in its poultry sector. Despite this, one of the major factors curbing the rapid progress of the broiler industry is the increasing cost of feedstuffs which represents roughly up to 70 percent of the total recurring cost of poultry production. So it is the need of the hour to provide not only balanced but also cost effective feed for the further betterment of the broiler industry.

In tropical countries, mostly soybean and groundnut-based diets are fed which are deficient in sulphur amino acids (mainly lysine and methionine) for which sufficient amounts of vegetable and animal protein are required in broiler diet. To meet these requirements, one very good source is fish meal which is valued by farmers as well as nutritionists due to its highly digestible crude protein content, essential amino acids, fat, vitamins and minerals, but a large amount of fish meal is required to be added in ration to meet out demands of essential amino acids like methionine and lysine. But limited availability, lack of uniformity, higher cost relative to plant sources and storage issues due to its oxidizable nature responsible for rancidity are some strong reasons to find substitutes for fish meal in broiler diets. Availability and quality issues of the fish meal were further aggravated during the tough times of the COVID pandemic.

To maintain the amino acid balance in the ration of broilers, the use of certain substances which can possibly spare the inclusion of certain essential amino acids upto some extent is desired. There is a need to formulate an isoproteinic fish meal-free ration to reduce the feed cost. Inorganic sulphates from exogenous dietary sources and from endogenous release from sulphur-containing amino acids are used in synthesizing the chondroitin matrix, in the biosynthesis of taurine, heparin and in maintaining optimum dietary electrolyte balance [16]. Sodium Sulphate also helps in sparing methionine through conversion to cystine etc. 18% of recommended methionine can be replaced with 0.1% of Sodium Sulphate [28]. The incorporation of Sodium Sulphate and methionine in all vegetable rations appears to provide sulphur-containing amino acids from sulphate and replaces fish meal respectively in a vegetable protein diet [1].

Oils, the main source of energy used in the broilers diet have the

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highest caloric value among all dietary ingredients and have several advantages like reduction of feed dust, reduction in the rate of feed passage through GI tract, enhance absorption of nutrients [27], improvement in hydrolysis and absorption of the lipoproteins that supply fatty acids [25], increase diet palatability, improve the utilization of the consumed energy etc. They often present higher than expected biological value, increasing dietary metabolizable energy, which usually results in higher growth rates and better feed efficiency.

Fish Oil (FO), an important source of dietary long-chain n-3 polyunsaturated fatty acids (LC-PUFA; n-3), eicosapentaenoic acid (EPA; 20:5) and docosahexaenoic \acid (DHA; 22:6) have been reported to improve the performance of chicken broilers [17, 26 and 7]. 1.5 % FO had the best values for feed conversion ratio (FCR), body weight (BW) and body weight gain (BWG); this level of supplementation increased the feed intake (FI) and improved the BWG and FCR in broilers [29]. Low levels of FO in the diet improved the production parameters in broilers [29 and 13]. Therefore, the present investigation was planned to study the growth parameters of chicken broilers with sodium sulphate and fish oil supplementation in a isoproteneic and isoenergetic fish meal-free ration.

MATERIALS AND METHODS

Experimental birds and design

The present investigation was conducted in the poultry shed of the Department of Livestock Production Management, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar. One hundred eighty, one-day-old broiler chicks of Ven-Cobb strain-400 were purchased from a reputed local commercial hatchery. The chicks were individually weighed, wing-banded and randomly distributed into four treatment groups T0, T1, T2 and T3. The birds under T0 group were kept as a negative control group and offered a basal diet without a fish meal, T1 birds were fed the basal diet with fish meal (Control Group), T2 group birds were offered a basal diet without fish meal but supplemented with 0.35% Sodium Sulphate, T3 birds were offered basal diet without fish meal but supplemented with 0.35% Sodium Sulphate and Fish Oil (in place of vegetable oil). Each treatment group was having 45 chicks and each group was further divided into three replicates of 15 chicks each. A Completely Randomized Design (CRD) was used as an experimental statistical design. The experiment was approved by the Institutional Animal Ethics Committee of Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar (Haryana). (Registration No.-1669/GO/ReBiBt-S/Re-L/12/CPCSEA)

