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Effects of the Ratio of Dietary Fish Meal to Soybean Meal on the Performance of Broiler Chicks

Nwe Nwe Htin[1*], May Phyo Chit[2]

[1]Faculty of Agro Based Industry, Universiti Malaysia Kelantan, Kelantan, Malaysia
[2]Livestock, Feedstuff and Milk Products Enterprise, Yangon, Myanmar

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⌧*Corresponding author:
Dr. Nwe Nwe Htin,
Faculty of Agro Based Industry,
Universiti Malaysia Kelantan,
Kelantan, Malaysia.
Email: nwe.htin@umk.edu.my

Abstract

A completely randomized design (CRD) was used with a total of 160 day-old commercial broiler chicks which were randomly assigned to four treatment groups with five replicates into 20 pens and brooded. Feed and water were provided *ad libitum*. From day old chick to 21 day, the broiler chicks were fed Diet 1 (5% fish meal and 25% soybean meal, 1: 5), Diet 2 (3% fish meal and 30% soybean meal, 1: 10) was served as control diet, Diet 3 (2% fish meal and 30% soybean meal, 1: 15) and Diet 4 (1.5% fish meal and 30% soybean meal, 1: 20). From day 22 onwards, the broiler chicks were fed finisher diet, Diet 1 (5% fish meal and 25% soybean meal, 1: 5), Diet 2 (2.6% fish meal and 26% soybean meal, 1: 10, serve as control diet, Diet 3 (1.8% fish meal and 27% soybean meal, 1: 15) and Diet 4 (1.3% fish meal and 26% soybean meal, 1: 20). Weekly performances and mortality are measured. By feeding FS5 diet (5% fish meal and 25% soybean meal), the heavier body weight, increased feed consumption and feed conversion ratio of broiler chicks was observed when compared to that of other treatment groups. Conclusively, it is obvious that the ratio of dietary fish meal to soybean meal 1: 5 (FS5) improved body weight but the lower feed efficiency of this diet should be considered in economical point of view.

1. Introduction

The general aims of feeding in poultry production should be, firstly, to supply the nutrients for an economic level of animal production and, secondly, to control animal production in a way, which would beneficial to the enterprise, to animal welfare and to the consumer. In all situations a sufficient description of the properties and qualities of the feed should be an essential requirement [1].

Among the protein concentrates, the vegetable protein meals produced from soybeans, cottonseeds, peanuts, etc. were the second-largest portion of the formula [2]. It was indicated that soybean meal is by far the most important protein used in poultry feeding today [3]. When processed properly at the right temperature, however, soybean oil meal is palatable and serves as an excellent plant - protein supplement and, in addition, is relatively economical in price [4]. Soybean oil meal is produced by removing the oil from soybeans by a solvent extraction process [3]. Soybean oil meal varies in protein content depending upon the method of manufacture. The protein is very high of quality, and may be used to furnish a major part of the protein concentrate in rations for most livestock [5]. The protein in soybeans is improved by the heating process used in the manufacture of soybean oil meal. Therefore, the quality of protein found in heat-processed soybean meal is higher than that in the raw soybeans [6]. Raw soybeans are unpalatable and are not recommended as a poultry feedstuff [4].

In addition, a critical cost appraisal of poultry feed formulae shows protein, especially protein of animal origin, to be the most expensive per unit cost [7]. Animal protein sources almost always gave better results when fed to livestock and poultry [8]. Fish meal is a well-known source of true protein with high biological value in the nutrition of monogastric animals. Except for highly essential amino acid content, this feedstuff also has a good balance of unsaturated fatty acids, high content of certain minerals (available phosphorus) and vitamins (A, D, B-complex). However, there are a number of unfavorable characteristics, which present limiting factors in fish meal usage. Firstly, there is a permanent danger of transmission of alimentary disease causative gents, such as *Salmonella* species [9]. It is also well known fact that fish meal, as a protein-rich feedstuff, is very sensitive to storage conditions. In the event of inadequate storage conditions degradation processes of protein can appear, followed by emergence of biogenic amines such as histamine. High levels of histamine in feed can cause

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gizzard erosion in chickens, which in turn influence on the performance of broiler chicks [9].

