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EFFECT OF POULTRY BYPRODUCT MEAL BASED DIET ON PERFORMANCES OF WEANING AND GROWING PIGS

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The major constraint for pork production is high feed costs. Poultry by-product meal (PBM) is a cheap, locally produced animal protein source available in Sri Lanka which is high protein feed ingredient potentially suitable for swine diet. This study was conducted to determine the effect of low cost standard diet and low cost high protein diet formulated with PBM as an animal protein supplement on performances of weaning and growing pigs. Landrace weaner piglets (n=18) in both sexes with live weight of 7-8 kg were assigned to three dietary groups of T1: standard diet without PBM: (control), T2: standard diet with PBM, and T3: high protein diet with PBM. The body weight, length, heart girth and height were measured for 90 days. Average daily feed intake, average daily gain, FCR and feed costs were calculated. Two sample t-tests were carried out using SAS 9.2 to analyse average weight gain and body parameters. There was a significant difference ($p<0.05$) between treatment and control group of pigs for body weight gain, heart girth gain, height gain from 65 days to 130 days of age with high protein PBM based diet. No significant difference was recorded for length ($p>0.05$). Higher FCR was observed in piglets fed with diets containing higher levels of PBM. High protein swine diets with over 15% PBM gave better performance with relatively low cost. The experiment concludes that High protein swine diet containing 10% - 26% of poultry by-product meal can be used without negative effect in growth performances of pigs.

Keywords: performance, growing pigs, poultry by-product meal

Pigs are omnivorous, highly social and intelligent animals which are valuable for their flesh, prepared as ham, bacon and pork, and for their fat (lard). They also provide many other products, such as leather, bristles for brushes and ingredient for cosmetics. Swine sector is one of the main livestock sub- sectors which places next to the poultry and dairy sectors in Sri Lanka. More than 6,000 farmers are engaged in swine farming as their main income generating activity. Number of pig farms in the country in 2014 has been recorded as 10,699. Pig farming is mainly concentrated into four districts along western coastal belt in Sri Lanka; Colombo, Gampaha, Kurunegala and Puttlam. Swine farms could be categorized as small scale (60%) medium scale (25%) and large-scale (15%). Estimated pork production in the country had been 7,080 tons during the year 2014 (DAPH, 2014). Swine has the ability to obtain nutrients from a wide variety of feedstuffs (Wang, *et al.,* 2013). They can consume both plant and animal food sources. Feedstuffs from animal sources have been efficiently used in swine diets (Cho and Kim 2011; Lei and Kim 2013). Feed stuff that contain animal proteins such as fishmeal, meat meal, meat and bone meal, and poultry byproduct meal are potentially important protein sources and feed ingredients for swine nutrition because of their amino acid profiles and crude protein levels (Lee, 2001).

Feed cost comprises 65-75% of the variable costs of pork production. Reducing feed costs by using poor-quality diets may not be very economical, as feed usage would be higher and pig meat returns lower because of poor carcass grading. Using very high-quality diets or severely restricting feed

intake does not improve carcass quality and returns. To achieve a profitable compromise, pigs must be fed diets that satisfy their needs to reach their potential for lean meat growth, in the case of growers. Increased grain and supplement costs have complied pork producers seeking alternatives for traditional ingredients in swine diets. Pigs are monogastric omnivores which compete directly with human for grains. Feed manufacturers and livestock producers are facing problems as prices of grains, oil cakes and fishmeal are increasing day by day. Poultry by-product meal is one of the alternative sources of animal protein that can be used to feed domestic animals, along with meat and bone meal, blood meal, feather meal and fish meal (Meeker *et al.,* 2006).

There is a paucity of information regarding the use of poultry byproduct meal (PBM) which is also referred to as hypromeal in the local market, in the diet of growing pigs. PBM has been used in poultry broiler diets at 10% inclusion rate (Jayaweera and Premasiri, 2014) and proven better performance. This study was conducted to test poultry byproduct meal as the major protein source in pig diets and the study was designed to investigate the effect of poultry byproduct feeding on feed intake, growth performances of weaned pigs and to evaluate the economics of feeds formulated incorporating poultry byproduct meal.

