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Performance and Economic Feasibility of Using Soybean Oil, Palm Oil and Fish Oil in Broiler Diet

Research Article

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ABSTRACT

Six hundred day old unsexed broiler chicks were used in a 35-day trial to compare the effects of soybean oil, palm oil and fish oil supplementation on the performance of broilers in terms of feed intake, weight gain and feed conversion. The chicks were randomly distributed following a completely randomized design in four groups having three replications per treatment. Each treatment had 150 birds with 50 birds per replicate. Four diets were formulated using locally available ingredients as diet without oil, diet containing 3.0% soybean oil, 3.0% palm oil and 3.0% fish oil. Results indicated that supplementation of different types of oil did not affect (P>0.05) feed intake of broilers up to 2nd week except increased (P<0.05) at 3rd, 4th and 5th weeks. Live weight gain of broilers did not differ (P>0.05) among groups up to 3rd week of age except at 4th week. The highest live weight gain at 4th week was found in 3.0% fish oil supplemented group. The palm oil group showed the least feed conversion value that differed only from fish oil group. Feed cost per broiler receiving fish oil was higher than that of without oil, palm oil and soybean oil groups. Total cost per broiler also differed (P<0.01) among the groups. Net profit expressed in US$ per kg live weight of broilers did not differ (P>0.05) between treatments. Maximum net profit was obtained from birds fed diet containing palm oil and minimum from broilers fed diet containing soybean oil. It was concluded that supplementation of fish oil at 3.0% level gave slightly higher live weight gain and feed conversion than those of the same level of soybean and palm oil. However, net profit as well as price per kg live broiler was comparatively higher in palm oil supplementation than in soybean oil and fish oil.

KEY WORDS broiler, feed conversion, feed intake, fish oil, palm oil, soybean oil, weight gain.

INTRODUCTION

Oils have always been used as source of energy in the diets for broilers. There are a number of other advantages for incorporating oils in poultry diets including, increase in palatability, absorption and digestion of lipoproteins and decrease in dustiness. Oils also help in absorption of vitamin A, vitamin E and Ca (Leeson and Atteh, 1995). There are a number of vegetable sources that may be used to meet the requirements of broilers. However, satisfying the nutritional requirements of broilers with least cost ration is a difficult task. This is due to scarcity and high cost of cereal grains and soybean oil. Meeting the energy needs of broilers represents a very substantial part for optimizing cost of feeding (Oyedeji and Atteh, 2003). Due to high cost and scarcity of feed ingredients poultry farmers occasionally and haphazardly mix ingredients together without due to the consideration for net cost of the formulated diets. There are several kinds of soybean oil, palm oil and fish oil that are being used in broiler diets in Bangladesh. However, no systematic reports are available on the effects of these oilson performance broilers. Therefore, the present experiment

was conducted to examine the effect of supplementing soybean oil, palm oil and fish oil in the broiler diets on productive performance as well as comparison in economic benefits of rearing broilers.

MATERIALS AND METHODS

Birds and housing

Six hundred day old, unsexed, commercial broiler chicks were purchased from the chicken hatchery for the study purpose.

A bamboo house was constructed for rearing broiler. The house was covered with corrugated sheet. One and half feet of the sidewall from floor was made of bamboo and the remaining portion was made of wire net to facilitate proper ventilation. The floor of the house was made of bamboo splits on which fresh dry rice husk was used as litter material at a depth of 4.5 cm. Old litter materials were removed from the pen and new litter was replaced twice a week. The floor of the house was divided by wire net into 12 compartments to maintain desired replication. A floor space of 929.0 square cm was allocated per bird. Arrangement for rearing broilers was made according to treatments and replications.

The compartments were selected in an unbiased way according to treatments and replications for uniform distribution of chicks. The compartments were enclosed with chick guard. Birds were brooded under single-tired electric brooder at 95 $^{\circ}$F, 90 $^{\circ}$F, 85 $^{\circ}$F and 80 $^{\circ}$F for the 1st, 2nd, 3rd and 4th week, respectively. The broilers were exposed to continuous lighting. Room temperature and humidity was maintained using 200 watt incandescent lamps and exhaust fans.