It was also reported that broiler chicks fed diets containing soybean meal as the sole dietary protein concentrate consistently showed poor growth in a number of feeding trials [10]. On the contrary, Arafa et al. [11] compared the effect of feeding diets containing all-vegetable protein versus mixture of vegetable and animal protein sources on the performance and carcass characteristics of broiler chicks. They found that live body weight, feed consumption and feed conversion ratio of chicks fed on vegetable protein diets such as soybean meal (containing 38.65 percent SBM), corn gluten meal and/or sunflower seed meal were not significantly different from those of the control fish meal. In view of these factors, it is of interest to study the effects of the ratio of dietary fish meal to soybean meal on the performance of broiler chicks.

2. Materials and Methods

A total of 160 day-old broiler chicks provided by Livestock, Feedstuff and Milk Products Enterprise (LFME) were used in this study. A completely randomized design (CRD) was used in this experiment. Upon arrival, the chicks were individually wing-banded, weighed and randomly assigned to four treatment groups with five replicates into 20 pens. Each replicate was included 8 chicks. Feeding period was started from 1 day of age until day 49. The diets were formulated to maintain a constant ratio of energy and protein to meet the minimum requirement of [12]. Ration formulas for dietary treatments is described in Table 1 and 2. The processed soybean meal used in this experiment was purchased from local market, Yezin.

Upon arrival, the initial body weights of all broiler chicks were measured (at day 0). Body weights were measured individually on days 7, 14, 21, 28, 35, 42 and 49. Average body weight of chick for each treatment was calculated and recorded. Mortality rate was also recorded. The daily feed consumptions were recorded and the average feed consumption per bird per day was calculated. Feed conversion ratios were calculated on weekly basis. The data were analyzed according to ANOVA using general linear model (GLM) procedure of SAS® [13]. The significant differences among treatments were determined at P<0.05 by Duncan's Multiple Range Test (DMRT).

Table 1: Diet 1 (1:5) and Diet 2 (1:10).

Ingredients	Diet 1 (1:5)		Diet 2 (1:10)	
	Starter ration	*Grower ration*	*Starter ration*	*Grower ration*
Maize	54.53	62.03	56.5	62.50
Fish meal	5.00	5.00	3.00	2.60
Soybean meal	25.00	25.00	30.00	26.00
Groundnut meal	7.00	1.00	4.03	2.43
Rice bran	2.00	1.00	1.00	1.00
Broken rice	2.00	1.50	1.00	1.00
Oyster shell	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Lysine	0.20	0.20	0.20	0.20
60% choline chloride	0.25	0.25	0.25	0.25
Vitamin and minerals[1]	0.20	0.20	0.20	0.20
Soybean oil	3.00	3.00	3.00	3.00
D.C.P	0.50	0.50	0.50	0.50
Antioxidant	0.02	0.02	0.02	0.02
Total	*100*	*100*	*100*	*100*
Calculated analysis				
ME (kcal/kg)	3053	3109.2	3033.5	3095.1
Crude Protein (%)	21.6	19.2	21.4	19.1
Calcium (%)	0.9	0.8	0.8	0.8
ME/CP	141.3	162.1	141.6	162.2

[1]Supplied mgkg^{-1}; vitamin A 150,000 IU, vitamin D 300,00 IU, vitamin E 500 mg, vitamin B_2 400 mg, vitamin K_3 100 mg, vitamin B_{12} 1,800 meg, choline chloride 50 g, dl-methionine 10 g, l-lysine 10 g, Ca-d-Pantothenate 800 mg, manganese 5 g, iron 5 g, zinc 3 g, magnesium 1 g, iodine 100 mg, copper 80 mg, cobalt 10 mg.