MATERIALS AND METHODS

Livestock and Avian Sciences, Faculty of Livestock, Fisheries and Nutrition, Wayamba University of Sri Lanka which is located in low country intermediate zone (IL2) at the coordinates of 7°19'25.0"N 79°59'17.9"E. Landrace weaner piglets (n=18) of both sexes with nearly equal weight (live weight 7-8 kg) weaned at 30 days were selected from three litters for the experiment. They were assigned to three groups (n=6) taking one male and a female randomly from each litter and managed intensively under uniform conditions other than the treatments. The pre-experimental period of 10 days was given for the piglets to acclimatize before the experiment. The experimental diets were formulated using nine ingredients: maize, rice polish, broken rice, soybean meal, fish meal, PBM coconut poonac, animal fat, premix, Mineral supplements, common salt and toxic binders and enzyme as additives.

Table 1 Proximate composition and energy content of poultry byproduct meal

Component	Composition Average (%) ± SD
Dry matter %	93.2 ± 1.5*
Crude protein %	52.2 ± 3.3**
Ether extract %	11.2 ± 3.0*
Metabolizable energy (kcal/kg)	2030 ± 160*
Ash %	5.1 ± 1.8*
Ca (g/kg)	15.0 ± 4.8*

Sources: * Jayaweera and Amadari, (2015), ** Jayaweera and Premasiri, (2014),

The ration were formulated according to NRC recommendation of crude protein, metabolizable energy, Ether extract, calcium, phosphorus, Sulphur containing amino acids and lysine for the growing stage (Table 1) using Swine ration builder (Jayaweera, 2015). Each treatment had three rations for different growing stages. Rations were balanced keeping the uniform composition of major nutrients. The difference between T1 and T2 rations were that T1 has fishmeal as animal protein supplement while T2 has PBM. T3 has PBM as animal protein supplement in higher inclusion rate and contains 6% more protein (Table 2).

The required amount of bulk feed stuff were powdered to 2 mm mash and mixed together with fat and additives. Weekly feed requirement was processed into 4mm pellets and secured in store.

The experimental animals were fed as per their body weight (4% of body weight/day) twice a day following the NRC, recommendation.

Data were collected to investigate the effect of inclusion of PBM based high protein diets and standard diet on growth performance by measuring body weight, total length, total height and heart girth in three growing stages based on body weight G1(10-20 kg), G2 (20-35kg) and G3 (35-60 kg). Body

Table 2 Composition of three experimental diets

Growing stage and Live weight,	Nutrients	Composition T1	T2	T3
0G1- 10 – 20 kg	Digestible energy, kcal/kg*	3347	3361	3410
	Metabolizable energy, kcal/kg	3092	3105	3109
	Crude Protein, %	18	18	24
	PBM content %	0	15	26
G2 -20 – 35kg	Digestible energy, kcal/kg*	3347	3347	3390
	Metabolizable energy, kcal/kg	3106	3105	3104
	Crude Protein, %	16	16	22
	PBM content %	0	11	20
G3- 35 – 60kg	Digestible energy, kcal/kg*	3329	3326	3370
	Metabolizable energy, kcal/kg	3102	3099	3100
	Crude Protein, %	14	14	20
	PBM content %	0	07	15.5

Note :* estimated with the formula ME=DE x (96- (0.202x crude protein%))/100

T1: standard protein content, with soymeal, coconut poonac and fishmeal as protein supplement.

T2: standard protein content, with soymeal, coconut poonac and PBM (<10%) as protein supplement.

T3: high protein content (6% extra protein compared to standard), with soymeal, coconut poonac and PBM (10-26%) as protein supplement.

weight of animals were recorded in every 05 days interval in the morning before feeding. Body length were taken between rump and front side of armpit and height was taken at the withers from floor.

Cumulative feed intake and survivability were recorded for each treatment. Feed Conversion Ratio (FCR) and growth rate (weight gain) was calculated. As the performance parameters, gain and FCR were assessed at the end of each growing stage. The starting weight of each stage was used as co-variable for gain.

The costs of the experimental diets were calculated based on the existing price of the ingredients during the experimental period. Cost of production per respective treatment was calculated based on feed cost per unit gain. Gross margin was calculated taking the market price of live weight/kg and total variable cost into account.

