Effect of replacement of fish meal with poultry by-products on body growth of crossbred Hampshire pigs

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Abstract

The present study was carried out to study the effects of the inclusion of poultry by-product meal in the ration of pig replacing the fish meal at different levels viz. 50% and 100% on the Linear body measurements of crossbred Hampshire pigs. A total of Eighteen (18) weaned Crossbred Hampshire pigs (9 castrated male and 9 female) with an average age of 8 weeks and average body weight of 11.11±0.02 kg were selected from an institutional pig farm (30-Sow Teaching Unit) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22. The trial was conducted for 150 days, from 15th October 2021 to 14th March 2022. The piglets were divided into three treatment groups depending upon the nearness of body weight and age in such a manner that each treatment will consist of six pigs (3 males and 3 females in each group) viz. groups C, T_1, and T_2. The animals under T_1 group were provided with Standard conventional feed with 2.5%, T_2 group with 5% inclusion of poultry by-product meal replacing 50% and 100%of fish meal respectively. However, the control group was provided with standard conventional feed without the inclusion of poultry by-products. Analysis of variance revealed that there are no significant differences existed between the different treatment and control groups. The coefficient of correlation of body length with the body weight of crossbred Hampshire pigs was found to be positively correlated.

Key words: Crossbred Hampshire Pig, Poultry By-Products, Linear body measurements

Introduction

India's economy is heavily reliant on agriculture, with the livestock sector forming a significant component in terms of income generation, employment opportunities, and foreign exchange earnings. This sector contributes approximately 26% to the total income of smallholder households, compared to an average of 24% across all rural households. Livestock production plays a crucial role in meeting the country's food demands by supplying animal-based products such as meat, milk, and eggs for human consumption. According to BAHS (2023–24), India produces around 10.25 million tonnes of meat annually. However, despite this substantial production, the per capita availability of animal protein remains low at only 15 grams per person per day, which is significantly below the Indian Council of Medical Research's recommended intake of 30 grams per day. As per the 20th Livestock Census, the pig population in India stands at 9.06 million, accounting for roughly 1.7% of the country's total livestock population. In this context, poultry slaughterhouse by-products—such as heads, shanks, and intestines—present a viable, nutrient-rich alternative source of animal protein for livestock feed, particularly for pigs and poultry.

Chicken meal, derived from these by-products, contains 55% protein, 19% fat, 3% calcium, 0.96% phosphorus, 2.16% lysine, 0.72% methionine, 0.72% cysteine, and delivers approximately 3.4 Mcal ME/kg (Chandrasekaran, 2013). Owing to its rich content of essential amino acids, fatty acids, minerals, and vitamins, poultry by-product meal is generally considered a palatable and high-quality feed ingredient. Given these attributes, the effective utilization of poultry by-products in pig diets-without adversely affecting growth or performance-could lead to significant reductions in feed costs and thereby enhance the economic viability of pig farming. However, research on the use of poultry by-product meal in pig diets under Indian conditions remains limited. In light of this gap, the present study was undertaken to assess the impact of incorporating poultry by-product meal into the diets of weaned crossbred Hampshire pigs, with specific emphasis on their linear body measurements.

Materials and methods

The experiment was conducted in the institutional pig farm (30-Sow Teaching Unit) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22. The experiment was carried out for 5 months (150 days) i.e. from 15th October 2021 to 14th March 2022. Eighteen (18) weaned Crossbred Hampshire pigs (9 castrated male and 9 female) with an average age of 8 weeks and average body weight of 11.11±0.02 kg were selected for the study. Thereafter, the piglets were divided into three experimental treatment groups depending upon the nearness of body weight and age in such a manner that each treatment consisted of six pigs (3 male and 3 female in each group) *viz*. groups C, T_1, and T_2.

Standard rations were prepared by using different conventional feed ingredients, viz. Maize, Wheat bran, Rice polish, GNC (DO), Fish meal, mineral mixture, Iod. Salt and Poultry by-product meal (PBM).

