



Comparative Study of Rapeseed Meal and Fermented Rapeseed Meal Replacing Soybean Meal in Diet on Growth Performance, Nutrient Digestibility and Economics in Broiler Chicken

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ABSTRACT

Background: The escalating costs of soybean meal (SBM), coupled with environmental and socioeconomic considerations, necessitate exploration into alternative protein sources. Due to consistent increase in feed cost of SBM it was the need of hour to explore the alternatives for SBM. The present experiment was designed to evaluate the comparative study of rapeseed meal (RSM) and fermented rapeseed meal (FRSM) replacing soybean meal in diet on performance of broilers.

Methods: Four hundred twenty, day old Vencobb-430Y straight run broiler chicks were randomly distributed into seven treatment groups with four replicates in each having fifteen chicks. The seven treatments were control group (T1), basal diet with 5% RSM (T2), basal diet with 10% RSM (T3), basal diet with 15% RSM (T4), basal diet with 5% FRSM (T5), basal diet with 10% FRSM (T6), basal diet with 15% FRSM (T7).

Result: The live body weight and cumulative weight gain at the end of 6th week significantly ($P < 0.01$) decreased in T4 (15% RSM) and T7 (15% FRSM) as compared to control group T1. At 6th week, significantly ($P < 0.01$) better cumulative feed conversion ratio was recorded in groups T1, T2, T3, T5 and T6 as compared to groups T4 and T7. There were non-significant differences for dry matter digestibility (%), nitrogen retention (%), ether extract digestibility (%) and crude fibre digestibility (%) in all groups. The highest net profit per kg live body weight was observed in treatment group T5 followed by groups T6, T3, T2, T1, T7 and T4. Thus, it was concluded that the inclusion of RSM and FRSM up to 10% level with replacing soybean meal do not have any adverse effect on growth performance, nutrient digestibility and improved economics of broiler production. Moreover, the inclusion of 5% FRSM with replacing soybean meal in diet has more economically profitable without affecting production performance in broilers.

Key words: Broiler, Economics, Fermented rapeseed meal, Growth performance, Nutrient digestibility, Rapeseed meal.

INTRODUCTION

Poultry industry faces continual challenges in meeting the increasing demand for high-quality animal protein while addressing concerns related to sustainability and feed costs. The escalating costs of SBM, coupled with environmental and socioeconomic considerations, necessitate exploration into alternative protein sources. Rapeseed meal (RSM), an oil-byproduct of high yield, is a cheaper alternative source of plant protein (crude protein, 35-42%) for poultry diets compared with SBM (Zhu *et al.*, 2019). Rapeseed meal emerges as a potential source for partially or completely replacing soybean meal in broiler diets due to its abundance and protein content. RSM has a well-balanced amino acid composition, contains more choline, biotin and folic acid than soybean meal (Korelesky and Jerzy, 1993). The use of RSM in monogastric animal nutrition is mainly limited by the presence of glucosinolates (GLS) and its toxic metabolites of enzymatic hydrolysis (Fazhi *et al.*, 2011; Rabie *et al.*, 2015). In addition, anti-nutritional factors (ANFs) of RSM including phytate, sinapine, condensed tannin (CT) and non-starch polysaccharides (NSP) which can all have a negative impact on development, digestibility, feed intake, feed palatability, metabolism of feed nutrients, growth performance and overall health (Belostas *et al.*, 2007).

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Additionally, fermentation processes have been employed to enhance the nutritional value and alleviate anti-nutritional factors associated with RSM. Fermented

rapeseed meal (FRSM) may offer a viable alternative that addresses both economic and nutritional concerns in broiler production. The process of microbial fermentation can be an efficient way to boost animal nutrition bioavailability and decrease anti-nutritional factors (Fazhi *et al.*, 2011; Sun *et al.*, 2013). Microbial fermentation has been demonstrated to lower the glucosinolate content and increase the nutritional value of RSM (Hu *et al.*, 2015; Vig and Walia, 2001). Fermented rice bran by rumen inoculum had increased live weight gain and feed conversion efficiency of the broiler (Alam *et al.*, 2023). As a result, adding fermented RSM (FRSM) to poultry's diet may enhance their overall health and growth performance. Thus, considering above facts the present investigation has been designed to appraise the effect of rapeseed meal and fermented rapeseed meal replacing soybean meal in diet on growth performance, serum biochemical and nutrient digestibility in broiler chicken.

