ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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International Journal of Poultry Science 7 (6): 560-564, 2008
ISSN 1682-8356

Effect of Finger Millet and Sorghum Replacing Corn in Presence of Soy Oil / Fish Oil and Enzymes on Performance of Broilers

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Abstract: A trial was conducted in commercial day old broiler chicks to study the effect of replacing corn with finger millet and sorghum and supplementation of soy oil / fish oil and Non-starch polysaccharide degrading enzymes to these diets. Basal diet was formulated using corn, soy bean meal and pea nut extraction. In the test diets, 50% of the corn was replaced with either finger millet or sorghum or equal parts of the both and then supplemented with soy oil / fish oil and enzyme mixture. Weekly body weight, feed intake, feed conversion ratio, livability were recorded. Body weight slightly improved in the test diets than the control. Compared to the soy oil, fish oil was better in improving body weight, feed efficiency and livability. Though supplementation of enzymes did not significantly improve body weight and feed efficiency, slight numerical improvement was noticed in fish oil supplemented groups.

Key words: Finger millet, sorghum, fish oil, soy oil, enzymes, broilers

Introduction

Poultry in India has reached an industry status and the sector is growing at 12.64% per year. In poultry rearing, 70% of the recurring expenditure accounts for feed alone. The major energy source ingredient used is corn and the constant increase in the price and non-availability of corn forces search for other course cereals as alternate energy sources which are available in plenty and cheaper, such as finger millet and sorghum. Several poultry feeding trials have shown that finger millet and sorghum can replace corn as energy source without altering the performance (Thakur *et al*., 1985; Rama Rao *et al*., 2002; Raju *et al*., 2003).

Supplementation of Broiler diets with small quantities of fats and oils is a long standing practice for improving the energy density of course cereals with low metabolizable energy and researchers have found that it improves body weight gain, feed intake and feed conversion ratio (Mehmet A. Azman *et al*., 2005). High level of non-starch polysaccharides in finger millet and sorghum adversely affect the performance of birds. Supplementation of non-starch polysaccharides degrading enzymes to diets containing course cereals have improved performance in broilers (Rama Rao *et al*., 2004). However, studies using enzymes and oils to enhance the nutritive value of finger millet and sorghum are scanty. The present study was conducted to study the effect of feeding finger millet and sorghum with soy oil / fish oil and enzymes on performance parameters of broilers.

Materials and Methods

Collection of feed ingredients, oils and enzymes preparation: Corn, Soybean meal, pea nut meal, finger millet and sorghum were procured from the local market. Soy oil and fish oil of feed grade were also procured from local market. The enzyme mixture containing Non-starch polysaccharide degrading enzymes (Anazyme®) was procured from Varsha Biotech[1].

Experimental diets: The basal starter diet (0 to 3 weeks) and finisher diet (4 to 6 weeks) was formulated using corn, soybean meal, peanut extraction, soy oil /fish oil to meet the nutrient requirement of commercial broilers (BIS, 1992, Tables 1 and 2) in diets 1, 5, 7 and 11. Finger millet and sorghum were used as test ingredients individually with 50% replacement of corn (diets 2,3,8 and 9) and combination of the two in equal parts replacing 50% of the corn (diets 4,6,10 and 12). Soy oil and fish oil (4.25%) were supplemented to diets 1 to 6 and 7 to 12 respectively. Enzyme mixture at 0.05% level was included in the basal diets 5 and 11 and test diets 6 and 12 (Table 3).

Birds and management: 480 commercial day old broiler chicks (Vencobb[2]) of both the sex were used. The day old chicks were wing banded, weighed individually and assigned to 12 treatment groups with 2 replicates in each group and 20 chicks in each replicate. Each replicate group of 20 chicks were housed in an independent pen of 6' x 6' dimension in an open sided deep litter house.

Chicks of all the groups were reared under uniform standard condition thought the study. Brooding was done till 3 weeks of age using incandescent bulbs. Continuous light was provided through out the study.

