International Conference on "Novel Approaches in Agro-ecology, Forestry, Horticulture, Aquaculture, Animal Biology and Food Sciences for Sustainable Community Development"
(Agro-tech-2017)

Effect of energy levels in the diet of Large White Yorkshire pigs on growth and feed intake pattern

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Abstract—*Experiment was conducted to study the effect of different levels of energy in the diet of Large White Yorkshire pigs on growth and feed intake pattern. Twenty weaned female Large White Yorkshire piglets were randomly divided into two groups and allotted to the two dietary treatments, T1-control ration: as per NRC, 2012 and T2-high energy ration: control ration + 400 kcal/kg of ME and maintained for 70 days. The daily feed intake, fortnightly body weight were recorded and average daily gain and feed conversion efficiency were calculated. The average daily gain and feed conversion efficiency were 769.86, 828.14 and 2.88, 2.57 respectively for two dietary treatments. The pigs of T2 had higher (P<0.05) average daily gain and feed conversion efficiency than that of T1 treatment. The high energy ration (3663 kcal/kg) increased the average daily gain and reduced total feed intake thereby improved in feed conversion efficiency in the growing Large White Yorkshire female pigs compared to the ration containing energy as per NRC (2012).*

Key words*: Energy, Pig, Growth, feed intake, Feed efficiency*

INTRODUCTION

Energy is one of the costliest factors in commercial pork production. Indian Council of Agricultural Research (ICAR, 1985) recommended digestible energy (DE) levels of 3100 and 3000 kcal/kg feed for pigs weighing 5 to 10 and 10 to 60 kg, respectively. The National Research Council (NRC, 2012) recommended 3400 kcal of DE or 3265 kcal of ME per kg diet for pigs of all age groups. When pigs were given increasing levels of energy (13.3, 14.0 and 14.7 MJ of DE/kg feed) the average daily gain and gain to feed ratio increased linearly (Kyriazakis and Emmans, 1992; Nam and Aherne, 1994). Significant improvement in feed efficiency was observed in pigs as the energy level was increased from 3.23 to 3.39 Mcal of DE/kg feed (Balogun *et al.*, 1988), from 3.5 to 3.78 Mcal of DE/kg feed (Lawrence *et al.*, 1994; Chang, 2000), from 5.4 to 8.1 Mcal of ME/day (Liao and Venum, 1994), from 9.5 and 10.1 Mcal of ME intake per day (Williams *et al*., 1994), from 12.0 to 14.4 MJ of DE/kg feed (Henman *et al.*, 1999), from 3.35 to 3.61 Mcal of DE/kg feed (Llata *et al*., 2001), from 3034 to 4384 kcal of DE/kg feed (Ding *et al.*, 2003), from 14.5 to 16.4 MJ of DE kg in barrows (Campbell, 2005) and from 3.09 to 3.57 Mcal of DE/kg feed (Beaulieu *et al*., 2009).

Higher average daily gain was observed in pigs fed diets containing 14.5 MJ of ME/kg of feed than that fed 13.5 MJ of ME/kg of feed (Urynek and Buraczewska, 2003). Pigs fed with ration containing 351 KJ of DE/kg$W^{0.75}$ had better average daily gain than that of 506 or 566 KJ of DE/kg$W^{0.75}$ per day (King *et al.*, 2004). Cho *et al.* (2008) reported that increasing energy content of the diets to 3 times maintenance requirement resulted in significantly higher feed intake, daily body weight gain and feed to gain ratio in pigs compared with those fed at 1.8 times maintenance energy.

The availability of findings is scanty and also with high variation prompted to undertake this study to find out effect of different energy levels in the diet of large White Yorkshire pigs on carcass and sensory parameters.

MATERIALS AND METHODS

Twenty weaned female Large White Yorkshire piglets were randomly divided into two groups with five replicates in each group. Each replicates were allotted with two piglets and housed in a single pen. All piglets were maintained under identical management conditions throughout the experimental period of 70 days.

Experimental rations

Restricted feeding was followed by allowing them to consume as much as they could, within a period of one hour and the balance feed was collected and weighed after each feeding. Daily feed intake was recorded. The animals were fed with

ISBN: 978-93-85822-60-5

standard grower ration containing 18 per cent of crude protein (CP) and 3265 kcal of metabolizable energy (ME)/kg of feed up to 50 kg body weight and finisher ration with 16 per cent CP and 3265 kcal of ME /kg of feed from 50 kg body weight as per NRC (2012). The two groups of piglets were randomly allotted to the two dietary treatments, T1-control ration: as per NRC, 2012 and T2- high energy ration: control ration + 400 kcal/kg of ME. Ingredient and chemical composition of pig grower and finisher rations were given in the Table 1and 2.