Cost of Feeding

The average cost per kg grower diet was worked out to be Rs. 29.60 for the C group, Rs.29.44 for T_1, and Rs.29.29 for the T_2 group. Similarly, the average cost per kg finisher diet was worked out to be Rs.28.13. for the C group, Rs.27.97 for T_1, and Rs.27.81 for the T_2 group. Based on feed consumed per kg weight gain, the cost of production per kg live weight in grower were found to be Rs.96.29 for C group, Rs.93.59 for T_1, and Rs.87.92 for T_2 group with cost difference over C, in group T_1 and T_2 were Rs.(-2.70) and Rs.(-8.37). In the finisher stage, similar patterns of descending order of cost of production with feed consumed per kg weight gain were also observed. The cost of production per kg live weight in the finisher stage were found to be Rs.138.17, Rs.132.80, and Rs.129.29 for C, T_1, and T_2 respectively with cost difference over C, in group T_1 and T_2 were Rs.(-5.38) and Rs.(-8.88). From the table, it was evident that the lowest cost per kg gain in body weight was recorded in group T_2 followed by T_1 and C group, respectively in both the grower and finisher period.

Feeding of experimental animals

All experimental pigs were managed intensively under individual feeding with the above feeding regime for 150 days. The animals under the T_1 group were provided with Standard conventional feed with 2.5% inclusion of poultry by-product meal replacing 50% of fish meal. However, the animals of the T_2 group were provided with Standard conventional feed with 5% inclusion of poultry by-product meal replacing 100% fish meal. The control group was provided with standard conventional feed without the inclusion of poultry by-products. The grower rations were provided to the pig from weaning to 5 months of age and thereafter, finisher rations were provided till the end of the experiment. A measured quantity of respective concentrate mixtures was offered to the pigs reared in different groups in the morning at 9 a.m. and in the evening at 3 p.m., and then the leftover was collected the next day and recorded. From these data, the total feed intake was worked out at fortnight intervals. The amount of feed was adjusted at fortnightly intervals along with the change in live weight. Throughout the experimental period, the pigs had free access to clean and fresh drinking water on 24 hours basis

Table 1: Percentage composition of experimental ration

Type of ration	Feed Ingredients	Experimental groups		
		C	T1	T2
Grower ration	Maize	45.00	45.00	45.00
	Wheat Bran	20.00	20.00	20.00
	Rice Polish	7.00	7.00	7.00
	GNC(DO)	20.00	20.00	20.00
	Fish meal	5.00	2.50	0.00
	Poultry By-product meal (PBM)	0.00	2.50	5.00
	Mineral mixture	2.50	2.50	2.50
	Iod. salt	0.50	0.50	0.50
	Total	100	100	100
	CP (%)*	18.31	18.75	19.19
	ME (Kcal/kg)*	3079.27	3115.81	3152.35
Finisher ration	Maize	42.00	42.00	42.00
	Wheat Bran	28.00	28.00	28.00
	Rice Polish	10.00	10.00	10.00
	GNC(DO)	12.00	12.00	12.00
	Fish meal	5.00	2.50	0.00
	PBM	0.00	2.50	5.00
	Mineral mixture	2.50	2.50	2.50
	Iod. salt	0.50	0.50	0.50
	Total	100.00	100.00	100.00
	CP (%)*	16.27	16.71	17.15
	ME (Kcal/kg)*	3059.27	3095.81	3132.35

*Calculated Value.

Feeding of experimental animals

All experimental pigs were managed intensively under individual feeding with the above feeding regime for 150 days. The animals under the T_1 group were provided with Standard conventional feed with 2.5% inclusion of poultry by-product meal replacing 50% of fish meal. However, the animals of the T_2 group were provided with Standard conventional feed with 5% inclusion of poultry by-product meal replacing 100% fish meal. The control group was provided with standard conventional feed without the inclusion of poultry by-products. The grower rations were provided to the pig from weaning to 5 months of age and thereafter, finisher rations were provided till the end of the experiment. A measured quantity of respective concentrate mixtures was offered to the pigs reared in different groups in the morning at 9 a.m. and in the evening at 3 p.m., and then the leftover was collected the next day and recorded. From these data, the total feed intake was worked out at fortnight intervals. The amount of feed was adjusted at fortnightly intervals along with the change in live weight. Throughout the experimental period, the pigs had free access to clean and fresh drinking water on 24 hours basis

