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Effect of dietary incorporation of pea (*Pisum Sativum* L.) pods residue powder by replacing rice polish on growth performance, nutrient utilization, carcass characteristics and economic evaluation in commercial broiler chickens

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Abstract
A feeding trial was conducted to discern the effect of dietary incorporation of pea (*Pisum sativum* L.) pods residue powder on growth performance, nutrient utilization, carcass traits in commercial broiler chickens. 120 (one day-old) broiler chicks divided into four treatment groups with three replicates of 10 chicks in each for 42 days *viz.*, 0-21 days (starter phase) and 22-42 days (finisher phase). The groups were T_1 (control) having no any replacement where as T_2, T_3 and T_4 were incorporated with pea pods residue powder at 50, 75 and 100 per cent levels by replacing rice polish, respectively. During starter phase the body weight gain of T_2 and T_4 groups were significantly ($P< 0.05$) higher than T_1 and T_3. Performance index was higher in T_4 as compared to other groups. During finisher and entire rearing phase body weight gain, feed intake, FCR and performance index were similar in all groups. Nutrient utilization in terms of dry matter, crude protein, crude fat and organic matter did not differ significantly among different groups. Sensory attributes *viz.*, juiciness, texture, overall acceptability and appearance were significantly higher in T_4 treatment group. The protein content in breast ($P< 0.05$) and thigh muscle ($P< 0.01$) were higher in pea pods residue powder incorporated groups. There were no any significant ($P>0.05$) differences were observed between the treated groups fed pea pods residue powder in terms of carcass characteristic and revealed no significant difference in the terms of feed cost per kg live weight gain (Rs) for the overall periods (0-6 weeks).Therefore, it could be concluded that incorporation of pea pods residue powder in the diets of commercial broiler chickens had no marked positive effect on their growth performance.

Keywords: Nutrient utilization, pea pods, rice polish, carcass characteristics, commercial broiler chickens

Introduction
India has emerged as the third largest in egg and fifth largest in poultry meat production in the world (20th Livestock census, 2019). As per 20th Livestock census, poultry population has increased from 729.21 million to 851.81 million during the year 2012 to 2019. Feed is a major factor affecting net income from the poultry business, because approximately 70-80% of the total cost of poultry production is due to feed (Asghar *et al.*, 2000) [3]. India was among top producing countries whose production has increased substantially and it reached about 217% (FAO, 2007). The contribution of poultry production in our country is about 0.66% its GDP and 7.72% GDP of the livestock sector. (Prabakaran, 2014; Rajenderan *et al.*, 2014) [24, 25]. Due to rapid growth in poultry production the per capita availability for a year has also raised considerably and reached to 60 eggs and 2.5 Kg of meat. There may be huge problem of disposing by-products generated by plant food processing industries although these by-products are important sources of nutrients. These by-products act as possible source of functional feeds.

In India, yearly production of pea pod is more than one million tons out of which sizeable quantity discarded as waste. Pea pods which otherwise are discarded in bins or as animal feed and thus exploited for their nutritional benefits. Pea pods contain many nutrients like protein, sugars, minerals and vitamins. The pea pods contain protein 10.8%, fat 1.3%, sucrose 7.9%, glucose 11.9%, fructose 1.2%, starch 3.7%, and dietary fibre 58.6% on dry matter basis as well as iron (1.20%) which is higher than potassium (1.03%) (Mateos-Aparicio *et al.*, 2010) [19]. Pea pod contains dietary fibre as a major constituent.

The importance of dietary fibre has led to the development of a large and potential market for fibre-rich products and ingredients and now a days there is a trend to find new sources of dietary fibre such as agronomic by-products that have traditionally been undervalued. Dietary fibre plays an important role in many physiological processes and in the prevention of diseases (Jones *et al*., 2006) [14]. Pea pod powder produced is also use as a prospective dietary fiber supplement in biscuits with sugar replaced by jaggery to further enhance the nutritive value (Garg, 2015) [12]. Many people consume it as pea pod soup as it contains vitamins A and C for immunity, and phytosterols to regulate cholesterol. They are also good sources of vitamin K, iron, and copper to build blood as well as calcium for bone health. Pea pods produce a mellow juice, which can be taken with apple and lemon.