Table 2: Diet 3 (1:15) and Diet 4 (1:20).

Ingredients	Diet 1 (1:15)		Diet 2 (1:20)	
	Starter ration	*Grower ration*	*Starter ration*	*Grower ration*
Maize	55.53	62.00	56.03	62.00
Fish meal	2.00	1.80	1.50	1.30
Soybean meal	30.00	27.00	30.00	26.00
Groundnut meal	5.00	2.20	5.5	3.73
Rice bran	1.00	1.00	1.00	1.00
Broken rice	2.00	1.53	1.50	1.50
Oyster shell	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Lysine	0.20	0.20	0.20	0.20
60% choline chloride	0.25	0.25	0.25	0.25
Vitamin and minerals[1]	0.20	0.20	0.20	0.20
Soybean oil	3.00	3.00	3.00	3.00
D.C.P	0.50	0.50	0.50	0.50
Antioxidant	0.02	0.02	0.02	0.02
Total	*100*	*100*	*100*	*100*
Calculated analysis				
ME (kcal/kg)	3025	3087.1	3024.8	3087.1
Crude Protein (%)	21.4	19.0	21.4	19.0
Calcium (%)	0.8	0.7	0.7	0.7
ME/CP	141.5	162.1	141.6	162.1

[1]Supplied mgkg^{-1}; vitamin A 150,000 IU, vitamin D 300,00 IU, vitamin E 500 mg, vitamin B_2 400 mg, vitamin K_3 100 mg, vitamin B_{12} 1,800 meg, choline chloride 50 g, dl-methionine 10 g, l-lysine 10 g, Ca-d-Pantothenate 800 mg, manganese 5 g, iron 5 g, zinc 3 g, magnesium 1 g, iodine 100 mg, copper 80 mg, cobalt 10 mg.

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3. Results

3.1. Body weight

3.1.1. Body weight (on day 49)

The effect of diets on body weight of broiler chicks on day 49 is indicated in Table 3. The broiler chicks fed FS5 had the heaviest body weight and FS20 had the lowest body weight. The final body weight of broilers fed FS5 was significantly higher (*P*<0.05) than that of groups fed FS15 and FS20 but did not differ significantly (*P*>0.05) from that of group fed FS10. The final body weight of broilers fed FS10 did not differ significantly (*P*>0.05) from that of group fed FS15 but was significantly higher (*P*<0.05) than that of group fed FS20. The final body weight of broilers fed FS15 did not differ significantly (*P*>0.05) from that of group fed FS20.

Table 3: Body weight of broiler chicks by diet[1] on day 49.

Diet	Final body weight (Mean ± SEM)
FS5	1197.02 ± 24.44^{a}
FS10	1139.50 ± 27.08^{ab}
FS15	1076.16 ± 39.98^{bc}
FS20	1041.20 ± 21.78^{c}

[a-c]Means within a column with no common superscripts differ at *P*<0.05.

[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

3.1.2. Weekly body weight

The effect of the ratio of dietary fish meal to soybean meal on weekly body weight of broiler chicks is indicated in Table 4. On day 7, the body weights of broiler chicks fed FS5, FS10, FS15 and FS20 did not differ significantly (*P*>0.05). On day 14, the body weight of broilers fed FS5 was the highest and that of broilers fed FS20 was the lowest. The body weight of broiler chicks fed FS5 did not differ significantly (*P*>0.05) from that of groups fed FS10 and FS15 but was significantly higher (*P*<0.05) than that of group fed FS20. The body weights of broilers fed FS10 and FS15 did not differ significantly (*P*>0.05). The body weight of broilers fed FS20 did not differ significantly (*P*>0.05) from that of groups fed FS10 and FS15.

Table 4: Effects of the ratio of dietary fish meal to soybean meal on weekly average body weight (g/bird) of broiler chicks.