RESULTS

Experimental diets for three treatments and three growing stages were formulated and proximate composition of the nine rations (Table 3) were uniform in relation to all main nutrients other than the variation intended by the treatments. However, lysine content of the high protein rations with PBM (T3G1, T3G2 and T3G3) was high and requirement for calcium and phosphorus supplements such as di-calcium phosphate was low. Ratio between protein and energy (kcal/g of protein) was maintained in diets of T1 and T2 at the recommended level. However T3 diets had less protein to energy ratio because of high protein content in T3G1, T3G2 and T3G3 diets.

Additives: toxin binder, antioxidant, DCP: di-calcium phosphate, SAA: Sulphur containing amino acids, ME: metabolizable energy

Starting body weights of the piglets (at 40 days) were 7 to 8 kg and average final body weights were 51.65 kg, 41.61 kg and 55.70 kg in T1, T2 and T3, respectively. There was no significant difference between body weight of treatment groups until 65 days of age and after 65 days of age, significant difference ($P<0.05$) of body weight between T2 compared to T1 and T3 was observed

Table 3. Ingredient used and nutrient composition of the experimental diets

Ration	**Control (T1)**			**T2**			**T3**		
Protein content (%)	18	16	14	18	16	14	24	22	20
Growth Stage	T1 G1	T1 G2	T1 G3	T2 G1	T2 G2	T2 G3	T3 G1	T3 G2	T3 G3
Ingredients	**kg/ton**								
Maize	350	390	385	390	390	390	390	390	390
Rice	70	125	150	80	102	150	50	55	75
Rice polish	190	210	210	180	230	210	140	180	180
Animal Fat	30	10	15	25	13	15	10	5	10
Coconut poonac	110	55	85	110	95	110	60	65	65
Soymeal	190	145	105	35	30	25	75	90	100
Fishmeal	30	30	15	0	0	0	0	0	0
PBM (hypromeal)	0	0	0	150	110	70	260	200	155
DCP	22	27	27	22	22	22	7	7	17
Vitamin Premix	3	3	3	3	3	3	3	3	3
Additives & salts	5	5	5	5	5	5	5	5	5
Composition									
Crude protein %	18.0	16.0	14.0	18.0	16.0	14.0	24.0	22.0	20.0
Energy (ME kcal/kg)	3092	3106	3102	3105	3105	3099	3109	3104	3100
Ether extracts %	9.7	7.8	8.1	9.8	8.8	8.5	8.9	8.5	8.6
Crude fibre %	5.0	4.6	4.8	4.6	4.7	4.9	4.3	4.5	4.5
Ash %	7.6	7.8	7.8	9.1	8.8	8.3	9.2	8.6	8.8
Calcium %	0.77	0.87	0.80	1.0	0.92	0.81	1.10	0.83	0.94
Phosphorus %	0.64	0.73	0.70	0.70	0.74	0.67	0.60	0.60	0.71
SAA %	0.57	0.53	0.46	0.46	0.43	0.40	0.59	0.56	0.53
Lysine %	0.97	0.83	0.67	0.93	0.79	0.64	1.30	1.24	1.01

Table 4. Average cumulative body weight gain (kg) per pigs from 40 days to 130 days of age

Age (Days)	**Control(T1)**	**Treatment 1 (T2)**	**Treatment 2 (T3)**
40	0 ± 0	0 ± 0	0 ± 0
50	2.55 ± 0.35^{a}	2.50 ± 0.42^{a}	2.70 ± 0.84^{a}
60	5.85 ± 1.20^{a}	6.75 ± 0.07^{a}	6.35 ± 1.06^{a}
70	9.95 ± 1.62^{a}	9.65 ± 0.14^{a}	10.70 ± 0.98^{a}
80	14.55 ± 2.19^{a}	12.15 ± 0.21^{a}	15.45 ± 1.34^{a}
90	20.55 ± 2.89^{a}	16.15 ± 0.56^{a}	22.20 ± 1.69^{a}
100	25.55 ± 2.89^{a}	20.15 ± 0.91^{a}	28.20 ± 1.69^{a}
110	31.55 ± 2.89^{a}	24.15 ± 0.21^{b}	35.20 ± 1.69^{a}
120	37.43 ± 3.04^{a}	28.65 ± 0.91^{b}	41.45 ± 1.69^{a}
130	44.05 ± 2.89^{a}	33.65 ± 0.91^{b}	48.20 ± 1.69^{a}

Values are presented as mean ± SD, n=06, Values sharing different superscript letters indicate the **significant difference at p<0.05**

(Figure 1) and the highest final body weight was recorded in T3. However, difference between T1 and T3 was not significant (Table 4).