MATERIALS AND METHODS

Birds and experimental design

The experiment was conducted during year 2023-24 at Broiler unit of Department of Poultry Science, College of Veterinary and Animal Sciences, Parbhani, Maharashtra Animal and Fishery Sciences University (MAFSU), Nagpur, Maharashtra. The present experiment was conducted on 420 day old Vencobb-430Y straight run broiler chicks for a period of 422 days. On the arrival day-old broiler chicks were weighed and randomly distributed into seven treatment groups T1, T2, T3, T4, T5, T6 and T7 with four replicates of 15 chick each. The day-old chicks were distributed in such a way that body weight differences were non-significant in all treatment groups. The broiler birds in control group were offered basal diet (Maize-soy basal diet) and the broiler birds under different treatment groups T2, T3 and T4 were offered feed containing inclusion level at 5, 10 and 15% rapeseed meal (RSM) by replacing soybean meal, respectively. The treatment groups T5, T6 and T7 were offered diet containing inclusion level of 5, 10 and 15% fermented rapeseed meal (FRSM) by replacing soybean meal, respectively. The RSM and FRSM ingredients were procured from M/s. Shrihari Nutrition Private Limited., Gut No. 84, Gundewadi, Bhokardhan Road, Jalna, Maharashtra. The proximate analysis of the experiment diets was carried out as per A. O. A. C. (2012). All the diets were *iso-caloric* and *iso-nitrogenous* and formulated as per Bureau of Indian Standard (BIS), 2007. The standard and uniform managemental practices were followed to all treatment groups. The experiment was approved by Institutional Animal Ethics Committee vide resolution No. 05 IAEC/131/23 dated 15/12 /2023.

Data collection

The data were collected at weekly intervals by weighing the broilers and replicate wise weight gain was calculated by deducting the weight of the day old chick from that of the

current week. The feed intake was calculated by subtracting the left-over feed from the feed offered, however feed conversion ratio was calculated as feed intake divided by weight gain taking into consideration of mortality, if any. Metabolic trial for nutrient digestibility was conducted for three consecutive days at the end of 42nd day of experiment. For metabolic trial, one bird from each replication and a total of four birds from each treatment were randomly taken and caged individually for pre-experimental period for three days for acclimatization purpose during metabolic trial, record of feed offered, leftover was maintained on daily basis. A representative sample of feed offered, leftover on everyday was collected for dry matter determination. The excreta collected from each replication were oven dried at 80°C for 72 hours till the constant weight for dry matter determination. The dried samples of three consecutive days were pulled and then thoroughly mixed, powdered and used for nitrogen and nutrients analysis as per A.O.A.C. (2012). The economics of broiler production was worked out by considering the prevailing prices of inputs and sale price of broilers in local market. The cost of day old chick, feed, medication, vaccination, litter and other overheads were considered while calculating the cost of production.

Statistical analysis

All the data were analysed with completely randomized design by using software WASP-Web Agree Stat Package-2.0 (2004) developed at ICAR Research Complex, Goa. The differences among treatments; and within treatment groups were determined by analysing the data generated by using the completely randomized design for all the studied parameters. Significant level among the treatment groups were determined by ANOVA and treatment means were compared by critical differences (CD).

RESULTS AND DISCUSSION

Weekly live body weight and weight gain

The various treatments had significant ($P < 0.01$) effect on mean weekly live body weight in Table 1. At the end of 6th week, the live body weights and weight gain in treatment groups T2 (5% RSM), T3 (10% RSM), T5 (5% FRSM) and T6 (10% FRSM) were non-significantly reduced as compare to control group T1. However, the live body weights and weight gain decreased significantly ($P < 0.01$) in treatment groups T4 (15% RSM) and T7 (15% FRSM) as compared to control group T1. The present findings are in accordance with Wu *et al.* (2022), who reported that average body weight was not affected when birds were fed 10% FRSM. However, the broilers fed 15% FRSM revealed significantly lower body weights. Similarly, Zhu *et al.* (2019) that ducks fed with rapeseed meal the body weights and weight gain were decreased as dietary inclusion level increased at 20%. Yadav *et al.* (2022) observed that body weight was significantly lowered for rapeseed meal treated group at 30% level. Amerah *et al.* (2015) observed that birds fed high levels of rapeseed meal had lower ($p < 0.05$) body weight gain.