Year and season

The study was carried out in Chittagong, Bangladesh. The area has a latitude of 22 $^{\circ}$21'N, longitude 91 $^{\circ}$49'E and elevation 29 m (95 ft). The area is fairly hot at 25.1 $^{\circ}$C. Mean monthly temperature has a variation of 9 $^{\circ}$C. The variation of daily average temperature is 8.8 $^{\circ}$C. The hottest month is May having a mean temperature of 28 $^{\circ}$C. The coolest month is January which has a mean temperature of 19 $^{\circ}$C. The average annual relative humidity is 73.7% and average monthly relative humidity ranges from 58% in January to 86% in August. Chittagong has an average of 2735 mm of rainfall per year. On average, there are 135 days per year with more than 0.1 mm of rainfall. The driest month is in January when an average of 6 mm of rainfall is found. The wettest month is in July when there occurs an average of 598 mm of rainfall. The longest day of the year is 13:22 hour long and the shortest day is 10:37 hour long. The current study was carried out during August to October in 2012.

Diets

Experimental diets were of dry mash type. The diets were prepared by hand mixing method. All ingredients were purchased from a local market. Major ingredients were thoroughly mixed at first. Then micro-ingredients were mixed. Birds had unrestricted access to feed and water by plastic hanging feeder and bell type drinker. All diets were prepared with maize, rice polish, soybean oil, soybean meal, protein concentrate and other trace nutrients (Table 1). Four rations designated as T_0, T_1, T_2 and T_3 were formulated using locally available feed ingredients where T_1, T_2 and T_3 diet contained 3.0% soybean oil, 3.0% palm oil, 3.0% fish oil and T_0 was a without oil group. These rations were supplied to four groups of birds randomly. Detailed proportion of the feed ingredients in different rations is given in Table 1. Nutrient density in the experimental diet was maintained according to Singh (1980). Formulated diets were analyzed as per AOAC (1980). The starter diet was fed for the first two weeks and the finisher diet was fed for the remaining periods.

Medication

The slated floor and cages were cleaned and disinfected properly with phenyl solution. The room was fumigated overnight using potassium permanganate and formaldehyde. Feeders and drinkers were thoroughly cleaned and disinfected with phenyl solution and dried and left for 3 days before the arrival of the chicks.

Foot bath containing potassium permanganate was placed in front of the shed. The birds were vaccinated against New castle and Gumboro disease on the 4th and 10th day followed by a booster dose on 20th and 25th day. No outbreak of infectious diseases was found throughout the whole experimental period.

Design of experiment

The experiment was carried out following completely randomized design (Gomez and Gomez, 1984). Total six hundred birds were weighed and randomly divided into three treatment groups. Each treatment was divided into three replicates. Each group had one hundred fifty birds having fifty birds per replicate.

Statistical analysis

All birds from all groups were weighed weekly for weight gain, feed intake and feed conversion. Data related to weight gain, feed intake and feed conversion were compiled by using Microsoft Excel 2007 and analyzed for ANOVA by using Stata (2009) and SPSS (2007). Means showing significant differences were compared by Duncan's new multiple range test (Duncan, 1955). Statistical significance was accepted at $P<0.05$.