Table 1: Per cent ingredient composition of broiler starter diet

Ingredients	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
Corn	55.50	27.50	27.50	27.50	55.50	27.50	55.50	27.50	27.50	27.50	55.50	27.50
Soy bean meal	29.50	29.00	31.50	32.50	29.50	31.00	29.50	28.50	31.50	32.00	29.50	32.50
Peanut Extraction	9.00	9.50	7.50	6.50	9.00	7.60	9.00	10.50	7.50	6.50	9.00	6.50
Finger millet		27.50		13.87		13.87		27.50		13.87		13.87
Sorghum			27.50	13.87		13.87			27.50	13.87		13.87
Soy Oil	3.00	3.00	3.00	3.00	3.00	3.00						
Fish Oil							3.00	3.00	3.00	3.00	3.00	3.00
Mineral premix[1]	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin – D3[2]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Vitamin - AB2D32K[2]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin- B complex[2]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Anacox[3]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Furazolidone pure[4]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Anazyme[5]	-	-	-	-	0.05	0.05	-	-	-	-	0.05	0.05
ME (kcal/kg)	3125	3001	3045	3029	3125	3029	3125	3001	3045	3029	3125	3020
CP	20.47	20.36	20.30	20.16	20.42	20.16	20.47	20.36	20.30	20.16	20.47	20.61
Ca	0.97	1.06	0.98	1.02	0.97	1.02	0.97	1.06	0.98	1.02	0.97	1.02
P	0.40	0.45	0.41	0.43	0.40	0.43	0.40	0.45	0.41	0.43	0.40	0.43
Lysine	1.01	1.02	1.05	1.02	1.01	1.05	1.01	1.02	1.05	1.02	1.01	1.06
Methionine	0.46	0.50	0.46	0.48	0.46	0.48	0.46	0.50	0.46	0.48	0.46	0.48

[1]Mineral Premix, contained in addition to calcium and phosphorus, 3 mg of iodine, 2 mg of cobalt, 78 mg of zinc, 13 mg of copper, 130 mg of iron, 2 mg of selenium and 96 mg of manganese.

[2]Vitamin Premix (vitamin-D_3, vitamin-AB2D3K, Vitamin-B-complex) provided per kg of diet 8000 IU of Vit.A, 18mg of Vit.E, 1000 IU of Vit.D_3, 1mg of Vit. K, 10mg of Vit.B_1, 8mg of Vit. B_2, 16mg of B_{12}, 1500mg of choline chloride, 44mg of Niacin, 0.25mg of Biotin, 18mg of Pantothenic Acid.

[3]Anacox a coccidiostat product from Ranbaxy India Limited, New Delhi,India, was added at 50g per 100kg of feed.

[4]Furazolidone pure was added to the diet at 0.01 kg per 100 kg of the diet.

[5]Anazyme: A proprietary product of M/s Varsha Biotech Pvt. Ltd., West of Chord Road, Bangalore, India, was added at 50g per 100kg of diet.

Table 2: Per cent ingredient composition of broiler finisher diet

Ingredients	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}
Corn	58.75	29.37	29.37	29.37	58.75	29.37	58.75	29.37	29.37	29.37	58.75	29.37
Soy bean meal	24.00	24.25	28.50	26.25	24.00	28.00	24.00	24.25	28.50	26.25	24.00	27.50
Peanut Extraction	10.00	9.25	5.00	6.75	10.00	5.00	10.00	9.00	5.00	6.75	10.00	6.75
Finger millet		29.37		14.68		14.68		29.37		14.68		14.68
Sorghum			29.37	14.68		14.68			29.37	14.68		14.68
Soy oil	4.25	4.25	4.25	4.25	4.25	4.25						
Fish Oil							4.25	4.25	4.25	4.25	4.25	4.25
Mineral Premix[1]	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Vitamin – D3[2]	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Vitamin - AB2D3K[2]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin- B complex[2]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Anacox[3]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Furazolidone pure[4]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Anazyme[5]	-	-	-	-	0.05	0.05	-	-	-	-	0.05	0.05
ME (kcal/kg)	3130	3110	3099	3075	3103	3096	3075	3102	3084	3086	3126	3096
CP	19.17	19.18	19.55	19.44	19.75	19.61	19.35	19.83	19.62	19.35	19.67	19.73
Ca	1.23	1.26	1.22	1.19	1.22	1.18	1.15	1.23	1.18	1.15	1.26	1.21
P	0.46	0.49	0.47	0.51	0.43	0.44	0.45	0.46	0.45	0.49	0.44	0.45
Lysine	1.02	1.04	1.11	1.08	1.04	1.09	1.06	1.04	1.05	1.03	1.02	1.04
Methionine	0.48	0.49	0.61	0.63	0.49	0.48	0.47	0.52	0.53	0.54	0.51	0.52

[1]Mineral Premix, contained in addition to calcium and phosphorus, 3mg of iodine, 2mg of cobalt, 78mg of zinc, 13mg of copper, 130mg of iron, 2mg of selenium and 96mg of manganese.