Day	Weekly average body weight (Mean ± SEM)			
	Diet[1]			
	FS5	*FS10*	*FS15*	*FS20*
7	74.12 ± 1.49^{gx}	76.20 ± 1.30^{gx}	71.80 ± 1.48^{gx}	75.88 ± 1.41^{gx}
14	149.06 ± 3.37^{fx}	146.76 ± 3.56^{fxy}	143.88 ± 3.79^{fxy}	137.50 ± 3.44^{fy}
21	264.96 ± 6.17^{ex}	248.30 ± 6.64^{exy}	228.02 ± 9.62^{ey}	243.94 ± 5.71^{exy}
28	426.06 ± 12.80^{dx}	409.04 ± 7.87^{dxy}	380.68 ± 12.54^{dy}	376.42 ± 9.28^{dy}
35	622.80 ± 19.42^{cx}	636.86 ± 13.94^{cx}	592.62 ± 19.75^{cxy}	541.38 ± 19.33^{cy}
42	898.14 ± 38.93^{bx}	906.72 ± 18.86^{bx}	855.30 ± 33.74^{bx}	823.04 ± 24.72^{bx}
49	1197.02 ± 24.44^{ax}	1139.50 ± 27.08^{axy}	1076.16 ± 39.98^{ayz}	1041.20 ± 21.78^{az}

[a-f]Means within a column with no common superscripts differ at *P*<0.05.
[x-z]Means within a row with no common superscripts differ at *P*<0.05.
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

On day 21, the body weight of broilers fed FS5 was the highest and that of broilers fed FS15 was the lowest. The body weight of broiler chicks fed FS5 did not differ significantly (*P*>0.05) than that of groups fed FS10 and FS20 but was significantly higher (*P*<0.05) than that of group fed FS15. The body weights of broiler chicks fed FS10 and FS20 did not differ significantly (*P*>0.05). The body weight of broilers fed FS15 did not differ significantly (*P*>0.05) from that of groups fed FS10 and FS20.

On day 28, the body weight of broilers fed FS5 was significantly higher (*P*<0.05) than that of groups fed FS15 and FS20 but did not differ significantly (*P*>0.05) than that of group fed FS10. The body weights of broilers fed FS15 and FS20 did not differ significantly (*P*>0.05). The body weight of broilers fed FS10 did not differ significantly (*P*>0.05) from that of groups fed FS15 and FS20.

On day 35, the body weights of broilers fed FS5 and FS10 were significantly higher (*P*<0.05) than that of group fed FS20 but did not differ significantly (*P*>0.05) from that of group fed FS15. The body weights of broilers fed FS5 and FS10 did not differ significantly (*P*>0.05). The body weight of broilers fed FS20 did not differ significantly (*P*>0.05) from that of group fed FS15. On day 42, the body weights of broilers fed FS5, FS10, FS15 and FS20 did not differ significantly (*P*>0.05).

On day 49, the body weight of broilers fed FS5 was the highest and that of broilers fed FS20 was the lowest. The body weight of broilers fed FS5 was significantly higher (*P*<0.05) than that of groups fed FS15 and FS20 but did not differ significantly (*P*>0.05) than that of group fed FS10. The body weight of broilers fed FS10 did not differ significantly (*P*>0.05) from that of group fed FS15 but was significantly higher (*P*<0.05) than that of group fed FS20. The body weight of broilers

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fed FS15 did not differ significantly (P>0.05) from that of group fed FS20.

3.2. Feed consumption

3.2.1. Cumulative feed consumption

The effect of diets on cumulative feed consumption of broiler chicks is indicated in Table 5. The cumulative feed consumption of broilers fed FS5 was the highest than that of other treatment groups. The cumulative feed consumption of broilers fed FS5 was significantly higher (P<0.05) than that of groups fed FS10, FS15 and FS20. The cumulative feed consumption of broilers fed FS10 was significantly higher (P<0.05) than that of groups fed FS15 and FS20. The cumulative feed consumptions of broilers fed FS15 and FS20 did not differ significantly (P>0.05).