Table 1 Composition of diets

Feed ingredient[1]	Dietary treatments							
	T_0		T_1		T_2		T_3	
	Starter	Finisher	Starter	Finisher	Starter	Finisher	Starter	Finisher
Maize	57.30	60.03	54.30	57.03	59.00	62.00	54.30	57.03
Rice polish	7.36	7.36	7.36	7.36	3.36	3.11	7.36	7.36
Soybean oil	-	-	3.00	3.00	-	-	-	-
Palm oil	-	-	-	-	3.00	3.00	-	-
Fish oil	-	-	-	-	-	-	3.00	3.00
Soybean meal	30.80	28.00	30.80	28.00	28.50	26.50	30.80	28.00
Protein concentrate[2]	2.20	2.00	2.20	2.00	4.00	3.25	2.20	2.00
Lime stone[3]	1.10	1.37	1.10	1.37	0.90	0.90	1.10	1.37
Dicalcium phosphate[4]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
L-Lysine	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
DL-Methionine	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Vitamin A (mIU/100 kg)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Vitamin D_3 (mIU/100 kg)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vitamin E (g/100 kg)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Vitamin K_3 (g/100 kg)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vitamin B_1 (g/100 kg)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vitamin B_2 (g)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vitamin B_6 (g/100 kg)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Vitamin B_{12} (g/100 kg)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Niacin (g/100 kg)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Folic acid (g/100 kg)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Biotin (g/100 kg)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Iron (g/100 kg)	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
Zinc (g/100 kg)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Manganese (g)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Copper (g/100 kg)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Iodine (g/100 kg)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Selenium (g/100 kg)	0.075	0.075	0.075	0.075	0.075	0.075	0.075	0.075
Antioxidant	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Coccidiostat	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Calculated values								
ME (kcal/kg)	2856	2887	3022	3052	3025	3050	3021	3051
DM (%)	89.9	89.9	89.9	89.9	89.9	89.9	89.9	89.9
CP (%)	21.3	20.2	21.1	20	21.1	20	21.1	20
EE (%)	3.5	4	6.4	6.9	6.1	6.5	6.4	6.9
CF (%)	3.2	3.5	3.2	3.5	3.3	3.5	3.2	3.5
Ca (%)	0.8	0.9	0.8	0.9	0.8	0.8	0.8	0.9
P (%)	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.6

[1] Unit: % or otherwise stated.
[2] DM: 92.5%; ME: 2900 kcal/kg DM; CP: 60.0%; CF: 3.0%; EE: 13.0%; ash: 24.0%; Ca: 6.5%; P: 2.5%; lysine: 7.0% and methionine: 2.0%.
[3] DM: 98.9%; Ca: 35.8% and P: 0.02%.
[4] DM: 98.0%; Ca: 24.3% and P: 18.2%.
T_0: diet without oil; T_1: diet containing 3.0 % soybean oil; T_2: diet containing 3.0 % palm oil and T_3: diet containing 3.0 % fish oil.
DM: dry matter; ME: metabolizable energy; CP: crude protein; EE: ether extracts and CF: crude fibre.

RESULTS AND DISCUSSION

Feed intake

The average weekly feed intake (g/broiler) of broilers fed diets supplemented with different types of oil is presented in Table 2. No significant differences were found among the different dietary oils up to 2 weeks of age. However, significant (P<0.05) differences were evident at 3, 4 and 5 weeks of ages. Supplementation of different types of oil did not have an effect on feed intake of broilers except for fish oil where feed intake of broilers increased (P<0.05) at 3, 4 and 5 weeks of age. Among the groups of broilers fed oil supplemented diets, supplementation of fish oil caused higher (P<0.01) feed intake than those on other oils. The cumulative feed intake of broilers fed on diets supplemented with different types of oil is presented in Table 2. Cumulative feed intake of broilers on different dietary oils varied (P<0.05) during 4 and 5 weeks of age. Among the dietary oils, broilers fed on supplemented diets; fish oil consumed higher amount of feed during the experimental period, which differed (P<0.05) from the without oil and other oil receiving.

Higher feed intake by the broilers receiving fish oil supplemented diet compared to that on other oils indicated that fish meal had positive impact on the palatability of the diet. Saleh *et al.* (2009) reported that the inclusion of 1.5% of fish oil in poultry diet increased feed intake which is in agreement with present findings.

The present study result contrasts with the findings of Hulan *et al.* (1988) and Chekani-Azar *et al.* (2010) who observed that fish oil containing diets to broilers caused lower feed intake. Some studies reported that daily feed intake decreased in broiler fed diet containing high PUFA (Atteh *et al.* 1983; Sklan and Ayal, 1989; Huang *et al.* 1990). The effect does not appear to be consistent (Skrivan *et al.* 2000). Higher digestibility of the fat component of PUFA rich diet could be explained as a cause of lower feed intake by broilers (Carino *et al.* 1980; Brue and Latshaw, 1985), involving a higher dietary content of metabolizable energy and thus less feed needed to meet the energy requirement.