Presently there is very less information available about feeding of pea pods residue powder as feed additives in commercial broiler chickens. Rice polish is commonly used in poultry diets as a conventional feed ingredients. Though both of these feed additives have been fed separately in various experiments, but information about combined feeding of these feed additives and /or feed ingredients is not available. Therefore the objective of the present study was to investigate the effect of powder of pea pods residue by replacing rice polish on feed intake, growth performance, carcass characteristics and economic evaluations in commercial broiler chickens.

Materials and Methods

A total of 120, day-old commercial broiler chicks were procured from R. K. Poultry, Bajpur, Uttarakhand were randomly distributed into 4 treatment groups with 3 replication having 10 chicks in each in a completely randomized design. The broiler chicks' in-group T_1, were fed basal diet (control) whereas chicks of group T_2, T_3 and T_4 were fed basal diet incorporated with 50%, 75% and 100% replacement of rice polish with pea pods residue powder, respectively. The feeding trial lasted for 42 days *viz*., 0-21 days (starter phase) and 21-42 days (finisher phase). The ingredient compositions of diets are presented in Table 1.

Procurement of pea pods residue powder

Pea pods residue bought from Pantnagar shopping market and dried under ambient temperature After this the required amount of was weighed with weighing machine and grounded in mixer to convert it into powder of smaller particle size.

Growth performance parameters

Daily record of feed offered to birds of different treatment groups was maintained. The birds from each replicate were weighed individually at weekly basis. The body weight gain, feed conversion ratio and performance index were calculated.

Analysis of feed, meat and excreta samples

The representative samples of experimental broiler starter and finisher feeds as well as excreta obtained during metabolism trial and representative meat samples from breast and thigh were collected and proximate analysis was conducted on the samples collected, using the standard principles (AOAC, 2000) [2].

Carcass traits

For the carcass trait studies, two representative broiler chickens from each replicate of all treatment groups was sacrificed at the end of feeding cum growth trial for evaluation of carcass characteristics.

Economics Evaluation

The values for the economics by the incorporation of Pea pods residue powder during 0 to 21, 21 to 42 and 0 to 42 days.

Statistical analysis

The experimental data obtained in the present study were analyzed statistically (Snedecor and Cochran, 1994) [27] by using general linear model procedure. Difference between treatments means were compared using Duncan's multiple range test (Kramer, 1957) [16].

Results and Discussion

Growth performance

The growth performance of broiler chicks fed experimental diet presented in Table 2. During the starter phase (0-21 days) the body weight gain showed significant ($P< 0.05$) improvement due to dietary incorporation of pea pods residue powder in place of rice polish. Maximum weight gain was recorded in T_4 treatment group. Feed intake was statistically similar in treatment groups T_2 and T_4. Feed conversion ratio did not differ significantly ($P>0.05$) among different groups. Performance index having no any significant difference between T_1 and T_2 groups where as T_1 and T_3 as well as T_2 and T_3 differ significantly. During the finisher phase (21-42 days) average weight gain, feed intake, feed conversion ratio and performance index did not influenced significantly (Table 3). The overall (0-42 days) cumulative performance of broilers in terms of body weight gains, feed intake, feed conversion ratio and performance index did not differ significantly among different treatment groups of broiler chickens due to dietary incorporation of pea pods residue powder by replacing rice polish (Table 4).