Table 5: Cumulative feed consumptions of broiler chicks by diet[1] (day 0 to day 49).

Diet	Cumulative feed consumption (Mean ± SEM)
FS5	2592.32 ± 48.01^{a}
FS10	2317.79 ± 47.05^{b}
FS15	2129.13 ± 76.01^{c}
FS20	2035.48 ± 36.30^{c}

$^{a-c}$Means within a column with no common superscripts differ at P<0.05.
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

3.2.2. Weekly feed consumption

The effect of the ratio of dietary fish meal to soybean meal on weekly feed consumption of broiler chicks is indicated in Table 6. On weeks 1, 4 and 6, the feed consumptions of broilers fed FS5, FS10, FS15 and FS20 did not differ significantly (P>0.05). On week 2, the feed consumption of broilers fed FS5 did not differ significantly (P>0.05) from that of groups fed FS10 and FS15 but was significantly higher (P<0.05) than that of group fed FS20. The feed consumptions of broilers fed FS10, FS15 and FS20 did not differ significantly (P>0.05).

On week 3, the feed consumption of broilers fed FS5 did not differ significantly (P>0.05) from that of groups fed FS10 and FS20 but was significantly higher (P<0.05) than that of group fed FS15. The feed consumptions of broilers fed FS10, FS15 and FS20 did not differ significantly (P>0.05). On week 5, the feed consumptions of broilers fed FS5, FS10 and FS15 did not differ significantly (P>0.05) but were significantly higher (P<0.05) than that of group fed FS20.

On week 7, the feed consumption of broilers fed FS5 was the highest than that of other treatment groups. The feed consumption of broilers fed FS5 was significantly higher (P<0.05) than that of other treatment groups. The feed consumption of broilers fed FS10 was significantly higher (P<0.05) than that of groups fed FS15 and FS20. The feed consumptions of broilers fed FS15 and FS20 did not differ significantly (P>0.05).

Table 6: Effects of the ratio of dietary fish meal to soybean meal on weekly feed consumption (g/bird/week) of broiler chicks.

Week	Weekly feed consumption (Mean ± SEM) Diet[1]			
	FS5	*FS10*	*FS15*	*FS20*
1	67.90 ± 2.84^{fx}	68.75 ± 1.36^{fx}	67.18 ± 2.00^{ex}	73.20 ± 1.29^{ex}
2	149.02± 9.22^{ex}	129.16 ± 6.12^{exy}	130.43 ± 7.01^{dexy}	116.37 ± 4.89^{ey}
3	200.64 ± 12.67^{ex}	175.75 ± 12.60^{exy}	146.43 ± 14.34^{dy}	182.89 ± 11.47^{dxy}
4	295.61 ± 28.63^{dx}	289.77 ± 13.96^{dx}	266.21 ± 17.59^{cx}	242.5 ± 18.53^{cx}
5	406.75 ± 20.01^{cx}	443.61 ± 31.57^{cx}	431.82 ± 9.49^{bx}	315.34 ± 18.07^{by}
6	609.11 ± 44.89^{bx}	565.96 ± 29.14^{bx}	548.98 ± 40.57^{ax}	576.71 ± 19.97^{ax}
7	863.29 ± 36.81^{ax}	644.79 ± 10.77^{ay}	538.06 ± 37.70^{az}	528.47 ± 27.51^{az}

$^{a-f}$Means within a column with no common superscripts differ at P<0.05.
$^{x-z}$Means within a row with no common superscripts differ at P<0.05.
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

3.3. Feed conversion ratio

3.3.1. Cumulative feed conversion ratio (F.C.R.$_{1500}$)

Cumulative feed conversion ratio of broiler chicks by different diets at 49 day is indicated in Table 7. The cumulative feed conversion ratios of broilers fed FS10, FS15 and FS20 did not differ significantly (P>0.05) but were significantly narrower (P<0.05) than that of group fed FS5.