General weakness of animals and diarrhea was observed in T2 from 65 days to 90 days and feed intake and daily gain was recorded low. Behavior and condition of the animals

Table 5: Body measurements and Average gain of animal thought the experiment period

Character	T1	T2	T3
Initial body length (cm)	46.5±0.70 [a]	50.5±0.32 [a]	49.5±0.14 [a]
Final body length (cm)	77.5±2.82 [a]	78.5±0.70 [a]	82.5±0.70 [a]
Initial height (cm)	28.5±1.40 [a]	30.5±1.00 [a]	30.5±0.35 [a]
Final height (cm)	53.3±1.70 [a]	50.5±1.40 [b]	57.2±.34 [a]
Initial heart girth (cm)	43.5±0.35 [a]	46.0±0.51 [a]	45.5±0.70 [a]
Final heart girth (cm)	80.3±1.70 [a]	74.6±2.72 [b]	86.0±1.00 [a]
Initial body weight (kg)	7.6±0.14 [a]	7.9±0.35 [a]	7.5±0.42 [a]
Final body weight (kg)	51.7±2.89 [a]	41.6±0.91 [b]	55.7±1.69 [a]
Weekly body length gain (cm)	2.4±0.1 [a]	2.2±0.1 [a]	2.5±0.1 [a]

* Values are presented as mean ± SD, Values sharing different superscript letters within the row indicate the significant difference at $p<0.05$.

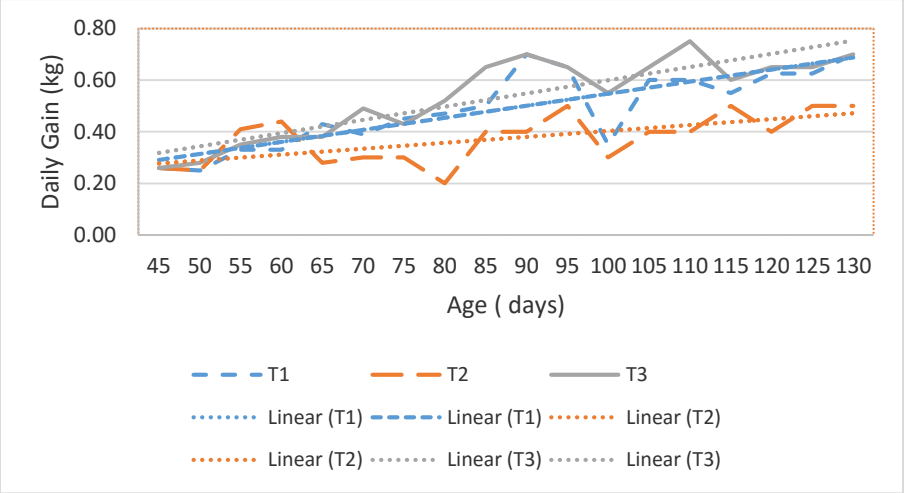

Figure 1: Average daily body weight gain (kg/day) from 40 days to 130 days of age