Procedure for preparation of poultry by-products meal

Poultry by-products meal was prepared as described by Ockerman & Hansen (1999). Inedible poultry by-products were collected hygienically from the local poultry slaughterhouse and transported to the laboratory in chilled condition. After the separation of the visible dirt, big feathers etc. the by-products were chopped into small pieces. The chopped by-products were sterilized at 121^0C for 15 minutes at 15 lb pressure. After sterilization, the solid cooked by-products were separated from the gravy. Extra pressure was applied to extract moisture/oil from the cooked material. The cooked by-products were minced in a mechanical mincer and thereafter, it was dried using a tray dryer maintained at 55-60^0C for 6-8 Hrs. The dried by-products were milled/ pulverized using one mechanical grinder. Thereafter, the ground by-products were packed in air-tight containers/ packages.

Nutritional composition of poultry by-product meal

The Nutritional composition (on DM basis) of poultry by-products like Dry matter, Organic matter, Crude protein, Ether extract, Crude fibre, and Total ash, were 94.18, 90.4, 60.55, 23.3, 0.30, and 9.6 percent, respectively. The minerals viz. Calcium and Phosphorus were recorded as 3.34 and 1.46 percent respectively.

Body length

Immediately after the animals were weighed, the body length was recorded. It was measured as a straight-line distance from the occipital bone to the base of the tail (Fig. 1). The measurements were taken in centimeters (cm) thrice on each animal with the help of a measuring cloth tape and the averages of the three values were recorded. The body length was recorded only when the animals stood squarely on four legs with the head erect.

Table 2: Chemical composition of the poultry by-product (on dry matter basis)

Components	Percentage (%)
Dry matter	94.18
Organic matter	90.4
Crude Protein	60.55
Ether extract	23.3
Crude fibre	0.30
Total ash	9.6
Ca	3.34
P	1.46

Heart girth

Heart girth was measured in centimeters (cm) at the circumference of the chest behind the elbow joint with the help of a measuring cloth tape (Fig. 2). While measuring, precaution was taken to ensure that the tape was tightened enough to keep the hair down but without indenting the flesh.

Height at withers

Height at withers was measured in centimeters (cm) with the help of a sliding bar while the animal was standing squarely on four legs. Height at withers was measured between the vertical distance from the top of the scapula bone and the ground, parallel to the forelegs (Fig. 3).

Linear body measurements

Fig-1: Measurement of Body Length

Fig-2: Measurement of Heart Girth

FIG-3: Measurement of Height at Wither

Results

Body length, Height at withers & Heart girth

The average monthly changes in body length, Heights at Withers and Heart Girth of crossbred Hampshire pigs in different experimental groups from weaning to 150 days of age have been depicted in Table 3. At weaning, the initial measurements of body length, height at withers, and heart girth were almost similar among all experimental groups, indicating uniformity at the beginning of the study. A consistent and gradual increase was observed in all three body measurements across the experimental period in all groups, reflecting normal growth progression with age. However, the rate of increase varied slightly among the groups, with comparatively higher growth trends observed in T_2, followed by C and T_1. The average daily changes in body length were 0.37 ± 0.02, 0.37 ± 0.01, and 0.38 ± 0.03 cm; height at withers were 0.28 ± 0.01, 0.27 ± 0.01, and 0.28 ± 0.02 cm; and heart girth were 0.37 ± 0.01, 0.37 ± 0.01, and 0.38 ± 0.02 cm in C, T_1, and T_2 groups, respectively. Overall, the increase in body measurements was associated with corresponding improvement in body weight across the groups. Statistical analysis revealed no significant differences ($P > 0.05$) among the control and treatment groups for body length, height at withers, and heart girth throughout the experimental period.

Correlation of Body Weight and Linear Body Measurements:

The coefficients of correlation between body measurements and body weight in crossbred Hampshire pigs showed a strong positive relationship across all experimental groups. Body length exhibited very high correlation with body weight, with R values of 0.998, 0.998, and 0.993 in C, T1, and T2 groups, respectively. Height at withers also showed strong positive correlation, with corresponding R values of 0.992, 0.993, and 0.989. Similarly, heart girth was highly correlated with body weight, with R values of 0.998, 0.998, and 0.995 in C, T1, and T2 groups, respectively.