The present findings are in agreement with that of McNeill *et al*. (2004) [20] who reported that feed intake was little affected in poultry by the inclusion of 100 g/kg of pea meal in the diet but 200 g/kg of peas caused a decrease in feed intake. Fenderick *et al.* (2005) [11] reported no any significant differences in average daily gain and feed conversion ratio. Field peas can replace 59% of the corn dry matter in beef finishing diet with no significant differences in weight gain or feed efficiency. Oelke *et al.* (1991) [22] found that partial or complete replacement of soybean meal with pea did not reduce growth rate or efficiency of feed conversion. However, no report exists in the literature on feeding value of pea pod powder in poultry. Lardy *et al.* (2009) [17] who found that field pea can be included successfully into rations of cattle at levels up to 36% of dry matter without negatively affecting growth performance. Laudadio *et al*. (2012) [18] also found that effect of substitution of soybean meal with dehulled-micronized peas in diets of guinea fowl broilers have no any adverse effect on growth performance. Dabral (2017) [7] observed that average daily dry matter intake was not affected by the supplementation of green pea pods residue in place of mixed green fodder in growing crossbred female calves. Stein *et al*. (2004) [29] concluded that the nutrients in field peas were highly digestible by growing pigs. Therefore, such field peas may be included in diets for nursery pigs and growing finishing pigs in amounts of at least 18 and 36%, respectively, without negatively affecting growth performance. Newman *et al*. (2011) [21] conducted a study on the effect of pea chips

(Pea chips are produced as a by-product when field peas are processed to produce split peas for human consumption) on pigs performance and recommended that pea chips can be used in the diet of pigs. The weight gain, feed intake and performance index of broiler chickens in the present study were comparable due to incorporation of pea pods residue powder by replacing rice polish in experimental diet. After shelling peas, the left over material is empty pea pods, which contain 19.80 percent crude protein and 1.0 percent ether extract. These are rich in total soluble sugars, total phenolics, macro and micro elements. The fractionation of true proteins revealed that albumins had the highest concentration followed by glutelins, globulins and prolamins (Wadhwa *et al.* 2006) [30].

Nutrient utilization

The average nutrient utilization in broiler chickens during finisher phase of different treatment groups are presented in Table 5. The similar average dry matter and crude protein intake by the supplementation of green pea pods residue in place of mixed green fodder in the diet of crossbred female calves have been reported by Dabral (2017) [7].

Carcass characteristics

Data pertaining to the average dressing percentage, carcass yields, cut-up parts, organ weights and processing losses of broilers of different treatment groups due to incorporation of pea pods residue powder by replacing rice polish in the diet did not differ significantly between the groups and are presented in Tables 6 and 7. These results are similar with Laudadio *et al*. (2012) [18] who found that substitution of soyabean meal with peas had no adverse effect on dressing percentage, or breast and thigh muscle relative weights of the guinea broilers. No differences were shown in dressing percentage and contents of major muscles (breast, drumstick and thighs) in carcasses of guinea fowl broilers fed diets with and without micronized-dehulled pea meal. Eichie *et al*. (2015) and Juodka *et al*. (2016) [10, 15] reported pea had no significant effect on carcass characteristics of broiler chickens. The experiment of Corazzin *et al*. (2018) [6] also found that no any effect on carcass traits on feeding pea based diet in bull. McNeill *et al*. (2004) [20] found that absolute breast muscle weight of broiler chickens was affected by diet but there was no significant difference in breast weight as a proportion of total body weight. Xie *et al*. (2010) [31] found that treatments were statistically similar in the relative weight of carcass, breast and thigh muscles of pigeon squabs. Dotas *et al*. (2014) [9] found that replacement of soybean meal and corn with up to 480 g field pea/kg of diet did not affect carcass yield traits, skin colour and chemical composition in broiler chickens. Lardy *et al*. (2009) [17] concluded that field pea can be included successfully into rations at levels up to 36% of dry matter without negatively.