[2]Vitamin Premix (vitamin-D_3, vitamin-AB2D3K, Vitamin-B-complex) provided per kg of diet 8000 IU of Vit.A, 18mg of Vit. E, 1000 IU of Vit.D_3, 1mg of Vit. K, 10mg of Vit.B_1, 8mg of Vit.B_2, 16 mg of B_{12}, 1500 mg of choline chloride, 44mg of Niacin, 0.25mg of Biotin, 18mg of Pantothenic Acid.

[3]Anacox a coccidiostat product from Ranbaxy India Limited, New Delhi, India was added at 50g per 100kg of feed.

[4]Furazolidone pure was added to the diet at 0.01 kg per 100 kg of the diet.

[5]Anazyme: A proprietary product of M/s Varsha Biotech Pvt. Ltd., West of Chord Road, Bangalore, India, was added at 50g per 100kg of diet.

Broiler starter diet was fed up to first 3 weeks of age followed by broiler finisher diet till 6th week of age of the trial. Chicks were vaccinated for New castle disease with lasota strain on 7th day and for infectious bursal disease on 18th day with intermediate plus strain. The experiment was conducted for a duration of 42 days.

Traits measured: Body weights and feed intake was

Table 3 : Percent proximate composition of broiler starter and finisher diets (% DM)

Type of Oil	Enzyme	%Substitution level of cereal CN	FM	SG	Diet	DM I	DM II	CP I	CP II	CF I	CF II	EE I	EE II	TA I	TA II	NFE I	NFE II
Soy Oil	Nil	100	-	-	T1	91.3	91.3	21.3	19.5	2.8	2.9	5.23	6.7	7.6	8.0	65.9	62.8
		50	50	-	T2	91.5	91.6	21.1	19.4	3.1	3.0	5.27	6.6	7.5	8.0	66.1	63.0
		50	-	50	T3	91.6	91.4	21.1	19.2	3.1	3.2	5.65	6.5	7.4	8.3	66.8	62.7
		50	25	25	T4	91.6	91.2	20.8	19.1	3.1	3.4	5.12	6.6	8.2	9.7	66.6	61.2
	0.05%	100	-	-	T5	90.9	91.6	21.2	20.0	3.1	3.1	5.24	6.7	7.3	7.9	66.1	62.2
		50	25	25	T6	91.6	91.8	21.0	20.1	3.1	3.0	5.57	6.6	7.8	7.5	66.4	61.8
Fish Oil	Nil	100	-	-	T7	91.8	91.9	20.9	20.2	3.3	3.2	5.21	6.7	8.2	7.3	66.4	62.6
		50	50	-	T8	90.8	91.6	21.1	19.8	3.3	3.2	5.13	6.6	8.6	8.4	64.9	61.9
		50	-	50	T9	91.3	91.9	20.9	19.8	3.3	3.2	5.48	6.5	7.9	8.6	66.4	61.9
		50	25	25	T10	91.5	90.9	20.8	19.9	3.4	3.3	5.29	6.6	7.6	8.9	66.9	61.3
	0.05%	100	-	-	T11	91.2	91.8	21.1	19.2	2.9	2.8	5.53	6.7	8.2	7.9	65.2	63.4
		50	25	25	T12	91.1	91.8	21.0	19.6	3.2	2.9	5.68	6.6	8.3	7.5	65.9	63.4

CN-Corn; FM-Finger millet; SG-Sorghum; DM-Dry matter; CP-Crude protein; CF-Crude fiber; EE-Ether extract; TA-Total ash; NFE-Nitrogen free extract; I-Starter diet; II-Finisher diet.