Table 7: Cumulative feed conversion ratio of broiler chicks by diet[1] (F.C.R.$_{1500}$).

Diet	Cumulative feed conversion ratio (Mean ± SEM)
FS5	2.29 ± 0.03^{a}
FS10	2.18 ± 0.03^{b}
FS15	2.15 ± 0.04^{b}
FS20	2.14 ± 0.02^{b}

$^{a-b}$Means within a column with no common superscripts differ at P<0.05.
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

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3.3.2. Weekly feed conversion ratio

The effect of the ratio of dietary fish meal to soybean meal on weekly feed conversion ratio of broiler chicks is indicated in Table 8. On week 1, the feed conversion ratio of broilers fed FS10 did not differ significantly (P>0.05) from that of groups fed FS5 and FS20 but was significantly narrower (P<0.05) than that of group fed FS15. The feed conversion ratios of broilers fed FS5, FS15 and FS20 did not differ significantly (P>0.05). On weeks 2, 3, 4 and 5, the feed conversion ratios of broilers fed FS5, FS10, FS15 and FS20 did not differ significantly (P>0.05).

On week 6, the feed conversion ratio of broilers fed FS20 did not differ significantly (P>0.05) from that of groups fed FS10 and FS15 but was significantly narrower (P<0.05) than that of group fed FS5. The feed conversion ratios of broilers fed FS5, FS10 and FS15 did not differ significantly (P>0.05).

On week 7, the feed conversion ratios of broilers fed FS15 and FS20 did not differ significantly (P>0.05) but were significantly narrower (P<0.05) than that of groups fed FS5 and FS10. The feed conversion ratios of broilers fed FS5 and FS10 did not differ significantly (P>0.05).

Table 8: Effects of the ratio of dietary fish meal to soybean meal on weekly feed conversion ratio of broiler chicks.

Week	Weekly feed conversion ratio (Mean ± SEM)			
	Diet[1]			
	FS5	*FS10*	*FS15*	*FS20*
1	2.05 ± 0.06^{bcxy}	1.92 ± 0.04^{bcy}	2.17 ± 0.06^{bx}	2.07 ± 0.08^{bxy}
2	1.99 ± 0.10^{cx}	1.84 ± 0.07^{cx}	1.81 ± 0.01^{cx}	1.90 ± 0.05^{cx}
3	1.73 ± 0.02^{dx}	1.74 ± 0.08^{cx}	1.74 ± 0.05^{cx}	1.72 ± 0.05^{dx}
4	1.85 ± 0.04^{cdx}	1.80 ± 0.03^{cx}	1.75 ± 0.04^{cx}	1.84 ± 0.03^{cdx}
5	2.08 ± 0.06^{bx}	1.94 ± 0.03^{bcx}	2.05 ± 0.08^{bx}	1.92 ± 0.04^{bcx}
6	2.22 ± 0.06^{bx}	2.10 ± 0.04^{bxy}	2.09 ± 0.06^{bxy}	2.05 ± 0.03^{by}
7	2.91 ± 0.12^{ax}	2.79 ± 0.12^{ax}	2.43 ± 0.07^{ay}	2.42 ± 0.05^{ay}

$^{a-d}$Means within a column with no common superscripts differ at P<0.05.
$^{x-y}$Means within a row with no common superscripts differ at P<0.05.
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

3.4. Mortality

The mortality data were subjected to Chi-square Test. The mortality rates among all treatments did not differ significantly. It is indicated in Table 9.

Table 9: Effect of diet on mortality of broiler chicks.