Live weight gain

The response of supplementation of diets with different types of oil at 3.0% level on the live weight gain of broilers at different ages is presented in Table 3. As in the case of live weight gain of broilers stated above no significant (P>0.05) difference was found among treatment groups up to 3 weeks of age of the broilers. However, significant (P<0.01) difference was observed only at 4 weeks of old.

The highest live weight gain at 4 weeks of age was found in 3.0% fish oil and it differed (P<0.05) from groups of broilers receiving without oil, soybean oil and palm oil containing diets. At the age of 5 weeks the broilers of different groups did not differ significantly (P>0.05) in terms of live weight gain. Lack of significant effect of supplementing different sources of oil with the diets of broilers on their live weight gain in the present study is in agreement with the findings of Tuncer *et al.* (1987), Liarn and Yang (1992) and Abas *et al.* (2004). These scientists reported that different fat sources vegetable oil and animal fat source and their different levels in poultry diet did not affect live weight gain of chicken. The only significant effect was observed in this study at 4 week of the age of broilers where only fish oil resulted in significantly higher live weight gain. Where as other two sources (soybean and palm oil) did not differ with the without oil group.

It can also be mentioned here that although fish oil gave higher value than other oils, at 5 weeks of age, it gave lower value compared to other two sources of oil. However, there are conflicting reports on the effect of oil in live weight gain of broilers. But Navidshad (2009) observed that the live weight gain broilers decreased (P<0.05) by consuming diet containing fish oil. These results contrasts the findings of other authors who reported an increased daily weight gain compared to the group without oil by adding fish oil to the base diet (Dobrzanski *et al.* 2002; Safamehr *et al.* 2008; Chekani-Azar *et al.* 2010).

Table 2 Feed intake (g/broiler) of broiler at different ages fed on diets supplemented with 3.0% soybean, 3.0% palm oil and 3.0% fish oil

Age (weeks)	Dietary treatments[1]				SEM	Significant
	T_0	T_1	T_2	T_3		
1st	123.02	124.48	114.63	118.92	3.96	NS
2nd	379.75	387.20	380.42	391.93	6.83	NS
3rd	649.58^{b}	650.38^{b}	642.82^{b}	748.78^{a}	11.85	*
4th	865.36^{b}	871.46^{b}	836.94^{b}	972.0^{a}	16.44	**
5th	970.6^{b}	978.75^{b}	958.91^{b}	1153.5^{a}	25.23	**
Cumulative feed intake						
1st to 4th	2017.71^{ab}	2035.51^{ab}	1974.82^{b}	2131.63^{a}	24.60	*
1st to 5th	2988.31^{b}	3012.27^{b}	2933.72^{b}	3285.39^{a}	59.58	*

[1] T_0: diet without oil; T_1: diet containing 3.0% soybean oil; T_2: diet containing 3.0% palm oil and T_3: diet containing 3.0% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
NS: non significant and SEM: standard error of means.
* (P<0.05) and ** (P<0.01).

Table 3 Live weight gain (g/broiler) of broilers at different ages fed on diets supplemented with 3.0% soybean, 3.0% palm oil and 3.0% fish oil

Age (weeks)	Dietary treatments[1]				SEM	Significant
	T_0	T_1	T_2	T_3		
1st	95.0	92.64	93.71	87.56	4.15	NS
2nd	198.6	210.14	201.85	199.09	7.12	NS
3rd	289.42	308.81	293.3	322.77	9.83	NS
4th	385.2^{b}	403.63^{b}	404.34^{b}	492.3^{a}	14.55	**
5th	419.33	439.98	446.43	423.35	20.65	NS
1st to 4th	968.23^{b}	1015.5^{ab}	993.2^{ab}	1101.72^{a}	24.17	*
1st to 5th	1387.56^{b}	1455.21^{ab}	1439.64^{ab}	1525.07^{a}	19.02	**

[1] T_0: diet without oil; T_1: diet containing 3.0% soybean oil; T_2: diet containing 3.0% palm oil and T_3: diet containing 3.0% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
NS: non significant and SEM: standard error of means.
* (P<0.05) and ** (P<0.01).