Cumulative feed consumption

The cumulative feed consumption showed non-significant differences among all treatment groups (Table 2) from 3rd to 6th week and significant differences ($P<0.05$) at 1st and 2nd weeks for all treatment groups. At 1st week, cumulative feed consumption was significantly ($P<0.05$) higher in birds fed 5, 10 and 15% FRSM as compared to birds fed 10% (T3) and 15% RSM (T4). At the end of 2nd week, significantly ($P<0.05$) reduced feed consumption was observed in treatment group T4 fed with 15% RSM than all other groups except treatment group T7. Significantly ($P<0.05$) higher feed consumption was reported in treatment groups T3 and T5 when compared to treatment group T4 and T7 at 2nd week. At the end of 6th week, cumulative feed consumption was non-significant ($P>0.05$) among all groups. Similarly, results are in accordance with Boroujeni *et al.* (2022) reported that inclusion of 15% enzymatic treated rapeseed meal had no impact on feed intake. Gao *et al.* (2020) observed that birds fed raw and fermented rapeseed cake revealed non-significant difference for weekly feed consumption. Ashayerizadeh *et al.* (2017) reported that feed intake was reduced when birds fed RSM replaced with soybean meal at 50 and 100% level compared to those birds receiving FRSM. Fu *et al.* (2021) revealed that RSM can be supplemented up to 16% in broiler diet without affecting average daily feed intake.

Feed conversion ratio (FCR)

The cumulative FCR at 2nd and 3rd week of age was significantly ($P<0.05$) higher in treatment groups T4 receiving diets with 15% rapeseed meal as compared to groups T1, T2, T5 and T6. At the end of 6th week, significantly ($P<0.01$) better cumulative FCR was recorded group T1, T2, T3, T5 and T6 as compared to treatment groups T4 and T7 fed diet with 15% RSM and 15% FRSM, respectively (Table 3). Whereas, there were non-significant differences for cumulative FCR in groups T1, T2, T3, T5 and T6. The present findings are in agreement with Chiang *et al.* (2010) reported that feed conversion of birds fed fermented rapeseed meal were superior to that of birds fed non-fermented rapeseed meal. Zhang *et al.* (2022) observed feed conversion ratio was non-significant with control group when birds fed 10% rapeseed meal at 21 and 42 days and significantly higher FCR was recorded in birds fed 20% RSM as compared with control group. Similarly, Wu *et al.* (2022) observed that birds fed with FRSM and RSM at 10% has no significant effect on feed conversion ratio. Amerah *et al.* (2015) found that birds fed RSM at different level (5, 8, 12% RSM) and enzyme supplementation had no effect on feed conversion ratio. Zhu *et al.* (2019) revealed that the inclusion of RSM at 5 and 10% levels was non-significantly affected as compared to control group, whereas, at 15 and

Table 1: Weekly live body weight (g/b) of broilers fed different levels of rapeseed meal and fermented rapeseed meal replacing soybean meal.

Treatments	Age (Weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
T1 (control)	159.07 ^{ab} ±3.77	454.13 ^b ±2.79	901.57±16.87	1502.50 ^a ±22.42	2153.33 ^a ±18.21	2696.67 ^a ±38.27
T2 (5% RSM)	155.47 ^{bc} ±1.89	450.93 ^b ±1.69	888.10±5.16	1469.17 ^{ab} ±15.54	2105.83 ^a ±27.57	2650.83 ^a ±28.33
T3 (10% RSM)	150.10 ^c ±1.02	448.83 ^b ±1.23	882.87±10.29	1449.17 ^{bc} ±14.74	2088.33 ^{ab} ±17.08	2608.3 ^{ab} ±22.34
T4 (15% RSM)	148.60 ^c ±1.96	430.90 ^d ±1.70	860.00±2.78	1398.33 ^d ±8.77	2005.83 ^c ±18.68	2506.67 ^c ±36.23
T5 (5% FRSM)	165.20 ^a ±3.20	459.60 ^a ±0.61	899.67±12.37	1484.17 ^{ab} ±7.62	2115.83 ^a ±40.12	2671.67 ^a ±48.18
T6 (10% FRSM)	160.57 ^{ab} ±2.34	453.23 ^b ±2.48	892.73±14.33	1477.50 ^{ab} ±9.85	2092.50 ^{ab} ±7.12	2633.33 ^a ±13.61
T7 (15% FRSM)	158.10 ^b ±1.09	439.27 ^c ±1.61	871.33±5.31	1427.50 ^{cd} ±7.62	2030.83 ^{bc} ±9.27	2540.83 ^{bc} ±16.63
CD	9.52 ^{**}	7.43 ^{**}	NS	53.53 ^{**}	89.25 ^{**}	125.36 ^{**}

^{abcdcd}Means having different superscripts within a column differ significantly. * $P<0.05$, ** $P<0.01$, NS-non-significant, Critical difference.