Table 4: Performance of broilers fed different experimental diets

Type of Oil	Enzyme	% Substitution level of cereal CN	FM	SG	Diets	Body weight(g)	Cumulative feed intake (g)	FCR	Livability (%)	Net returns (Rs.)
Soy Oil	Nil	100	-	-	T_1	1736.28^{b}±149.03	3286.00^{d}±13.86	1.89^{c}±0.01	92.5^{d}±0.00	15.48^{d}±0.01
		50	50	-	T_2	1774.78^{ab}±170.70	3527.50^{c}±16.74	1.99^{a}±0.02	95^{b}±1.06	14.35^{e}±0.04
		50	-	50	T_3	1819.58^{ab}±187.07	3373.50^{d}±12.12	1.85^{ef}±0.01	95^{b}±0.70	16.38^{b}±0.01
		50	25	25	T_4	1780.68^{ab}±166.46	3309.00^{ef}±9.24	1.86^{de}±0.02	100^{a}±0.00	15.32^{c}±0.01
	0.05%	100	-	-	T_5	1893.98^{a}±191.27	3564.00^{b}±25.40	1.88^{cd}±0.01	95^{b}±0.70	16.10^{b}±0.01
		50	25	25	T_6	1848.13^{ab}±208.73	3672.00^{a}±13.86	1.99^{a}±0.02	100^{a}±0.00	14.56^{e}±0.01
Oil as main factor pooled						1808.90^{NS}±178.88	3455.33^{a}±15.20	1.91^{a}±0.02	96.25^{a}±0.41	15.37^{b}±0.01
Fish Oil	Nil	100	-	-	T_1	1855.65^{ab}±183.78	3199.50^{g}±16.74	1.72^{h}±0.01	97.5^{bc}±1.41	18.10^{a}±0.01
		50	50	-	T_2	1840.53^{ab}±200.39	3367.00^{d}±18.48	1.83^{fg}±0.01	100^{a}±0.00	18.47^{a}±0.01
		50	-	50	T_3	1829.03^{ab}±183.56	3307.00^{ef}±9.24	1.81^{g}±0.01	100^{a}±0.00	18.51^{a}±0.01
		50	25	25	T_4	1871.55^{ab}±229.47	3613.00^{b}±27.71	1.93^{b}±0.02	97.5^{bc}±1.41	16.81^{b}±0.01
	0.05%	100	-	-	T_5	1801.33^{ab}±200.44	3356.50^{de}±2.89	1.86^{de}±0.01	100^{a}±0.00	15.75^{c}±0.01
		50	25	25	T_6	1836.08^{ab}±189.64	3142.50^{h}±6.36	1.71^{h}±0.01	100^{a}±0.00	19.36^{a}±0.01
Oil as main factor pooled						1839.03^{NS}±197.88	3330.92^{b}±13.57	1.81^{b}±0.01	99.16^{a}±0.47	17.83^{a}±0.02

CN-Corn; FM-Finger millet; SG-Sorghum; Note: Means within a column bearing different superscripts are statistically different ($P \leq 0.05$)

recorded replicate wise at weekly intervals. The efficiency of feed conversion ratio (FCR) was calculated based on feed intake per unit body weight gain. Mortality in different groups was recorded. The net economic returns was worked out based on the average saleable body weight and the total cost incurred.

Chemical and statistical analysis: The proximate compositions of the ingredients were determined by the method of AOAC, 1995. Weekly body weight, feed intake and FCR were calculated and subjected to a completely randomized design using GLM procedure of SAS software (SAS institute, 1990) and the treatment means were compared as per student tukey test.

Results

Body weight: The mean body weight at the end of 6 weeks in different treatment groups was numerically higher than that in the control group and among the different treatment groups, corn fed group supplemented with soy oil and enzyme mixture showed highest body weight of 1893 gm as against the control group with 1736 gm body weight. Among the two oil sources i.e., soy oil and fish oil the pooled mean body weights in fish oil fed groups was slightly higher (1839g) than that of the soy oil fed groups (1808g) (Table 4).

Feed intake: The mean cumulative feed intake at the end of sixth week was calculated and was significantly ($P<0.05$) lowest in the group with 50% corn replacement with equal parts of finger millet and sorghum supplemented with fish oil and enzymes (3142g) and that in control group was (3286). Highest mean cumulative feed intake (3272g) was recorded in group fed diet with replacement of corn with both finger millet and sorghum, supplemented with soy oil and enzyme mixture. Between the two different oils used, the pooled mean cumulative feed intake was significantly ($P<0.05$) lower in fish oil fed groups (3331g) as compared to soy oil fed groups (3455g).