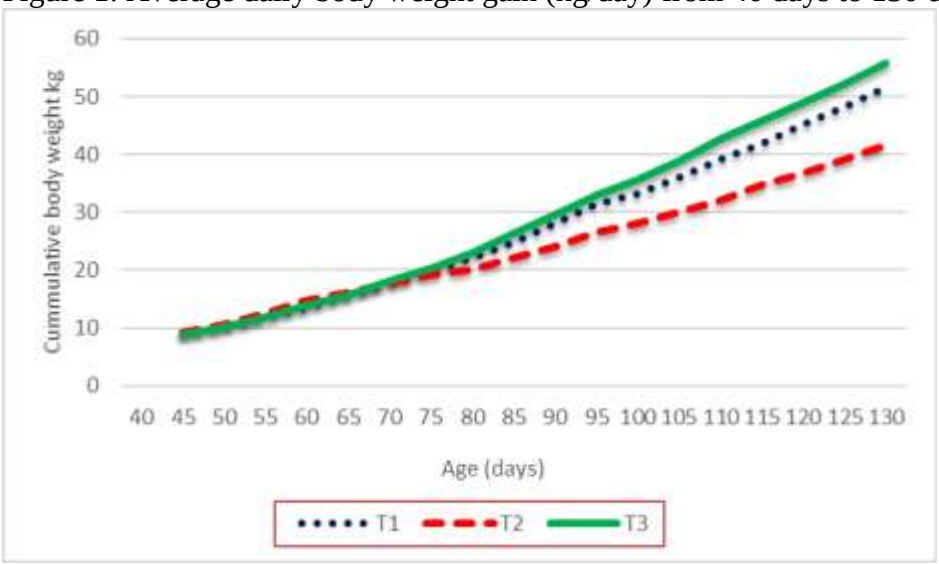

Figure 2: Growth pattern of piglets in three treatment groups during experimental period

were back to normal after 90 days of age. However feed intake of the group was low compared to the other groups until end of experimental period.

In compared with the control, there was no significant difference in body weight gain of T2 and T3 until 65 days of age ($P>0.05$). After the 65 days of age, there was

significant difference between T2 compared to control (T1) and T3 up to 130 days of age ($P<0.05$) (Figure 1). Sudden drop of daily gain was evident in T2 from 60 to 65 days of age and daily gain was low up to 85 days (Figure 1) parallel to the general weaknesses observed.

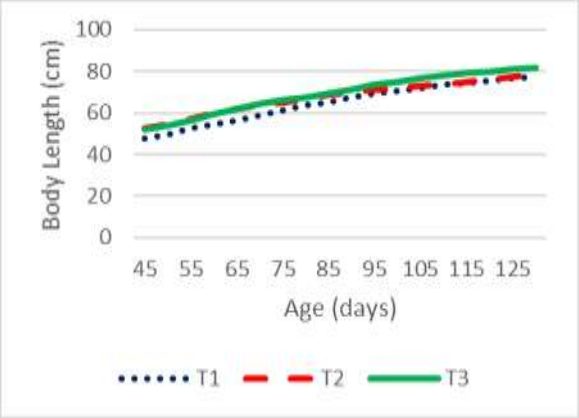

Figure 3: Growth of body (length) in three treatment groups during experimental period

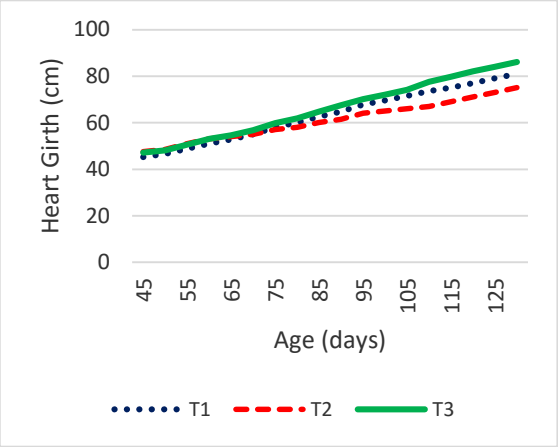

Figure 4: Average heart girth of pigs during experimental period

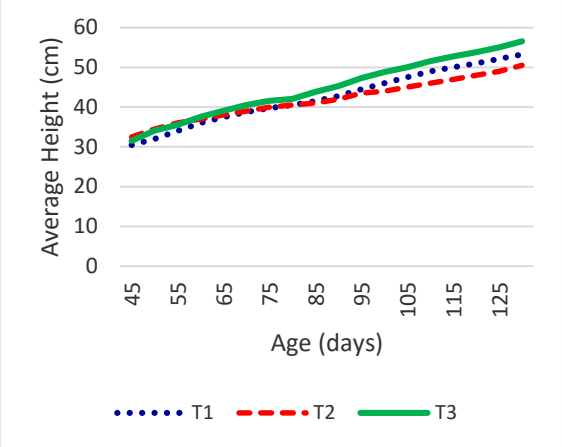

Figure 5: Average height gain of pigs during experimental period

There was no significant difference of the average final body weights or gain of male and female with the treatments at any stage of the experiment. All three dietary groups exhibited relatively uniform growth pattern after 85 days of age up to the end (Figure 2).