Experimental Feed

All feed ingredients, additives and supplements used in the experimental diet formulation were procured in one lot before the start of the experiment. Feed ingredients used for ration formulations were evaluated for proximate nutrients [5]. The proximate composition of the pre-starter, starter and finisher rations is as given in Table 1. The chicks were offered all mash broiler ration ad libtumlabrum, formulated according to [9] specifications. Standard managemental practices including brooding, proper lighting, raking of litter, cleaning of feeders, waterers, etc. were followed throughout the experiment.

OBSERVATIONS RECORDED

Body weight

The birds belonging to all the experimental groups were closely observed throughout the experiment, starting from day old till the end of the experiment i.e., 42 days, for body weight gain. Chicks were weighed individually at the start of the experiment and later on weekly using a single pan balance. On the basis of recorded data, mean cumulative weight gain, mean weekly body weight gain per bird, mean daily weight gain per bird and mean phase- wise weight gain of chicken broilers were calculated.

Feed intake

The weekly record of the feed offered and the residual amount was maintained for each replicate to calculate the feed consumption per bird. Mean cumulative feed intake, mean daily feed intake per bird and mean phase-wise feed intake was calculated on the basis of recorded data.

Feed conversion ratio

The feed conversion ratio is a measure of the efficiency of the utilization of feed. Feed Conversion Ratio (FCR) for each replicate was calculated as follows:

$$FCR = \frac{\text{Total feed consumed (g)}}{\text{Total body weight gain (g)}}$$

The mean cumulative feed conversion ratio and mean phase-wise feed conversion ratio was then calculated using suitable data.

Production indices

All the performance indices discussed below were calculated phase wise i.e., pre-starter, starter and finisher phase.

a) Performance Index

Performance Index (P.I) was calculated by applying the following formula advocated by [8]:

$$P.I = \frac{(\text{Body weight Gain})2}{\text{Feed consumed}}$$

b) Protein efficiency

Protein efficiency (P.E.) was calculated as suggested by [20]:

$$P.E. = \frac{\text{Body weight gain (g)}}{\text{Protein intake (g)}}$$

c) Energy efficiency

Energy efficiency (E.E) was calculated as suggested by [20]:

$$E.E. = \frac{\text{Body weight gain (g)}}{\text{Total ME intake (Kcal converted to MJ)}} \times 100$$

d) Production number

Production number (P. N) was calculated as suggested by [14]:

$$\text{Production number} = \frac{\text{Average weight gain (g) x percentage livability}}{\text{Days of fattening x FCR x 10}}$$

STATISTICAL ANALYSIS

Data obtained were subjected to statistical analysis as per [32] using a Completely Randomized Design (CRD). All the data were subjected to one-way ANOVA using the SPSS software (version-16). The mean differences among different treatments were separated by Duncan's multiple-range tests. Consequently, a level of ($P<0.05$) was used as the criterion for statistical significance [11].

RESULTS AND DISCUSSION

The literature revealed that scanty work had been done on the supplementation of Sodium Sulphate and Fish Oil on the performance of broilers, but no work has been found on a combination of the supplementation of Sodium Sulphate with Fish Oil. So, the research work available on the effect of supplementation of Sodium Sulphate and Fish Oil alone in the diet of chicken broilers has been used in support of the present findings.