Table 2: Cumulative feed consumption (g/b) of broilers fed different levels of rapeseed meal and fermented rapeseed meal replacing soybean meal.

Treatments	Age (weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
T1 (control)	135.70 ^{ab} ±5.15	522.94 ^{ab} ±7.88	1149.79 ±31.33	2033.49 ±42.68	3234.21 ±25.27	4365.82 ±65.39
T2 (5% RSM)	132.60 ^{ab} ±2.71	519.67 ^{ab} ±2.72	1141.53 ±7.08	1998.20 ±18.97	3173.21 ±41.60	4315.43 ±82.14
T3 (10% RSM)	127.73 ^b ±1.60	525.04 ^a ±4.33	1140.43 ±16.23	1983.75 ±15.89	3175.37 ±56.15	4267.47 ±40.33
T4 (15% RSM)	127.57 ^b ±4.04	505.14 ^c ±4.63	1123.01 ±8.40	1944.02 ±10.60	3105.72 ±29.93	4226.93 ±69.70
T5 (5% FRSM)	140.90 ^a ±2.39	523.57 ^a ±2.67	1145.41 ±22.27	2001.92 ±9.69	3160.94 ±69.17	4304.30 ±64.79
T6 (10% FRSM)	137.57 ^a ±2.33	523.16 ^{ab} ±4.82	1146.12 ±18.73	2014.51 ±12.59	3144.34 ±18.38	4274.37 ±23.52
T7 (15% FRSM)	137.33 ^a ±2.60	509.86 ^{bc} ±1.86	1127.74 ±9.45	1968.66 ±9.77	3100.18 ±24.23	4231.15 ±55.35
CD	9.34 [*]	13.32 [*]	NS	NS	NS	NS

^{ab}Means having different superscripts within a column differ significantly. * $P<0.05$, ** $P<0.01$, NS-non-significant, Critical difference.

20% levels of RSM feed conversion was significantly increased as compared to control group. The increasing inclusion rate of RSM and FRSM recorded poor in feed conversion ratio, this may be due the increasing levels of Glucosinolates, phytic acid and soluble NSP which affect nutrient digestibility.

Nutrient digestibility

The means values of nutrient digestibility and nitrogen retention parameters of different treatment groups are presented in Table 4. The dry matter (DM) digestibility (%), nitrogen (N) retention (%), ether extract (EE) digestibility (%) and crude fibre (CF) digestibility (%) were numerically reduced with increasing inclusion levels of rapeseed meal in diet. Whereas, there were non-significant differences for DM digestibility, N retention, EE digestibility and CF

digestibility percent in all groups. The findings are in accordance with Gopinger *et al.* (2014) reported that canola meal can be added up to 20% with no negative on crude protein digestibility. However, there was linear decrease in digestibility of dry matter and nitrogen free extract with increase inclusion of canola meal. Zhu *et al.* (2018) reported that dry matter and nitrogen retention (%) were not affected with inclusion of RSM. Gao *et al.* (2020) revealed that addition of 15% fermented rapeseed cake in diet experienced no effect on nutrient utilization in broilers. Amirahmadi *et al.* (2020) observed that protein digestibility was not affected when RSM was included in broiler diet.

Economics of broiler production

The cost of production (Rs. /kg) live weight for treatment groups T1, T2, T3, T4, T5, T6 and T7 was presented in Table 5.

Table 3: Cumulative feed conversion ratio of broilers fed different levels of rapeseed meal and fermented rapeseed meal replacing soybean meal.