Body measurements other than the weight were taken to compare the body conformation of animal in three groups. According to visual observations, and in relation to length and girth in all treatment and control groups, body conformation was uniform at the beginning. Initial average length of animals, heart girth and height in each treatment were not significantly different (Table 2).

Average weekly body length gain of T1, T2, and T3 were not significantly different (Figure 3). However, the final height, heart girth and body weight, were significantly different in T2 compared to T1 and T3 separately, but the difference was not significant between T1 and T3. (Figure 4)

In comparison to the control, there was no significant difference ($P>0.05$) in heart girth gain of treatment group until 100 days, but there was significant difference ($P<0.05$) between T2 compared to T1 and T3 form 105 days of age up to the end of the experimental period of 130 days (Figure 4). The highest heart girth gain of 40.5cm recorded in T3 while T1 and T2 recorded 36.8cm and 28.6cm, respectively.

The average gain of height the pigs, in the T1, T2 and T3 were 24.75cm, 20.00cm and 26.75cm at the end of 130 days respectively and therefore total height in T1, T2 and T3 were 53.3±1.70cm, 50.5±1.40 cm, and 57.2±.34 cm, respectively. There was significant difference ($P>0.05$) of height of animals in T1 and T3 compared to T2 from 100 days of age onwards (Figure 5).

DISCUSSION

The experimental area is located in hot humid climate in low country intermediate zone (IL2) in Sri Lanka which experiences average ambient temperature of 89.9^0 F during day and 80.6^0 F during night during

Table 6: Performance characters of pigs during body weight stage 1 (Live weight 10-20kg)

Performance characteristics	Treatment 1 (Control)	Treatment2 (T2)	Treatment 3 (T3)
Average Initial Live Weight (kg)	7.6	7.9	7.5
Days to achieve 20kg weight	75	80	75
Average Live Weight (kg) at 70 days	19.9	20	21.65
Average Weight Gain(kg) in stage G1	12.2	11.15	12.85
Average Total Feed Intake (kg/pig)	23.88	21.6	24.63
Feed Conversion Ratio (FCR)	1.96	1.94	1.92
Survival Rate (%)	100	100	100
Average Daily Gain (g/pig)	350	320	370

the season of experiment. The temperature in the experimental area is within the thermos-neutral zone of pig (Jensen *et al.*, 1969). Piglet growth parameters can be influenced by breed, sex, health, birth weight and age at weaning other than their diet (Melton *et al*, 1967). Ambient temperature, floor space and feed affects growth performance and meat quality (White, 2008). The piglets were selected for this experiment keeping all of these factors uniform by selecting, one breed, even body weights, equal number of male and female in each group. The rearing environment also was uniform for all the treatments. Growth performance analysis are commonly based on single bodyweight criterion at a corresponding age of animal. These recommendations are useful, when individual genetic differences such as initial weight were also incorporated (Heinrichs *et al*, 1990). The genetically uniform animals were used in all treatments by allocating two piglets from each litter in each treatment group.

According to the body parameters assessed, the pigs fed standard diet formulated PBM (T2) have shown poor growth rate than other two groups during experimental period after the 60 days. In this period some of the piglets were suffering from mild form of diarrhea and skin infection for a short period. That was observed only in T2. As a result, they exhibited low feed intake in some days from 60 to 70 days of age. This condition might have affected the poor growth rate in animals in treatment 2. The complication was not concluded as an effect of dietary treatment because animals recovered shortly without changing the feed. When compared to standard diet with or without PBM (T1 and T2) high protein diet with PBM (treatment T3), reported highest growth performances. A crude protein level of diets in treatment 3 were 24%, 22% and 20% at growing stage one (10kg-20kg body weight), growing stage two (20kg-35kg body weight) and growing stage three (35kg-60kg body weight) respectively which is 6% more in protein compared to standard for each corresponding stage. Zier, (2004) has reported that there was no difference in performance of piglets fed PBM in place of the other ingredients such as fishmeal and blood meal. Previous studies have revealed that, diet formulated with PBM up to 7.5% for pigs in growing stage from weaning to slaughter, can be used with no adverse effect on growth performances (Orozco-Hernandez *et al.,* 2003, Keegan, et al., 2004, Kannan, *et al*,. 2008). According to Zier, (2004) feed intakes were higher ($P < 0.01$) for pigs fed the conventional diet than for pigs fed the 20% PBM diet during post weaning Phase. However in this study, PBM has been used comparatively higher inclusion rates of 26%, 21% and 15.5% in T3G1, T3G2 and T3G3 diet at three different growing stages G1, G2 and G3 respectively with no effect of feed intake and any negative effect on animal performances. Lysine level of the T3G1, T3G2 and T3G3 diet were high compared to the diets in T1 and T2 (Table 3.3). Lysine level in diet has a positive relationship to growth and maximum yields including average daily gain, gain:feed ratio, carcass weight and grade can be achieved by administrating finishing pigs with an ideal