Body weight

The data pertaining to various body weight parameters are presented in Table 2. In our present study, the mean weekly body weight of chicken broilers was significantly ($P<0.05$) increased due to dietary supplementation of Sodium Sulphate with Fish Oil (T3) in comparison to the control group (T1). The results of improved body weight parameters of the experiment were analogous to the findings of [1, 2, 3, 4 and 22]. They reported improved body weight on supplementation of Sodium Sulphate in diets of chicken broilers which might be due to the ready availability of sulphur in the body. [31] reported higher body weight gains in turkey broilers due to the addition of Sodium Sulphate in their diets. The present study can also be compared with [17, 23, 10and 13] who have studied the inclusion of FO in the diets of chicken broilers and reported improved body weight parameters due to FO inclusion in diets of chicken broilers which might be due to a higher degree of unsaturation (more n-3 PUFA) in FO as compared to Soybean oil. [7 and 26] also reported higher body weight gains due to FO inclusion in the diets of broiler chickens which is in agreement with the present findings. [21] observed increased body weight parameters due to the inclusion of n-3 fatty acid sources i.e., either Linseed Oil or Fish Oil in the diets of Japanese quails. The good performance of FO might be related to the fatty acid composition of fish oil in chicken broilers [10]. Diverging from the present findings, [18] reported decreased body weight to increase red fish oil in the diets of chicken broilers. Similar results were concluded by [29] that on high levels of FO supplementation i.e., 6% led to a significant reduction in BW and BWG. [24] reported decreased body weight and body weight gain due to FO inclusion in grower diets. In contrary to our findings, [28, 30 and 19] reported no significant effect on the body weight of chicken broilers due to dietary supplementation of either Sodium Sulphate or Fish Oil which might be due to pungent smell of feed.

Feed intake

The feed intake parameters are presented in Table 3. The mean weekly feed intake in the present study was significantly ($P<0.05$) high during the whole experiment in Sodium Sulphate with Fish Oil supplemented group (T3) as compared to T1 group. The present results of feed intake were in agreement with [10, 13 and 6]. They reported higher feed intake in chicken broilers fed FO-supplemented diets which might be due to the rich content of n-3 fatty acids, EPA and DHA content of FO. Contrary to the present findings, [17 and 7] recorded decreased feed intake in fish oil supplemented diets of chicken broilers which might be attributed to the pungent smell of fish oil. Similarly, [29] concluded that higher levels of FO in the diet results in decreased feed intake in chicken broilers. Also, [3] recorded the lowest feed intake in Sodium Sulphate supplemented diet as compared to other dietary treatments which is against the findings of the current study. However, [15, 24 and 19] recorded non-significant differences in the feed intake of chicken broilers due to the supplementation of fish oil in their diets. Similarly, [12 and 21] found that fish oil supplementation in diets of Japanese quails has no significant effect on feed intake.

Feed Conversion Ratio

The mean FCR of chicken broilers differed non-significantly among T2, T3 and T1 groups at all the stages of the experiment, however, FCR was better in T3 i.e., Sodium Sulphate with Fish Oil supplemented group (Table 3). Concomitant to the present findings, the FCR varied non-significantly either due to Sodium Sulphate supplementation [2 and 4] or due to FO supplementation [24 and 19] in chicken broilers. Similarly, [12 and 21] concluded that fish oil supplementation in the diets of Japanese quails has no significant effect on FCR. However, [15 and 26] reported improved FCR in chicken broilers due to FO-supplemented diets. [28] also reported improvement in the FCR of chicken broilers due to Sodium Sulphate supplementation in the diet.

Performance indices

The data relating to performance index, protein efficiency, production number and energy efficiency is presented in Table5-8. Significant ($P<0.05$) differences were observed in the values of performance index, protein efficiency, production number and energy efficiency of broilers fed Sodium Sulphate with Fish Oil (T3) during all three phases as compared to the T1 group except during the finisher phase where protein efficiency and energy efficiency were comparable with T1 group. The performance indices of broilers were improved due to Sodium Sulphate with Fish Oil supplementation which is in agreement with [13] and it might be due to the nutritional values of fish oil. These values although, calculated indirectly but were in accordance with the facts that fish oil supplementation improves feed utilization, facilitates better nutrient absorption, and strengthens the immune system.

CONCLUSION

Thus, it can be concluded that a combination of Sodium Sulphate and Fish Oil has a positive effect on body weight, feed intake, feed conversion efficiency and performance indices of chicken broilers and can possibly replace fish meal in the diets of chicken broilers.