The cumulative live weight gain of broilers fed diets with different types of oils are presented in Table 3. At 4 and 5 weeks of age there were significant (P<0.05, P<0.01) differences in cumulative live weight gain of broilers. Throughout the experimental period, supplementation of oil of different types resulted in higher cumulative live weight gain of broilers except that of the broilers of without oil group.

Within the supplemented groups of broilers, higher cumulative live weight gains were observed in 3.0% fish oil group of broilers in comparison with without oil group. Unlike live weight gain, cumulative live weight gain in the supplemented groups of broiler was significantly higher than that of without oil group. This result is in agreement with Barbour *et al.* (2006). They found improved (P<0.05) cumulative weight gain in birds fed diets with soybean oil at different levels. Cumulative weight gain was also improved (P<0.05) through the addition of soybean oil at 20 or 30 g/kg (Barbour *et al.* 2006).

Feed conversion

The weekly feed conversion at different ages of broilers fed diets supplemented with different types of oil at 3.0% level is presented in Table 4. The analysis of data revealed no significant difference among treatment groups of broilers up to 4 weeks of age, but it increased in fish oil group (P<0.05) as compared to without oil and other treated groups. The palm oil group showed the least feed conversion value that differed only from fish oil group. It seems from the results of the present experiment that sources of oil did not have significant effect on feed conversion of broilers up to market age. The result are in agreement with Chekani-Azar *et al.* (2010) who reported better feed conversion in broilers fed a diet with fish oil compared to another without fish oil. This result contrasts the findings of the present study and Hulan's *et al.* (1988) results. Navidshad (2009) reported that dietary fish oil level did not affect daily feed intake and feed conversion. Abas *et al.* (2004) also concluded that different fat sources and their level of inclusion in the diets did not affect the feed conversion of broilers. Pesti *et al.* (2002) observed no significant differences in feed conversion due to different fat sources. However, Pinchasov and Nir (1992) and Zollitsch *et al.* (1997) have reported an improved feed conversion in broilers when dietary PUFA intake increased. In contrast, Al-Athari and WaUS$ins (1988) found no difference in feed conversion of broilers fed with diets containing 5% added saturated fat or soybean oil. Saleh *et al.* (2009) reported that feed conversion improved when diet contained 1.5% fish oil but significant reduction in feed intake, body weight and body weight gain were observed with the highest level of fish oil supplementation (6%). Newman *et al.* (1998), Lopez-Ferrer *et al.* (2001) and Farhoomand and Checani-azer (2009) have reported that the digestibility of fat increases as the degree of un-saturation increases. Therefore, the good performance of fish oil fed broilers may be related to the fatty acid composition of the of fish oil. The cumulative feed conversion of broilers fed diets treated with different types of oils is presented in Table 4. The analysis of data on cumulative feed conversion revealed no significant (P>0.05) differences among the treatment groups at 4 and 5 weeks of age.

Cost benefit analysis

The data on cost of this experiment are presented in Table 5. It was observed that feed cost did not differ (P>0.05) among the treatments. Feed cost/broiler receiving soybean oil was slightly higher than that of without oil, palm oil and soybean oil groups, respectively. Total cost per broiler was also similar (P>0.05) among the treatments. In terms of profit, net profit expressed in US dollar per kg LW of broilers did not differ (P>0.05).

However, maximum net profit was obtained from birds fed a diet containing palm oil and minimum net profit was obtained from broilers fed a diet containing soybean oil. Addition of different oil at 3.0% level in diets of broilers increased feed costs in all the treatment groups compared to that of the without oil.