Table 7: Performance characters of pigs during body weight stage 2 (20 35 kg)

Performance characteristics	Treatment 1 (Control)	Treatment 1 (T2)	Treatment 2 (T3)
Average Initial Live Weight (kg)	19.9	20	21.65
Average Live Weight (kg) at 100 days of age	33.25	29	37
Days taken to gain 35 kg weight	105	120	100
Average Weight Gain (kg) in stage G2	13.35	9	15.35
Average Total Feed Intake (kg/pig)	28.9	24.9	31.4
Feed Conversion Ratio (FCR)	2.16	2.77	2.04
Survival Rate (%)	100	100	100
Average Daily Gain (g/pig)	535	360	615

Table 8: Performance characters of pigs during stage G3 (35- 60kg)

Performance characteristics	Treatment 1 (Control)	Treatment 1 (T2)	Treatment 2 (T3)
Average Initial Live Weight (kg)	33.25	29	37
Average Live Weight (kg) at 130 days	51.75	42.5	57
Average Weight Gain (kg) in stage G3	18.5	13.5	20
Average Total Feed Intake (kg/pig)	52.425	37.125	55.25
Feed Conversion Ratio (FCR)	2.83	2.75	2.77
Survival Rate (%)	100	100	100
Average Daily Gain (g/pig)	620	450	670

Lysine: digestible energy ratio, Lys 2.1 g/DE Mcal (Cho, 2012). All the diets in the experiment had more than 2.1g of lysine/DE Mcal and T3 diets had over 3.5g of lysine/DE Mcal.

According to the performance analysis based on body weight, length, heart girth and height as body parameters and calculated performance characters such as average feed intake, average daily gain and FCR, higher protein diets with high PBM contents have resulted better growth rate in relation to body weight and FCR (Table 6)

According to the NRC (1998) the expected daily gain is 500g and FCR is 2.00 at the live weight between 10kg-20kg of pigs. In this experiment better FCR have been recorded in three treatments however, expected daily gain of 500g in growth stage one have not been achieved in any of the treatments. This may be because piglets in stage one had not consumed the recommended amount of daily ration. The level of PBM in T3 diet was very high (26%) compared to T2. However highest FCR, highest feed intake and highest body weight at the end of the growth stage have been recorded in T3. According to Zier (2004) PBM can be used in nursery diets in place of blood meal and fish meal without affecting performance. The feed intake and growth performance in growing stage G1 suggest that there is no adverse effect of higher inclusion rate of PBM on palatability and performance of weaners from 10 to 20 kg body weight.

According to the NRC (1998) the expected daily gain is 600g/pig and FCR is 2.50 at the live weight between 20kg-35kg of pigs. Both control (T1) and treatment 2 groups have recorded less average daily gain and less FCR than expected value but treatment 3 had recorded daily gain which is higher than expected value with better FCR (Table 7). Treatment 2 recorded lower feed intake than the recommendation for the stage. Low weight gain and low FCR in treatment 2 suggest that though the protein and energy content is up to the standard, diet is low in palatability and feeding values. The particular diet contains PBM instead of fishmeal other than that there was no other difference even in proximate composition. (Table 3).

Fishmeal is more palatable in growing pig diets. Research has indicated that pigs of different breeds or genetic background may have different capacities for production, thus different nutrient requirements according to the guidelines for pig feeding (Kansa State University, 2007). A common mistake that happens in ration formulation for growing pig is inclusion of more digestible ingredients but less palatable ingredients. However, poor palatability has not been reported in T3 irrespective to the high content of PBM (15.5 to 26%) in all three T3G1 . T3G2 and T3G3 diets. Animals in T3 have achieved expected body weight in short period and this may be due to higher protein intake of animals per day.