Meat composition

The average dry matter, crude protein and ether extract contents (% on dry matter basis) of breast and thigh muscle and sensory characteristics in different treatment group of broiler chickens are presented in Table 8. The protein content of thigh muscles of broiler chickens were influenced by pea pods residue powder. Significantly ($P< 0.01$) highly crude protein content was recorded in T_4 and T_3 treatment groups as compared to other treatment groups. Significant increase in crude protein content ($P< 0.05$) in breast and thigh muscle by pea pods residue powder feeding might be due to presence of high levels of the essential amino acids, lysine and tryptophan (Oelke *et al.* 1991) [22]. Wadhwa *et al*. (2006) [30] also reported buck fed with pea pods residue that the nitrogen excretion as % of nitrogen intake was lower resulting in significantly higher nitrogen retention and apparent biological value.

Sensory characteristics

Appearance

The appearance was found to be better in pea pods residue powder incorporated groups due to the presence of antioxidant (leutein and phenolics) which prevent it from free radicals reaction (Table 9). The similar result was also reported by Laudadio *et al*. (2012) [18] in breast and thigh meat of guinea fowl fed the pea diet had higher lightness scores ($P< 0.05$).

Flavor

The flavour of broilers meat ware not affected by dietary replacement of rice polish by pea pods residue powder. The pea pod incorporated group had better juiciness as compared to control group.

Juiciness

The Juiciness may be due to the better water holding capacity and better lipid distribution in meat by incorporation of pea pods residue powder in feed. Dotas *et al*. (2014) [9] found that replacement of soybean meal and corn with up to 480 g field pea/kg of diet affect some differences in fatty acid (lenoleic acid) distribution in total lipids of breast and thigh muscles. The similar result was found by Laudadio *et al*. (2012) [18] in breast and thigh meat of guinea fowl fed the pea diet had higher water holding capacity ($P< 0.01$) than the control that influences juiciness of meat.

Texture

Significantly higher ($P< 0.05$) hedonic scale value of texture of chicken meat was shown by broiler chickens of T_4 group. The hedonic scale value of overall acceptability of broiler chicken meat showed significant ($P< 0.05$) improvement due to dietary pea pods residue powder incorporation by replacing rice polish.

Overall acceptability

The colour or appearance was found to be better in T_4 group. It might be due to the presence of phenolics (Wadhwa *et al.* 2006) [30] and lutein which acts as antioxidant compounds that inhibit or retard the free radical generating chain mechanism of lipid (n- 3 polyunsaturated fatty acid) oxidation (O'Sullivan, 2016) [23] and preventing from rancidity and so texture of meat was found to be better. Laudadio *et al.* (2012) [18] found that breast and thigh meat of birds fed the pea diet had higher lightness scores ($P< 0.05$) than the control. The above results of sensory evaluation are in agreement with the findings of Lardy *et al.* (2009) [17] who found that field pea could be included successfully into rations at levels up to 36% of dry matter without negatively affecting sensory characteristics of finishing beef cattle. Laudadio *et al*. (2012) [18] found that carcass quality and favorable lipid profile of guinea fowls was improved as pea diet had higher concentrations of phospholipids. Feeding peas increased n- 3 polyunsaturated fatty acid concentration in breast and thigh muscles and decreased n- 6 polyunsaturated fatty acid concentration so lowered the n- 6/n- 3 polyunsaturated fatty

acid ratio of the guinea broiler muscles. Anderson *et al.* (2006) [1] found that sensory panel analysis indicated a linear increase in tenderness with addition of peas. Sensory panel ratings indicated a tendency for increased juiciness and no differences in flavor noted. The improved tenderness observed in this study has implications for improving beef acceptability.

Economics Evaluation

The total cost (Rs/kg) noted for T1, T2, T3 and T4 treatment was 86.05, 84.49, 85.56 and 84.74 respectively. The feed cost per kg weight gain was noted to be 44.33, 47.08, 45.16 and 42.40 rupees for T1, T2, T3 and T4 treatment respectively (Table 10). There was no significant difference observed between the values of different groups.