Table 3: Average monthly body length, heights at withers and heart girth of crossbred Hampshire pigs in the different experimental groups

Days	Body Length (Cm)				Heights At Withers (Cm)				Heart Girth (Cm)			
	Experimental Group			P value	Experimental Group				Experimental Group			P value
	C	T_1	T_2		C	T_1	T_2	P value	C	T_1	T_2	
0	36.58 ± 0.30	36.57 ± 0.28	36.50 ± 0.29	0.977	21.90± 0.50	22.05 ± 0.48	21.83± 0.45	0.947	31.88 ± 0.32	31.77 ± 0.26	31.82 ± 0.34	0.969
30	44.88 ± 0.34	45.08 ± 0.24	44.83 ± 0.46	0.871	28.05 ± 0.51	28.20 ± 0.49	28.00 ± 0.47	0.956	39.88 ± 0.32	39.78 ± 0.26	39.76 ± 0.42	0.964
60	55.38 ± 0.36	55.58 ± 0.32	55.33 ± 0.23	0.643	35.20 ± 0.54	35.35 ± 0.52	35.42 ± 0.52	0.964	50.47 ± 0.31	50.18 ± 0.26	50.26 ± 0.42	0.830
90	67.38 ± 0.43	67.58 ± 0.43	67.33 ± 0.56	0.549	43.40 ± 0.57	43.55 ± 0.54	43.75 ± 0.58	0.901	61.47 ± 0.31	62.10 ± 0.29	61.96 ± 0.42	0.417
120	80.38 ± 0.37	80.58 ± 0.54	80.33 ± 0.67	0.237	52.45 ± 0.67	52.60 ± 0.64	52.80 ± 0.51	0.921	75.47 ± 0.31	75.58 ± 0.42	76.04 ± 0.43	0.557
150	92.39 ± 0.71	92.46 ± 0.99	93.86 ± 0.80	0.401	63.12 ± 0.68	63.27 ± 0.65	63.84 ± 0.46	0.682	86.97 ± 0.31	87.16 ± 0.26	88.65 ± 0.42	0.573

Table 4: Average changes in linear body measurements (body length, heights at withers and heart girth) of pigs in different experimental groups

Days	Body Length (Cm)				Heights At Withers (Cm)				Heart Girth (Cm)			
	Experimental Group			P value	Experimental Group			P value	Experimental Group			P value
	C	T_1	T_2		C	T_1	T_2		C	T_1	T_2	
Initial body length (cm)	36.58 ± 0.30	36.57 ± 0.28	36.50 ± 0.29	0.977	21.90 ± 0.50	22.05 ± 0.48	21.83 ± 0.45	0.948	31.88 ± 0.32	31.77 ± 0.26	31.82 ± 0.34	0.969
Final body length (cm)	92.39 ± 0.71	92.46 ± 0.99	93.86 ± 0.80	0.400	63.12 ± 0.68	63.27 ± 0.65	63.84 ± 0.46	0.682	86.97 ± 0.50	87.16 ± 0.38	88.65 ± 0.42	0.066
Difference in body length (cm)	55.81 ± 0.71	55.89 ± 0.97	57.36 ± 0.87	0.377	41.22 ± 0.19	41.22 ± 0.20	42.01 ± 0.27	0.065	55.09 ± 0.22	55.40 ± 0.13	56.83 ± 0.13	0.084
Daily changes in body length (cm)	0.37 ± 0.02	0.37 ± 0.01	0.38 ± 0.03	0.376	0.28 ± 0.01	0.27 ± 0.01	0.28 ± 0.02	0.129	0.37 ± 0.01	0.37 ± 0.01	0.38 ± 0.02	0.067

Table 5: Correlation of body weight (kg) with linear body measurements (cm) of crossbred hampshire pigs in the different experimental groups

Linear body measurements	Body weight		
	C	T_1	T_2
Body Length	0.998**	0.998**	0.993**
Height at Withers	0.992**	0.993**	0.989**
Heart Girth	0.998**	0.998**	0.995**