Outcome	Diet[1]				Total
	FS5	*FS10*	*FS15*	*FS20*	
Dead	1	2	2	1	6
Live	39	38	38	39	154
Total	40	40	40	40	160

x^2=0.70; Table value for 3 df at 5% level=7.81 (ns, P>0.05)
[1]FS5 = Fish meal to soybean meal ratio (1:5)
FS10 = Fish meal to soybean meal ratio (1:10)
FS15 = Fish meal to soybean meal ratio (1:15)
FS20 = Fish meal to soybean meal ratio (1:20)

4. Discussion

On day 21, the broiler chicks fed FS5 showed the heaviest body weight and that of broilers fed FS15 was the lowest body weight. These data indicated that inclusion of fish meal to soybean meal ratio (1: 5) had no adverse effect on body weight, but higher inclusion ratios of soybean meal (1: 10, 1: 15, 1: 20) decreased body weight of broiler chickens during the starting period. Uni et al. [14] reported that the traditional corn-soybean meal broiler starter diets are considered highly digestible, they may contain a variety of complex proteins, but that may not be easily digested by the young chick due to the lack of the necessary intake enzymes at early stage of life. The depressed performance observed for broiler chicks fed diet including Kunitz trypsin inhibitor (Kti) and raw soybean meal, non-steamed, or steam-pelleted with and without DL-methionine supplementation suggest that younger birds are more susceptible to the effects of soybean trypsin inhibitor [15].

From day 22 to day 49, no significant body weights of broiler chicks fed FS5 and FS10 (control) did not differ significantly. But, the body weight of broiler chicks fed FS15 and FS20 had lower body weight than that of those fed FS5. Furthermore, the body weights of broiler chicks fed FS10 (control) and FS15 did not differ significantly. The body weight of broiler chicks fed FS15 did not differ from that of those fed FS20. It was indicated that the ratio of fish meal to soybean meal 1: 15 (FS15) and 1: 20 (FS20) significantly lowered the body weight of broiler chicks.

Decrease in body weight of the broiler chicks with higher inclusion ratios of soybean meal is probably due to better amino acids profile of fish meal in compare to soybean meal. Protein biological value, methionine, lysine and arginine content, digestibility and bioavailability of fish meal are higher than soybean meal [12]. Takahashi et al. [16] also corresponded that animal protein sources contain higher concentration in protein with a good amino acids balance and in available phosphorus compared to soybean meal, a typical plant protein source. Jull [4] also reported that fish meal is apparently a complete source of amino acids. Then, fish meal is an excellent source of minerals, calcium and phosphorus are especially abundant (3-6% and 1.5-3%) and one of the richest sources of vitamin B_{12} [17]. Saxena et al. [18] reported that unavailability of amino acids has been considered a major factor in explaining the poor growth of chicks fed diets containing raw soybean meal. Shinn [19] also suggested that over-heating of soybean meal during the processing at soybean crushing plant would destroy some key amino acids necessary to attain normal growth and production of animals. Heat processing of protein sources may change L-amino acids to form of D-amino acids which may decrease its digestibility and amino acid availability [20].

Several research workers have come to the conclusion that some feedstuffs such as fish meal contain an unidentified growth factor. This factor improves the palatability of these feedstuffs which, when fed to broilers, results in an improvement in growth [21] [22]. In this experiment, it was noticed that broiler chicks fed fish meal to soybean meal ratio 1: 5 (fish meal 5% and soybean meal 25%) showed significantly heaviest body weight and the lowest body weight was observed with broiler chicks fed FS20. It was in accordance with the reports of Shinn [19] that the inclusion rate of soybean meal is estimated at 20-24% in broiler feeds.

The reduced growth obtained when birds were fed the higher level of soybean meal agrees with the results of Irish and Balnave [10]. Irish and Balnave [10] found that growth of broiler chickens was consistently lower in a number of trials when soybean meal was the sole source of supplemental protein in sorghum-wheat based diets. Further research indicated that the water-soluble xylose content of the soybean meal influenced the growth of the broilers and that multi-enzyme preparations designed to act on the non-starch polysaccharide fraction of the meals did not improve growth [23]. It was noticed that (FS5) 5% of fish meal in broiler ration improved the body weight than those of other treatment groups such as FS10 (2.6%), FS15 (1.8%) and FS20 (1.3%). This finding is compatible with previous finding [24]. This author reported that the beneficial effect of fishmeal on broiler performance becomes most evident at higher use levels and during the latter growth periods, mainly via stimulation of feed intake.