Table 4 feed conversions of broilers fed on diets supplemented with 3.0% soybean, 3.0% palm oil and 3.0% fish oil

Age Weeks	Dietary treatments[1]				SEM	Significant
	T_0	T_1	T_2	T_3		
1st	1.32	1.38	1.22	1.36	0.02	NS
2nd	1.92	1.84	1.89	1.67	0.04	NS
3rd	2.25	2.11	2.20	2.32	0.06	NS
4th	2.25	2.18	2.05	1.99	0.05	NS
5th	2.32^b	2.23^b	2.11^b	2.74^a	0.08	*
1st to 4th	2.09	2.00	1.99	1.94	0.02	NS
1st to 5th	2.15	2.07	2.03	2.15	0.04	NS

[1] T_0: diet without oil; T_1: diet containing 3.0% soybean oil; T_2: diet containing 3.0% palm oil; T_3: diet containing 3.0% fish oil.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
NS: non significant and SEM: standard error of means.
* (P<0.05).

Table 5 Cost of production and returns of broilers receiving diets supplemented with 3.0% soybean, 3.0% palm oil and 3.0% fish oil

Parameter	Dietary treatments[1]				SEM	Significant
	T_o	T_1	T_2	T_3		
Chick cost (US$/chick)	0.51	0.51	0.51	0.00	0.51	NS
Cost of oil (US$/kg)	-	1.15	0.83	0.90	-	NS
Feed cost (US$/kg)	0.26	0.29	0.28	0.28	0.26	NS
Feed cost (US$/broiler)	0.78	0.88	0.83	0.93	0.78	NS
Miscellaneous cost (US$/broiler)	0.15	0.15	0.15	0.15	0.15	NS
Total cost (US$/broiler)	1.45	1.54	1.49	1.60	1.45	NS
Total cost (US$/kg broiler)	1.02	1.03	1.01	1.02	1.02	NS
Total sale price (US$/kg broiler)	1.15	1.15	1.15	1.15	1.15	NS
Sale (US$/broiler)	1.65	1.73	1.71	1.80	1.65	NS
Net profit (US$/broiler)	0.20	0.18	0.21	0.21	0.20	NS
Net profit (US$/kg live broiler)	0.14	0.12	0.14	0.13	0.14	NS

[1]T_0: diet without oil; T_1: diet containing 3.0% soybean oil; T_2: diet containing 3.0% palm oil and T_3: diet containing 3.0% fish oil.
NS: non significant and SEM: standard error of means.
US$: United States Dollar.

This is justified as because, the price of oil was high and that were used in all the supplemented diets. The variation in feed cost among the supplemented groups was for the differences in the price of different types of oil. Total cost of production of broiler did not differ significantly for supplementation of different oils. Among the oil supplemented groups, palm oil group seems to incur slightly to lower costs.

Among the treatment groups, feed costs per kg broilers differed significantly indicating that higher costs were observed in the different oils supplemented compared to that without oils, which is obviously related to higher costs of oil. However, when the supplemented oil groups were compared it was found that the fish oil supplementation (3% oil) gave the highest feed cost in comparison with other costs for a higher intake of feed. Increasing feed intake was related to the increasing sensitivity of adult chicks to fishy smell in the supplemented diet with fish oil (Tuncer *et al.* 1987; Zollitsch *et al.* 1997; Pike, 1999; Sanz *et al.* 2000; Abas *et al.* 2004).

Broilers were sold at US$ 1.15 per kg of live weight and fish oil group gave rise to the highest price and was closest to the soybean and palm oil dietary group. This was due to their highest live weight. But the highest net profit was observed in palm oil treatment group compared to other treatments and it was closed to without oils and fish oil treatment. The lowest net profit was reached in the soybean oil treatment. This might be for high price of soybean oil compared to palm and fish oil.

CONCLUSION

It may be concluded that supplementation of fish oil at 3.0% level gave slightly higher live weight gain and feed conversion ratio than those of the same level of soybean and palm oil. However, net profits was similar with soybean, palm and fish oil supplementation.

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