Table 1: Ingredient composition (%) of broiler chicks (Starter and Finisher) basal diets

Ingredients	Starter (0-3 weeks) feed				Finisher (3-6 weeks) feed			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Yellow maize	52.00	52.00	52.00	52.00	56.00	56.00	56.00	56.00
Deoiled soybean meal	30.00	30.00	30.00	30.00	25.00	25.00	25.00	25.00
GNC	10.00	10.00	10.00	10.00	08.00	08.00	08.00	08.00
Rice polish	4.00	2.00	1.00	0.00	6.00	3.00	1.50	0.00
Dried pea pods residue powder	0.00	2.00	3.00	4.00	0.00	3.00	4.50	6.00
Vegetable oil	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00
Dicalcium phosphate	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
DL- methionine	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Choline chloride	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Mineral mixture	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Hepatocare	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Coccidiostates	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total (kg)	100	100	100	100	100	100	100	100
Cost of feed (Rs./kg)	23.30	22.90	22.70	22.50	23.8	23.30	23.00	22.70

Table 2: Average growth performance of commercial broiler chicks from 0-21 days fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Body weight at 21stday	41.00±1.90	39.90±0.75	40.37±0.50	41.17±0.81	1.18
Body weight at 42ndday (g)	529.46^{b}±13.90	572.50^{ab}±14.82	508.30^{b}±14.28	583.17^{a}±7.67	13.13
Weight gain (g)	488.46^{b}±12.21	532.60^{a}±15.55	467.93^{b}±13.78	542.00^{a}±7.31	12.74
Feed intake (g)	862.66^{b}±30.20	990.17^{a}±28.59	872.75^{b}±19.01	938.11^{ab}±29.5	26.48
Feed conversion ratio	1.77±0.03	1.86±0.07	1.87±0.08	1.73±0.05	0.04
Performance index	276.47^{b}±6.84	287.23^{b}±16.61	251.68^{c}±16.35	313.64^{a}±9.55	9.87

Table 3: Average growth performance of commercial broiler chicks from 21-42 days fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Body weight at 21stday	529.46^{b}±13.90	572.50^{ab}±14.8	508.30^{b}±14.28	583.17^{a}±7.67	13.13
Body weight at 42ndday (g)	1981.31±27.30	1842.73±92.70	1935.69±66.41	2042.44±61.48	64.93
Weight gain (g)	1451.85±18.75	1270.23±78.89	1427.39±55.13	1459.27±60.75	57.33
Feed intake (g)	2764.61±117.1	2652.33±81.7	2856.86±117.3	2798.12±112.5	88.91
Feed conversion ratio	1.90±0.07	2.10±0.13	2.00±0.06	1.92±0.11	0.11
Performance index	764.86±28.58	612.56±69.02	714.58±39.82	766.14±69.85	61.79

Table 4: Average growth performance of commercial broiler chicks from 0-42 days fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Initial body weight (g)	41.00±1.90	39.90±0.75	40.37±0.50	41.17±0.81	1.18
Body weight at 42ndday (g)	1981.31±27.30	1842.73±92.70	1935.69±66.41	2042.44±61.68	64.93
Weight gain (g)	1940.31±26.32	1802.83±93.38	1895.32±66.04	2001.27±62.30	65.45
Feed intake (g)	3630.04±142.4	3642.67±106.8	3729.77±114.0	3736.23±106.5	110.53
Feed conversion ratio	1.87±0.06	2.03±0.11	1.97±0.03	1.87±0.07	0.08
Performance index	1039.15±29.81	897.00±86.25	963.66±43.30	1075.51±68.84	68.39

Table 5: Average nutrient utilization (%) in commercial broiler chickens fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Dry matter	71.07±0.48	72.52±1.18	71.01±0.43	73.69±0.94	0.87
Organic matter	63.26±0.33	64.91±0.85	65.59±0.89	66.94±0.33	1.42
Crude protein	75.52±1.65	75.16±1.60	76.03±0.46	79.28±0.95	1.40
Ether extract	71.57±1.15	73.27±1.68	71.98±0.67	74.90±1.07	1.34

Table 6: Average values for dressing percentage and carcass yield (%live weight) of finisher commercial broilers fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Dressing %	66.54±1.23	65.97±0.14	65.93±0.59	65.68±0.62	0.67
Carcass yield	74.39±1.17	73.90±0.05	73.67±0.43	73.50±0.48	0.59