N.B.: **= P<0.01

Discussion

In the present study, all the body measurements were increased linearly as the age of the animal is increased. Daily changes in body length, heart girth, and height at withers had no significant difference between all experimental groups. This finding was well attributed to the finding of Jimenez *et al.* (2009); Vidyarathna and Jayaweera (2016). The higher daily changes in body length; heart girth and height at withers of pigs fed with poultry by-product diets might be attributed to the higher growth rate of pigs that were fed with poultry by-product in ration as compared to the fish meal in the ration. However, in contrast to the present finding, Pathak (2016) reported significant effect of dietary energy levels on body measurements. Keegan *et al*. (2004) also reported significant effect in the different body measurements after the inclusion of different levels of poultry meal in the pig diet. Similar findings were also recorded by Banik *et al*. (2012) in body measurement traits in Ghungroo pigs. Vidyarathna and Jayaweera (2016) studied the effect of poultry by-product meal-based diet on the performances

of weaning and growing pigs. They reported non-significant differences in different body measurements i e. for length, height at wither, and heart girth ($p>0.05$) which is in agreement with the present study.

In support of the present finding, the following reports can be considered to have a close agreement: Li *et al.,* (2022) studied on body size measurement and live body weight estimation for pigs based on back surface point clouds. During their study they found that result of size measurement showed the mean relative absolute errors of body length, height, shoulder width were 0.7%, 1.8%, and 3.3%, respectively. They observed a high positive correlation coefficient with BW ($P<0.001$). The correlation between BW with BL and BH was above 0.9, BW was found to be highly Correlated with volume. These results are also in line with the Previous studies (Kongsro,2014). Thapar *et al.,* (2023) also found that body weight was highly correlated with manually measured body length (0.974), total body length (0.974), barrel length (0.969), heart girth (0.967), height at hip (0.958), punch girth (0.955), oblique down (0.95), and middle girth (0.95). Banik *et al.* (2012) reported a marginally lower correlation of body weight with body length (0.90), heart girth (0.90), punch girth (0.89), and height at hip (0.87) at the pre-weaning age of Ghoongroo breed of pigs. Morenikeji *et al.,* (2013) reported a moderate to high correlation of body weight with body length (0.61), height at shoulder (0.75), heart girth (0.83) in Duroc, large white and their hybrid pigs at 56 days of age. Njoku *et al.,* (2013) found that the linear body dimensions (Height at wither, chest and loin girths) and nutrient digestibilities (dry matter intake, crude protein and crude fiber digestibilities, nitrogen intake, absorption and retention) of finishing pigs were influenced by feed quantity offered. Kumari *et al.,* (2020) performed experiment on evaluation of morphometric measurements to Estimate Body Weight in Crossbred Landly Pigs (Landrace × Desi). The results showed high positive correlations of weight with Heart girth. Onyimonyi *et al.,* (2010) found that growing pigs in Nigeria should be fed 4% of their body weight for optimum performance, superior linear body measurement increases and better economic yields.

As the differences in body weight and linear body measurements of the pigs in different experimental groups were not significant, the data of all 3 groups were pooled separately for each month. Analysis of pooled data revealed that the body length, heart girth, and height at withers are dependable measurements for accurately predicting the body weight of crossbred pigs irrespective of their dietary treatments. Thus, the present study revealed a close association of live weight with body length, heart girth, and height at withers and appeared to be a very good indicator of live weight in crossbred Hampshire pigs.

Conclusion

Inclusion of poultry by-products meal at different levels was found to improve the body weight of the experimental pigs. Analysis of variance revealed that there are no significant differences existed between the different treatment and control groups. The coefficient of correlation of body length with the body weight of crossbred Hampshire pigs was found to be positively correlated. Thus, it can be concluded that the inclusion of poultry by-products up to 5% level in the pig ration as a replacer of the fish meal may be recommended for better growth and economic pig production without any adverse effect on general performance. However, further studies are needed for a complete evaluation of the effect of the inclusion of poultry by-products in pig rations to support its usefulness.

Conflict of Interest

There is no conflict of interest. All authors read and approved the final manuscript. The research was conducted following the guidelines of the Institutional Animal Ethics Committee of Assam Agricultural University, Khanapara, Guwahati-781022, Assam, India vide memo no m770/GO/Re/S/03/CPCSEA/FVSC/AAU/IAEC/20-21/819/ dtd 31.07.2021.

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