In this experiment, the chicks were fed starter ration up to 3 weeks of age. The broiler chicks fed FS5 (fish meal, 5% and soybean meal, 25%) showed the highest amount of feed consumption than that of the other treatment groups. Karimi [24] demonstrated that broiler average daily feed intake was increasingly (P<0.05) improved by increasing fish meal level inclusion to the diets during the starting period.

After 7 week of age, the broiler chicks fed FS5 showed the highest feed consumption among all treatment groups. The results of the present study indicated that different ratios of fish meal to soybean meal significantly affected feed intake of broiler chicks. Jackson et al. [25] reported that essential amino acid imbalances in diet decreases biological value of the diet and hence decrease feed intake. Poor quality and lower palatability of soybean meal in compare to fish meal might be other reasons of lower feed intake by the broiler chickens. It was noticed that feed consumption decreased with the higher inclusion ratios of soybean meal in broiler diet (1: 15 and 1: 20). This finding is compatible with previous finding [26]. The author reported that feed intakes also decreased as the level of soybean in the diet increased. The documentary report [27] indicated that this reduction in growth as the dietary soybean levels increase was due to the higher bulk density of these diets, which caused a reduction in feed intakes.

It was evident that (FS5) 5% of fish meal in broiler ration improved the feed consumption than those of other treatment groups such as FS10 (fish meal 2.6%), FS15 (fish meal 1.8%) and FS20 (fish meal 1.3%). Karimi [24] also reported that throughout the experimental period (0-42 day), the average chicks daily gain and feed intake were significantly (P<0.05) improved by fish meal supplementation to the diets. Moreover, this author also concluded that the beneficial effects of fish meal on broiler performance become most evident at higher inclusion level and during the mid-points of the growing period, mainly via stimulation of feed intake rather than improvement in feed conversion ratio of diets.

From 7 to 21 days of age, the feed conversion ratio of broilers fed FS5, FS10, FS15 and FS20 were 1.73, 1.74, 1.74 and 1.72, respectively and did not differ significantly. During the finishing period of the trial (from day 22 to 49), the feed conversion ratios of broilers fed FS15 and FS20 did not differ significantly (P>0.05) but were significantly narrower (P<0.05) than that of groups fed FS5 and FS10. The feed conversion ratios of broilers fed FS5 and FS10 did not differ significantly (P>0.05). The results of the present study showed that different ratios of fish meal to soybean meal had significant effect on feed conversion ratio.

It was noticed that higher inclusion amount of fish meal (FS5, fish meal 5%) showed the highest value of feed conversion ratio at 49 day of age. Opstvedt et al. [28] demonstrated that the inclusion of fish meal improved feed conversion by about 4%, but had no consistent effect on growth. These authors also indicated that the inclusion of 5% fish meal, replacing soybean meal on an iso-nitrogenous basis, but with a consequent increase in energy from the low to the high level, improved feed conversion by an average of 6.8% in the

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presence and 4.6% in the absence of rapeseed meal. Solangi et al. [29] reported that fish meal is one of the best ingredients for broilers, as it enhances the feed consumption and feed efficiency. In this study, although FS5 diet improved body weight, the wider FCR than that of the others need to be considered in economical point of view.

In the present study, most of the mortality occurred in the first two weeks of age (0-14 day). Mortality rate in the present trial for FS5, FS10, FS15 and FS20 groups were 2.5%, 5%, 5% and 2.5%, respectively and it did not differ significantly.

5. Conclusion

Conclusively, it is obvious that the ratio of dietary fish meal to soybean meal 1: 5 (FS5) improved body weight but the lower feed efficiency of this diet should be considered in economical point of view.

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