FUTURE SCOPE OF STUDY

By replacing fish meal with Sodium Sulphate and Fish Oil, better performances of chicken broilers can be attained, thus can be an economical substitute to fish meal.

ACKNOWLEDGEMENT

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DECLARATION OF CONFLICT OF INTEREST: The authors declare that there is no conflict of interest.

Table 1: Quantity of ingredients and chemical composition (% DM basis) of experimental diets (kg/100 kg feed)

Ingredients	Quantity											
	Pre-starter (0-1 weeks)				Starter (2-3 weeks)				Finisher (4-6 weeks)			
	T0	T1	T2	T3	T0	T1	T2	T3	T0	T1	T2	T3
Maize	55	54	54	54	55.2	55.2	54.65	54.65	58	58	57.35	57.35
Soyabean meal	23	20	26.15	26.15	23	19	23	23	13.7	10	13.5	13.5
Ground nut cake	18	14.5	15	15	16	12.8	16	16	20.3	17	20.8	20.8
Fish meal	-	7	-	-	-	7	-	-	-	7	-	-
Mineral mixture	2	2	2	2	2	2	2	2	2	2	2	2
Sodium Sulphate (99% Anhydrous)	-	-	0.35	0.35	-	-	0.35	0.35	-	-	0.35	0.35
Vegetable oil	2	2.5	2.5	-	3.8	4	4	-	6	6	6	-
Fish Oil	-	-	-	2.5	-	-	-	4	-	-	-	6
Chemical composition	Pre-starter				Starter				Finisher			
Crude Protein %	23.49	23.91	23.52	23.54	22.67	22.87	22.58	22.61	20.57	20.87	20.61	20.63
Ether Extract %	4.62	5.48	5.06	5.09	6.39	6.99	6.55	6.57	8.63	9.03	8.58	8.61
Crude Fibre %	3.39	3.08	3.23	3.25	3.24	2.95	3.24	3.23	3.31	3.01	3.32	3.30
Total Ash %	3.46	4.87	3.37	3.39	3.31	4.71	3.29	3.31	3.15	4.56	3.15	3.17
Metabolizable Energy (MJ/Kg)	12.30	12.35	12.34	12.34	12.79	12.80	12.78	12.79	13.54	13.50	13.47	13.49

Table 2: Effect of Sodium Sulphate and Fish Oil on mean body weight (g) of chicken broilers

Age (In days)	TREATMENT			
	T_0	T_1	T_2	T_3
0	47.64±0.43	47.51±0.59	47.51±0.57	47.64±0.52
7	113.62^{ab}±1.52	111.20^{a}±1.96	117.80^{b} ±2.05	117.91^{b}±1.79
14	261.93^{a}±4.02	286.77^{b}±4.90	329.24^{c}±4.80	335.64^{c}±4.12
21	603.55^{a} ±12.84	652.79^{a} ±12.58	719.51^{b} ±12.21	762.43^{b} ±11.97
28	944.62^{a}±22.61	1004.63^{a}±23.10	1134.93^{b}±22.38	1232.80^{b} ±19.63
35	1382.33^{a}±29.43	1550.90^{b}±28.82	1628.29^{b}±28.99	1787.29^{c}±27.86
42	1799.59^{a} ±33.08	1916.04^{ab}±33.60	1998.75^{b}±32.13	2212.43^{c}±33.76

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 3: Effect of Sodium Sulphate and Fish Oil on mean weekly feed intake (g/bird) of chicken broilers

Age (In days)	TREATMENTS			
	T_0	T_1	T_2	T_3
7	92.46^{c}±0.17	85.14^{a} ±0.06	91.35^{c} ±0.43	87.82^{b} ±0.58
14	211.64^{a}±0.41	258.03^{b} ±1.47	301.55^{d}±1.16	291.96^{c} ±1.83
21	619.71^{b} ±1.66	602.62^{a} ±1.45	623.65^{b} ±5.75	626.36^{b} ±2.96
28	625.29^{a} ±0.55	740.14^{b}±4.66	770.21^{c} ±3.11	806.44^{d} ±2.98
35	937.85^{b}±2.46	902.41^{a} ±2.06	1062.27^{c}±2.91	1058.88^{c}±5.06
42	1021.47^{d}±2.07	917.35^{b} ±2.89	847.34^{a} ±7.47	972.12^{c} ±6.13