Feed intake, Body weight and Feed efficiency:

Weighed quantities of feed were offered twice a day at 9.00 am and 3.00 pm. After adding feed in the manger little water was sprinkled over to moistening. The feed intake was measured daily after collecting the left over feed if any and body weight of the individual animals were taken fortnightly in the morning hours before feeding. Then average daily gain and feed conversion efficiency was calculated. Data collected on various parameters were statistically analyzed by Completely Randomized Design (CRD) method and m means were compared by Duncan Multiple Range Test (DMRT) using Statistical Package for Social Studies (SPSS, 2008) 17.0.1V software.

RESULTS AND DISCUSSION

Feed intake

Data on weekly average feed intake of pigs given the two experimental rations T1 and T2 and are presented in Table 3. The total feed intake recorded for two treatments were 154.98 and 148.61 kg, respectively. No significant difference in weekly feed intake except ninth and tenth week, during these period pigs in T2 had lower feed intake than T1. Overall high energy diet (T2) resulted in significantly lower ($P<0.01$) feed intake compared to control group, which may due to high energy density (3663kcal ME/kg) of the ration. The ability of animals to regulate the feed intake is based on the energy content of the feed and gut capacity of pigs (Azain, 2000; Ellis and Augspurger, 2000). Addition of fat to the diet of pigs increases energy density and results in a reduction in feed intake to maintain a constant DE intake (Ewan, 2000). Increase in energy concentration is usually associated with a reduction in voluntary feed intake in pigs (Noblet, 2006).

Body weight gain

The data on the body weight and weight gain of pigs are presented in Table 4. The average initial, final body weight and average daily gain of piglets belonging to two groups were 23.96, 24.18 kg; 77.85, 82.15 kg, and 769.86, 828.14 kg, respectively. The statistical analysis of the data revealed significant difference in the average body weight and weight gain between two treatments. High energy content of the ration over and above the requirement had significantly higher body weight and average daily gain.

Feed conversion efficiency

The data on the fortnightly feed conversion efficiency and their cumulative values of pigs under two treatment groups are presented in Table 5. The overall feed conversion efficiency recorded was 2.88 and 2.57, respectively. Statistically T2 treatment had higher feed conversion efficiency than that of T1 treatment for overall period and also in all the fortnight except in first and third fortnight, in this period both the treatment had similar feed conversion efficiency. Higher energy ration in the T2 treatment reduced the total feed intake and yielded higher body weight so could yield better feed conversion efficiency compared to control group fed diet with normal energy level.

Daily gain and feed conversion efficiency of growing pigs

Average daily gain and feed conversion efficiency of growing pigs maintained on the two experimental grower rations T1 and T2 are presented in Table 6. The average total weight gain and average daily gain of these pigs during growing stage was 25.49, 27.73 kg and 728.29 and 792.29 g, respectively for two treatments. The total feed intake of grower ration and feed conversion efficiency was 62.48, 61.43 kg and 2.45, 2.22, respectively for two treatments. The treatment T2 had significantly higher average daily gain and better feed conversion efficiency than that of T1 treatment due to higher energy content in the T2 ration.

Daily gain and feed conversion efficiency of finisher pigs

Average daily gain and feed conversion efficiency of growing pigs maintained on the two experimental finisher rations T1 and T2 are presented in Table 6. The average total weight gain and average daily gain of these pigs during growing stage was 28.40, 30.24 kg and 811.43, 864.00g, respectively for two treatments. The total feed intake of grower ration and feed conversion efficiency was 92.50, 87.18 kg and 3.26, 2.89, respectively for two treatments. The treatment T2 had significantly high average daily gain better feed conversion efficiency than that of T1 treatment due to higher energy content in the T2 ration.

Overall daily gain and feed conversion efficiency of experimental pigs

Average daily gain and feed conversion efficiency of growing pigs maintained on the two experimental finisher rations T1 and T2 are presented in Table 6. The average total weight gain and average daily gain of these pigs during growing stage was 53.89, 57.97 kg and 769.86 828.14 g, respectively for two treatments. The total feed intake of grower ration and feed conversion efficiency was 154.98, 148.61 kg and 2.88, 2.57, respectively for two treatments. The treatment T2 had significantly lower feed intake, higher average daily gain and better feed conversion efficiency than that of T1 treatment. Higher energy ration in the T2 treatment reduced the total feed intake and higher body weight, so could yield better feed conversion efficiency compared to control group fed diet with normal energy level. This is in agreement with the findings of Cera *et al.* (1989) and Apple *et al.* (2008). Significant improvement in feed efficiency was observed in pigs as the