At the weight between 35kg-60kg the expected daily gain of pig is 700g and FCR is 2.80 (NRC 1998). Average daily gain was less than expected value during this period in two treatments and the control but treatment 3 exhibited higher value compared to other two (Table 8). According to Onyimonyi, (2010) pigs reported optimum performance and better economic returns with the highest significant changes in chest girth, height at withers and body length when feeding growing pigs at level of 4% of their body weight. Animals in T1 and T3 have recorded 4% feed intake/day according to the body weight at the stage three but animals in T2 has recorded only 3.3% to the body weight. There were left over feed in the T2 suggesting that they have received *ad libitum* feeding. Average daily feed intake, growth, heart and lion girth, total length and carcass quality is influenced by the quantity of feed available (Njoku, *et al.* 2015). Low feed intake and lower growth was reported in T2. According to Patrick, (2001) pattern of average daily gain of light weight pigs and heavy pigs did not differ, but the gain was greater in pigs with higher weight. Therefore, low initial body weight in T2 at the beginning of the stage would have been the main factor for low final weight too. FCR recorded in T2 and T3 were better than the expected according to NRC and better compared to T2 though that was not significant ($p<0.05$).

Feed cost per kilogram gain is calculated by multiplying feed efficiency by the feed cost per kilogram (Table 9). The profitability of a piggery is very sensitive to the cost of feed used, and the efficiency to convert feed into meat. To maximize profits, a delicate compromise must be reached between minimizing feed costs and maximizing pig meat returns. Feed cost can vary between 55

Table 9: Cost analysis variables during research period per animal

Weight Stage	Variables	Control (T1)	Treatment 1 (T2)	Treatment 2 (T3)
10kg – 20kg	Cost Rs./kg of Feed	70.75	59.15	64.75
	Total Feed Intake (kg)	47.75	43.20	49.25
	Total Cost Rs./Feed	3378.31	2555.28	3188.94
20kg – 35kg	Cost Rs./kg of Feed	67.15	57.95	63.15
	Total Feed Intake (kg)	57.80	49.80	62.80
	Total Cost Rs./Feed	4082.72	2885.91	3965.82
35kg – 60kg	Cost Rs./kg of Feed	61.85	56.15	60.80
	Total Feed Intake (kg)	104.85	74.25	110.50
	Total Cost Rs./Feed	6484.97	4169.33	6718.40
	Cost of feed Rs/kg live weight	269.4	226.1	243.3
10kg - 60kg	Total Feed Cost Rs./Pigs	13946.00	9610.52	13873.16

to 70 percent of a piggery's total operating costs. Inclusion of PBM reduces the cost of feed and higher protein diets can be prepared at a low cost compared to the standard diet (Table 9). High protein diet used in T3 were always economical compared to control diet (T1) in this experiment. Diet in T2 was the least cost formula used in the experiment and that reported the lowest cost of production. However, reducing feed costs by using poor-quality diet may not be very economical, as feed usage would be higher and pig meat returns lower because of poor carcass grading (Kansas State University, 2007).

Cost for producing a given amount of pork reduces as pig market weight increases. This is mainly due to a decreased marginal production cost accompanying the increased market weight, because costs for sow management, nursery management and genetic premiums for sows per market pig decreases following an increase in market weight (Kim *et al.*, 2005). Therefore, T2 would be the most profitable dietary treatment and would have been even better if higher carcass weight could have been achieved. According to the data, treatment diets were cheaper than control diet and also treatment diet were very economical compared with some commercial feeds which are around Rs 66.00/kg for weaning pigs and Rs 65.50/kg for grower pigs.

CONCLUSION

The poultry by-product meal (hypromeal) has an effect to enhance the growth performances of pigs. High protein swine diet with contain 10%-26% of poultry by-product meal can be used without negative effect of growth performances of pigs, and high protein swine diet gives better performance with relatively low cost. Poultry by-product meal can be applied as economically beneficial alternative feed ingredient to produce high quality, low cost swine diet.

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