Treatments	Age (Weeks)					
	1 st	2 nd	3 rd	4 th	5 th	6 th
T1 (control)	1.18±0.01	1.28 ^{bc} ±0.01	1.34 ^{cd} ±0.01	1.39 ^c ±0.01	1.53 ^{cd} ±0.01	1.65 ^b ±0.00
T2 (5% RSM)	1.19±0.02	1.28 ^{bc} ±0.00	1.35 ^{bcd} ±0.00	1.40 ^{bc} ±0.01	1.54 ^{bcd} ±0.00	1.66 ^b ±0.02
T3 (10% RSM)	1.20±0.02	1.30 ^{ab} ±0.01	1.36 ^{abc} ±0.01	1.41 ^{bc} ±0.01	1.55 ^{bc} ±0.02	1.66 ^b ±0.01
T4 (15% RSM)	1.22±0.02	1.31 ^a ±0.01	1.38 ^a ±0.01	1.44 ^a ±0.00	1.58 ^a ±0.01	1.72 ^a ±0.01
T5 (5% FRSM)	1.17±0.01	1.26 ^c ±0.01	1.34 ^d ±0.01	1.39 ^c ±0.00	1.53 ^d ±0.01	1.64 ^b ±0.01
T6 (10% FRSM)	1.18±0.01	1.28 ^{bc} ±0.01	1.35 ^{bcd} ±0.00	1.40 ^{bc} ±0.00	1.53 ^{cd} ±0.00	1.65 ^b ±0.00
T7 (15% FRSM)	1.21±0.02	1.29 ^{ab} ±0.01	1.36 ^{ab} ±0.01	1.42 ^{ab} ±0.01	1.56 ^{ab} ±0.01	1.69 ^a ±0.01
CD	NS	0.026*	0.022*	0.029**	0.036**	0.036**

^{abcd}Means having different superscripts within a column differ significantly. *P<0.05, **P<0.01, NS-non-significant.

Table 4: Nutrient digestibility and nitrogen retention of broilers fed different levels rapeseed meal and fermented rapeseed meal replacing soybean meal.

Parameters	Treatment groups						
	T1 (control)	T2 (5% RSM)	T3 (10% RSM)	T4 (15% RSM)	T5 (5% FRSM)	T6 (10% FRSM)	T7 (15% FRSM)
DM digestibility (%)	76.63±1.63	75.99±1.57	74.28±1.34	71.47±1.57	71.98±0.84	72.41±0.82	70.25±4.24
N retention (%)	77.33±0.72	76.90±1.77	75.44±4.15	69.44±3.02	78.22±1.47	76.71±3.17	71.83±0.88
EE digestibility (%)	84.94±2.20	83.64±1.13	82.14±1.38	78.31±0.58	85.30±0.79	80.42±0.93	79.63±3.60
CF digestibility (%)	55.56±3.49	55.57±2.74	53.50±2.10	50.06±1.39	53.63±1.18	54.17±1.74	51.30±0.59

^{abc}Means having different superscripts within a column differ significantly. *P<0.05, **P<0.01, NS-non-significant, Critical difference.

Table 5: Economics of broiler production fed with different levels rapeseed meal and fermented rapeseed meal replacing soybean meal.

Particulars	Treatment groups						
	T1	T2	T3	T4	T5	T6	T7
Chick cost (Rs./chick)	43	43	43	43	43	43	43
Total feed cost (Rs./bird))	169.29	165.10	161.06	157.32	165.21	162.37	159.04
Miscellaneous cost (Rs. /bird))	10	10	10	10	10	10	10
Cost of production (Rs. /bird))	222.29	218.10	214.06	210.32	218.21	215.37	212.04
Cost of production (Rs./kg)	82.43	82.28	82.07	83.91	81.67	81.79	83.45
Return on sale @ Rs. 84/kg	226.52	222.67	219.10	210.56	224.42	221.20	213.43
Net profit (Rs. /bird)	4.23	4.57	5.04	0.24	6.21	5.83	1.39
Net profit (Rs./kg)	1.57	1.72	1.93	0.09	2.33	2.21	0.55
More profit than control (Rs./Kg)		0.15	0.36	-1.47	0.75	0.64	-1.01

The highest net profit per kg live body weight was observed in treatment group T5 followed by groups T6, T3, T2, T1, T7 and T4. The results are in agreement with Chiang *et al.* (2010) who reported that broilers fed with solid state fermented rapeseed meal potentially reducing the cost of broiler production. Gheorghe *et al.* (2005) revealed that the economic efficiency was improved when diet supplemented with RSM due to the lower cost of RSM.

CONCLUSION

It was concluded that the inclusion of RSM and FRSM up to 10% level with replacing soybean meal do not have any adverse effect on growth performance, nutrient digestibility and improved economics of broiler production. Moreover, the inclusion of 5% FRSM with replacing soybean meal in diet has more economically profitable without affecting production performance in broilers.

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Conflicts of interest

The authors declare that they have no conflicts of interest or competing interests.

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