Feed conversion ratio: The mean FCR at the end of the sixth week was significantly ($P<0.05$) lowest in corn fed group supplemented with fish oil (1.72) and in group fed

diet with 50% replacement of corn with 25% each of finger millet and sorghum supplemented with fish oil and enzyme mixture (1.71). Between the two oil sources, the pooled FCR values of fish oil supplemented group was significantly (P<0.05) lower (1.81) than that of soy oil supplemented group (1.91).

Livability (%): The livability percentage at the end of sixth week was significantly (P<0.05) lowest in the control group (92.5%). Pooled mean livability percentage was significantly (P<0.05) higher in fish oil fed group (99.16%) as compared to the soy oil fed group (96.25%).

Net returns: The net returns was significantly (P<0.05) highest in the group fed diet 50% replacement of corn with finger millet and sorghum (Rs.19.36). Significantly higher returns was recorded in fish oil supplemented groups compared to the soy oil supplemented groups. The pooled net returns of soy oil supplemented groups was significantly lower than the control group.

Discussion

Body weight: The highest body weight observed in the corn fed group supplemented with soy oil is in conformity with the results recorded earlier (Abate and Gomez, 1984; Yeong and syed Ali, 1976; Rama Rao *et al.*, 2002). Slightly higher body weight in fish oil fed group than the soy oil fed groups could be attributed to the improved absorption of fat soluble vitamins, decreased rate of passage of feed through gastro intestinal tract allowing better absorption of all nutrients in the diet (Rand *et al.*, 1958; Dam *et al.*, 1959; Summers and Leeson, 1979) and the same results have been reported earlier (Scaife *et al.*, 1994; Barbour *et al.*, 2006; Vieira *et al.*, 2006). As reported earlier (Rama Rao *et al.*, 2001; Abate and Gomez, 1984; Asha Rajani *et al.*, 1986; Travis *et al.*, 2006), replacement of corn with finger millet and sorghum either singly or in combination did not reduce the body weight significantly. Enzyme supplementation to finger millet and sorghum fed diets did not show any significant increase in body weight than corn based diet (Kantharaja *et al.*, 1995; Elangovan *et al.*, 2004), however its effect in the previous trails does not appear to be consistent.

Feed intake: Higher cumulative feed intake in pooled soy oil fed groups than the fish oil fed groups may be due to lower palatability of fish oil. Increased feed intake in finger millet and sorghum fed groups is in comparison with the results reported earlier (Raju *et al.*, 2003; Rama Rao *et al.*, 2004; 2005; Elangovan *et al.*, 2005). Influence of enzyme supplementation on feed intake in finger millet and sorghum fed groups however is not consistent (Raju *et al.*, 2003; Kantharaja *et al.*, 1995).

Feed conversion ratio: Lowered FCR in fish oil fed groups than the soy oil group may possibly be due to less feed intake in the former and the present study results are in accordance with Newman *et al.*, 2002. Better FCR in sorghum fed groups was also reported earlier (Hulan and Proudfoot 1982; Asha Rajani *et al.*, 1986). Enzyme supplementation improved FCR in finger millet and sorghum fed group supplemented with fish oil, whereas other groups did not show any beneficial effect. How ever these results when compared to the earlier reports (Kantharaja *et al.*, 1995, Rama Rao *et al.*, 2004) are inconclusive.

Livability: Improved livability in fish oil fed groups than the soy oil fed groups may be due to better immune response (Korver *et al.*, 1998).

Slightly better net returns in fish oil supplemented groups than soy oil supplemented groups could be attributed to increased body weight gain, less feed consumption and improved FCR in the former.

Conclusion: In conclusion, 50% replacement of corn with either finger millet or sorghum or both did not impair body weight and FCR when compared to the corn based diet. Among the oils used, fish oil proved to be better in improving body weight, FCR and net returns than the soy oil supplementation. Application and beneficial effects of Non-starch polysaccharide degrading enzyme supplementation to finger millet and sorghum based diets need to be further confirmed and validated.

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