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 4: Effect of Sodium Sulphate and Fish Oil on mean feed conversion ratio of chicken broilers

Age (In days)	TREATMENTS			
	T_0	T_1	T_2	T_3
7	1.43^{b}±0.03	1.40^{ab} ±0.04	1.36^{ab} ±0.05	1.28^{a} ±0.03
14	1.44±0.05	1.47 ±0.05	1.45±0.03	1.35±0.02
21	1.80^{b}±0.08	1.70^{ab}±0.11	1.65^{ab}±0.06	1.47^{a}±0.05
28	2.09±0.16	1.97±0.09	1.96±0.09	1.80±0.09
35	2.22±0.14	2.21±0.39	2.16±0.09	1.95±0.08
42	2.44±0.14	2.37±0.14	2.27±0.09	2.15±0.08

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 5: Effect of Sodium Sulphate and Fish Oil on mean phase wise performance index of chicken broilers

Phase	TREATMENTS			
	T_0	T_1	T_2	T_3
Prestarter	48.13^{a} ± 2.15	48.32^{a} ± 2.59	56.05^{b} ±2.89	57.59^{b} ± 2.69
Starter	283.69^{a} ± 17.04	332.40^{b} ± 17.28	397.42^{c} ±13.72	448.17^{d} ± 17.41
Finisher	529.73^{a} ± 32.77	604.61^{a} ± 40.76	606.22^{a} ± 26.95	735.46^{b} ± 29.26

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 6: Effect of Sodium Sulphate and Fish Oil on mean phase wise protein efficiency of chicken broilers

Phase	TREATMENTS			
	T_0	T_1	T_2	T_3
Prestarter	3.10^{a} ± 0.07	3.22^{a} ± 0.09	3.34^{ab} ±0.10	3.48^{b} ± 0.08
Starter	2.56^{a} ± 0.11	2.73^{ab} ± 0.11	2.96^{bc} ± 0.06	3.12^{c} ± 0.09
Finisher	2.16^{a} ± 0.10	2.30^{ab} ± 0.12	2.33^{ab} ± 0.07	2.50^{b} ± 0.07

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 7: Effect of Sodium Sulphate and Fish Oil on mean phase wise production number of chicken broilers

Phase	TREATMENTS			
	T_0	T_1	T_2	T_3
Prestarter	73.30^{ab} ± 2.86	69.02^{a} ± 3.70	80.07^{b} ± 4.13	82.28^{b} ± 3.84
Starter	196.02^{a} ± 11.79	226.89^{a} ± 11.79	283.87^{b} ±9.80	313.01^{b} ± 12.16
Finisher	241.05^{a} ± 14.91	286.95^{b} ± 19.00	285.90^{b} ± 12.20	358.03^{c} ± 13.63

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

Table 8: Effect of Sodium Sulphate and Fish Oil on mean phase wise energy efficiency of chicken broilers

Phase	TREATMENTS			
	T_0	T_1	T_2	T_3
Prestarter	$56.62^{a} \pm 1.28$	$58.79^{a} \pm 1.64$	$61.05^{ab} \pm 1.75$	$63.49^{b} \pm 1.50$
Starter	$43.26^{a} \pm 1.80$	$46.16^{ab} \pm 1.83$	$49.95^{bc} \pm 0.94$	$52.72^{c} \pm 1.50$
Finisher	$32.15^{a} \pm 1.51$	$34.28^{ab} \pm 1.74$	$34.67^{ab} \pm 1.07$	$37.18^{b} \pm 1.09$

Each value is a mean of three replicates (n=45).
Means bearing different superscripts differ significantly (P<0.05) row wise.

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