ISBN: 978-93-85822-60-5

energy level was increased from 3.23 to 3.39 Mcal of DE/kg feed (Balogun *et al.,* 1988), from 3.5 to 3.78 Mcal of DE/kg feed (Lawrence *et al.,* 1994; Chang, 2000), from 5.4 to 8.1 Mcal of ME/day (Liao and Venum, 1994), from 9.5 and 10.1 Mcal of ME intake per day (Williams *et al*., 1994), from 12.0 to 14.4 MJ of DE/kg feed (Henman *et al.,* 1999), from 3.35 to 3.61 Mcal of DE/kg feed (Llata *et al*., 2001), from 3034 to 4384 kcal of DE/kg feed (Ding *et al.,* 2003), from 14.5 to 16.4 MJ of DE kg in barrows (Campbell, 2005) and from 3.09 to 3.57 Mcal of DE/kg feed (Beaulieu *et al*., 2009).

Higher average daily gain was observed in pigs fed diets containing 14.5 MJ of ME/kg of feed than that fed 13.5 MJ of ME/kg of feed (Urynek and Buraczewska, 2003). Pigs fed with ration containing 351 KJ of DE/kg$W^{0.75}$ had better average daily gain than that of 506 or 566 KJ of DE/kg$W^{0.75}$ per day (King *et al.,* 2004). Cho *et al.* (2008) reported that increasing energy content of the diets to 3 times maintenance requirement resulted in significantly higher feed intake, daily body weight gain and feed to gain ratio in pigs compared with those fed at 1.8 times maintenance energy.

CONCLUSION

The high energy ration (3663 kcal/kg) increased the average daily gain and reduced total feed intake thereby improved in feed conversion efficiency in the growing Large White Yorkshire female pigs compared to the ration containing energy as per NRC (2012)**.**

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ISBN: 978-93-85822-60-5

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Table 1. Ingredient composition of pig grower and finisher rations, %

Ingredients	Experimental grower rations1		Experimental finisher rations1	
	T1	T2	T1	T2
Yellow maize	35	70	37	74
Wheat bran	31	1.5	34.7	3.6
Soyabean meal	25.5	26.25	19.7	20.5
Animal fat	6.5	5	7	5
Salt	0.5	0.5	0.5	0.5
Dicalcium phosphate	0.4	0.9	0.10	0.65
Calcite	1.1	0.85	1.0	0.75
Total	100	105	100	105
Nicomix AB2D3K 1, g	25	25	25	25
Nicomix BE 2, g	25	25	25	25
Zinc Oxide3, g	13	45	0	30
Oxylock antioxidant 4, g	10	10	10	10
Cost per kg feed5, Rs.		19.37		18.30

1Nicomix A, B2, D3, K (Nicholas Piramal India Ltd, Mumbai) containing Vitamin A- 82,500 IU, Vitamin B2-50 mg, Vitamin D3-12,000 IU and Vitamin K-10 mg per gram.
2Nicomix BE (Nicholas Piramal India Ltd, Mumbai) containing Vitamin B1-4 mg, Vitamin B6-8 mg, Vitamin B12-40 mg, Niacin-60 mg, Calcium pantothenate- 40 mg and Vitamin E-40 mg per gram.
3Zinc oxide (Nice Chemicals Pvt. Ltd., kochi) contain % of Zn.
4Oxylock antioxidant (Vetline Ltd., Indore) contains Ethoxyquin, Butylated HydroxyToluene (BHT), Chelators and Surfactantant.

Table 2. Chemical composition*of grower and finisher rations

Parameters	Treatments (grower ration)1		Treatments (finisher ration)1	
	T1	T2	T1	T2
Dry matter, %	90.56±0.11	89.10±0.13	90.41±0.17	89.10±0.06
Crude protein, %	18.18±0.17	17.88±0.17	16.28±0.06	15.76±0.12
Ether extract, %	8.53±0.09	7.75±0.06	9.04±0.11	8.05±0.04
Crude fibre, %	6.58±0.13	3.41±0.07	6.54±0.10	3.52±0.13
Total ash, %	9.50±0.20	5.45±0.24	9.54±0.12	5.23±0.10
Nitrogen free extract, %	57.21±0.21	65.51±0.31	58.60±0.30	67.44±0.12
Acid insoluble ash, %	4.51±0.09	1.05±0.05	4.29±0.13	0.93±0.06
GE, kcal/kg	4134.95 ±14.98	4436.27 ± 10.62	4203.07 ±17.05	4390.61 ±31.34
Calcium, %	0.62±0.006	0.58±0.006	0.65±0.01	0.60±0.007
Phosphorus, %	0.71±0.01	0.64±0.06	0.72±0.02	0.54±0.02
Magnesium, %	0.24±0.009	0.14±0.004	0.25±0.01	0.13±0.01
Manganese, ppm	39.14±1.76	15.92±0.25	38.76±0.96	15.91±0.01
Copper, ppm	9.34±0.06	6.30±0.10	9.17±0.08	6.10±0.20
Zinc, ppm	67.19±2.23	65.56±0.91	64.95±1.47	67.45±2.18