Table 7: Average values of cut-up parts of finisher commercial broilers chickens (% live weight) fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Neck	2.62±0.12	2.58±0.03	2.49±0.15	2.39±0.01	0.10
Wing	8.91±0.42	8.48±0.18	8.27±0.58	8.12±0.17	0.39
Back	10.23±0.11	10.50±0.53	9.02±0.14	9.08±0.22	0.56
Breast	24.98±0.81	24.21±0.92	26.25±0.49	26.70±0.30	0.57
Thigh	10.44±0.34	10.35±0.40	10.05±0.36	9.19±0.46	0.35
Heart	0.51±0.02	0.62±0.02	0.60±0.04	0.58±0.01	0.02
Liver	1.96±0.10	2.06±0.18	2.14±0.15	2.22±0.12	0.12
Blood	4.07±0.08	4.01±0.19	3.96±0.18	4.16±0.28	0.20
Abdominal fat	0.86±0.10	0.94±0.10	0.73±0.07	0.80±0.10	0.70

Table 8: Average values of meat composition (on DM basis) of commercial broiler chickens fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatment				S.Em
	T_1	T_2	T_3	T_4	
Breast muscle					
Crude protein (%)	79.98^{c}±0.44	80.7^{bc}±0.06	82.60^{a}±0.80	80.85^{b}±0.37	79.98^{c}±0.44
Ether extract (%)	10.83±1.52	12.23±0.22	12.92±1.13	10.25±1.37	10.83±1.52
Ash (%)	5.85±0.64	5.15±0.70	4.96±0.30	4.78±0.33	5.85±0.64
Thigh muscle					
Crude protein (%)	74.18^{b}±0.15	74.59^{b}±0.34	76.11^{a}±0.12	76.93^{a}±0.20	0.24
Ether extract (%)	17.88±1.82	21.40±0.75	21.18±0.98	19.73±0.07	1.07
Ash (%)	5.38±0.32	4.61±0.10	5.25±0.43	5.61±0.21	0.25

Table 9: Average values for sensory characteristics of meat of broilers fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
Appearance/colour	7.95^{b}±0.08	7.47^{c}±0.15	7.44^{c}±0.09	8.49^{a}±0.06	0.10
Flavour	7.95±0.14	7.53±0.13	7.66±0.12	8.04±0.11	0.12
Juiciness	7.81^{b}±0.10	7.55^{bc}±0.17	7.33^{c}±0.11	8.32^{a}±0.18	0.13
Texture	7.93^{ab}±0.24	7.08^{b}±0.33	7.61^{b}±0.09	8.20^{a}±0.18	0.20
Overall acceptability	7.79^{b}±0.18	7.82^{b}±0.15	7.61^{b}±0.10	8.49^{a}±0.14	0.15

Table 10: Economics for commercial broiler chickens fed diets incorporated with pea (*Pisum sativum* L.) pods residue powder by replacing rice polish (0-42 Days)

Parameters	Treatments				S.Em
	T_1	T_2	T_3	T_4	
0-42 Days					
Average body weight gain (g)	1940.31±26.32	1802.83±93.38	1895.32±66.04	2001.27±62.30	65.45
Average feed intake (g)	3627.27±144.23	3642.67±106.81	3729.77±114.03	3736.23±106.57	110.19
Total feed cost (Rs.)	86.05±3.43	84.49±2.48	85.56±2.62	84.74±2.42	2.56
Feed cost/ Kg weight gain (Rs.)	44.33±1.38	47.08±2.56	45.16±0.76	42.40 ±1.61	1.97

Conclusion

It could be concluded that incorporation of pea pods residue powder by replacing rice polish at the levels of 50, 75 and 100% in the feed of commercial chickens had no marked

positive action on the performance in terms of growth, utilization of nutrients, carcass characteristics and economic evaluation.

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