* On DM basis
1 Mean of four values with SE

Table 3. Average feed intake of LWY pigs maintained on the two experimental rations, kg

Week	Feed intake1		Cumulative feed intake 1	
	T1	T2	T1	T2
1	9.59±0.24	9.12±0.19	9.59±0.24	9.12±0.19
2	10.30±0.30	9.84±0.22	19.89±0.54	18.96±0.39
3	12.60±0.39	12.11±0.47	32.49±0.92	31.07±0.85
4	13.29±0.53	13.74±0.54	45.78±1.40	44.81±1.37
5	16.70±0.66	16.62±0.52	62.48±2.01	61.43±1.88
6	17.38±0.66	16.76±0.34	79.86±2.64	78.19±2.20
7	17.74±0.39	17.13±0.33	97.60±3.01	95.32±2.49
8	16.72±0.36	17.90±0.36	114.32±3.32	113.22±2.69
9	19.05±0.66b	17.56±0.26a	133.37±3.94 b	130.78±2.89 a
10	21.61±0.49b	17.83±0.27a	154.98±4.42 b	148.61±3.12 a
Average total feed intake	154.98±4.42 b	148.61±3.12 a	154.98±4.42 b	148.61±3.12 a

1Mean of 5 observations
a, b - Means of different superscripts within the same row differ significantly
Significant (P<0.05)

Table 4. Average body weight gain of LWY pigs maintained on the two experimental rations

Fortnight	Weight gain1		Cumulative weight gain1	
	T1	T2	T1	T2
Initial body weight	23.96±1.55	24.18±1.12		
1	10.13±0.27	10.39±0.47	10.13±0.27	10.39±0.47
2	9.53±0.46 a	10.95±0.47b	19.66±0.70a	21.34±0.74b

ISBN: 978-93-85822-60-5

3	11.53±0.49a	12.27±0.45b	31.19±1.04a	33.61±0.95b
4	9.9±0.27a	11.31±0.26b	41.09±1.06a	44.92±1.14b
5	12.80±0.41a	13.05±0.81b	53.89±0.85a	57.97±1.88b
Final body weight	77.85±2.35a	82.15±2.77b		
1Mean of 5 observations Significant (P<0.05)				

Feed conversion efficiency	2.45 ±0.03 b	2.22 ±0.04 a	3.26 ±0.10 b	2.89 ±0.07 a	2.88 ±0.05 b	2.57 ±0.04[a]
1Mean of 5 observations with SE a, b - Means with different superscripts within the same row differ significantly Significant (P<0.05)						

Table 5. Average feed conversion efficiency of LWY pigs maintained on the two experimental rations

Fortnight	Feed conversion efficiency1		Cumulative feed conversion efficiency1	
	T1	T2	T1	T2
1	1.97±0.06	1.83±0.05	1.97±0.06	1.83±0.05
2	2.73±0.07b	2.37±0.07a	2.33±0.05b	2.10±0.17a
3	2.97±0.12	2.74±0.13	2.56±0.05b	2.33±0.04a
4	3.49±0.11b	3.10±0.08a	2.78±0.05b	2.52±0.05a
5	3.19±0.16b	2.75±0.15a	2.88±0.05b	2.57±0.04a
1Mean of 5 observations a, b- Means of different superscripts within the same row differ significantly Significant (P<0.05)				

Table 6. Average daily gain and feed conversion efficiency of LWY pigs maintained on the two experimental rations

Parameters	Growing period		Finishing period		Overall period	
	T1	T2	T1	T2	T1	T2
Average initial body weight, kg	23.96 ±1.55	24.18 ±1.12	49.45 ±2.41a	51.91 ±1.85 b	23.96 ±1.55	24.18 ±1.12
Average final body weight, kg	49.45 ±2.41 a	51.91 ±1.85 b	77.85 ±2.35a	82.15 ±2.77 b	77.85 ±2.35a	82.15 ±2.77[b]
Total weight gain, kg	25.49 ±0.92 a	27.73 ±0.82 b	28.40 ±0.29a	30.24 ±1.11 b	53.89 ±0.85a	57.97 ±1.88[b]
Average daily weight gain, g	728.29 ±26.28a	792.29 ±23.42b	811.43 ±8.37a	864.00 ±31.67b	769.86 ±12.16a	828.14 ±26.80[b]
Total feed intake, kg	62.48 ±2.01 b	61.43 ±1.88 a	92.50 ±2.50 b	87.18 ±1.42 a	154.98 ±4.42 b	148.61 ±3.12[a]

ISBN: 978-93-85822-60-5