Full Length Article

EFFECT OF EXTRUSION OF SWINE GROWER FEED ON NUTRIENT DIGESTIBILITY AND PRODUCTION PERFORMANCE IN LARGE WHITE YORKSHIRE PIGS

R. Murugeswari*[1], M. Murugan[2], C. Bandeswaran[3] and C.Valli[4]

Institute of Animal Nutrition
Tamil Nadu Veterinary and Animal Sciences University
Kattupakkam, Chengalpattu, Tamil Nadu, India

ABSTRACT

A study was conducted to determine the effect of extrusion of swine grower feed on the nutrient digestibility and production performance in twenty-four conventionally weaned LWY piglets 30 days of age and 7.60 kg average body weight. They were grouped in to two groups with twelve piglets in each group and fed individually with mash feed (MF) and extruded feed (EF) ad libitum.The experiment was conducted for 90 days. The feed was formulated with maize (62.5%), soybean meal (10%), fish meal (6%), wheat bran (8%), deoiled rice bran (11%), mineral mixture (2%) and salt (1%). The extrudate was air-dried overnight and analysed for its chemical composition.The results indicated that the moisture (MF- 9.54% and EF - 5.17%), total ash -TA (MF- 7.77% and EF - 6.35%), crude protein-CP (MF- 18.14% and EF - 17.36%), ether extract -EE (MF- 2.04% and EF - 1.74%), crude fibre– CF (MF- 6.13% and EF - 5.04%), nitrogen free extract – NFE (MF- 65.05% and EF - 69.51%), calcium (MF- 0.07% and EF - 0.06%), phosphorus (MF- 0.44% and EF - 0.45%) and gross energy– GE (MF- 3870.55 kcal/kg and EF - 4105.75 kcal/kg). The extrusion process decreased moisture, TA, EE and CF significantly ($P<0.05$) and also increased NFE and GE significantly ($P< 0.01$) in the extruded feed.The digestibility of dry matter (MF- 84.19% and EF -87.28%), CP (MF- 91.29% and EF -93.21%), EE (MF- 69.21% and EF - 1.74%), CF (MF- 81.44% and EF -87.54%) and energy (MF- 77.94% and EF -83.36%) were recorded.The digestible nutrients of EE and CF were increased significantly ($P<0.05$) and energy of (MF – 77.94%) extruded feed was increased significantly ($P<0.01$) by 7 per cent than the mash feed (EF- 83.36%).The average feed intake was significantly ($P<0.05$) different from MF (2417.43g/day) to EF (2106.97g/day) group. The average daily

*Corresponding author, email: drmmurugeswari@yahoo.co.in
[1]Assistant Professor
[2]Professor and Head, Veterinary University Training and Research Centre, Tamil Nadu Veterinary and Animal Sciences University, Melmaruvatur, Tamil Nadu, India
[3]Professor, Department of Animal Nutrition, Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai, Tamil Nadu, India
[4]Professor and Head

gain (MF- 446.02g and EF - 479.44g) and feed conversion ratio (MF- 5.42 and EF - 4.39) were highly significant (P<0.01) in EF group. The average feed cost for every kg body weight gain was Rs.108.40/- for mash feeding and Rs. 92.29/- for extruded feeding. Extrusion of mash feed increases the gelatinization and surface area of starch granules, which improves starch utilization present in the maize, energy utilization, palatability and nutrient digestibility. Extruded feed increases the feed conversion ratio and reduces the feed cost. Hence, it is concluded that extruded feed is recommended for feeding pigs to improve the production performance.

Key words: Digestibility and performance, Extruded feed, Piglets

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INTRODUCTION

Feeding pigs accounts 60 to 75 per cent of the total cost for pork production. Ways and means to increase feed efficiency will increase profitability of a swine farm. Swine are fed a complete mash type of feed, prepared by grinding and mixing different feed ingredients. Grinding feed ingredients decreases their particle size and increases their digestibility (Wondra *et al.*, 1995). Mash feeding has certain disadvantages in that it leads to dustiness and also feed wastage is inevitable. Extrusion technology is limited to pet and aquaculture to compensate the increased processing costs. The extrusion process consists of pressuring the feed material through a barrel by the use of single or twin-screw extruders, which results in generation of heat (Hancock and Behnke, 2001). Both types of extruders are used for the finished feed and also for the individual feed ingredients. Extruded feed is used for pigs to increase the feed conversion ratio and there by increases their productivity and to reduce the feed wastage. Extrusion results in change in the physico-chemical characteristics of the feed ingredients because of the change in temperature, pressure, friction, and attrition of the feedstuffs inside the extruder (Hancock and Behnke, 2001).Extrusion gelatinizes starch in the cereals, improving its digestibility which in turn to increase the digestible energy. Extrusion cooking modifies the particle size, solubility and chemical structure of dietary fibre and this causes changes in bacterial degradation in the intestine (Urriola *et al.*, 2010).Hence, a study was conducted on the effect of extrusion of the swine grower feed on feed intake, nutrient digestibility and production performance in large white Yorkshire (LWY) piglets.

MATERIALS AND METHODS

Feed Preparation

Feed was prepared as per BIS (2016). The composition of feed (Mash and extruded feed) having Maize (62.5 per cent), soybean meal (10 per cent), fish meal (6 per cent), wheat bran (8 per cent), deoiled rice bran (11per cent), mineral mixture (2 per cent) and salt (1 per cent) was formulated. The feed was ground to the particle size at 2.5 mm and mixed in horizontal mixer. It was prepared as mash form. The one portion of mash feed (MF) was used for one group of treatment as MF. Another portion of mash

feed was prepared as extruded feed. Mash feed was added with 12.5 per cent water and extruded through single screw cold extruder (Lerdsuwon and Attamangkune, 2008). The dry extrusion process was carried with a barrel length of 1.31 m, 31 die openings, and a die diameter of 1.4 cm with 100 hp motor. During the process the feed was heated to 75°C and it was pushed through 5 mm die to expand and produce extruded feed. The extrudate was air-dried overnight. The chemical composition of mash and extruded feed was analyzed as per AOAC, (2012).The gross energy of feed was measured with an adiabatic calorimeter bomb (IKA C7000, Staufen - Germany).

Experimental animals and design

Twenty-four conventionally weaned LWY piglets 30 days of age and 7.60 kg average body weight were allotted on the basis of body weight to two treatments. Two treatments were grouped into MF and EF. Each treatment was conducted in two replicates with six piglets per replicate. Totally 24 piglets were randomly divided into 4 replicates. Piglets were dewormed before the feeding trial. The piglets were housed in partially slotted and concrete floored pens individually. The adaptation period of 15 days was allowed before the actual start of the experiment. The experimental animals were fed as per their body weight following ICAR (2013) requirements. They were fed twice daily according to schedule at 9:00 am and 3:00 pm. Piglets were allowed *ad libitum* access of clean potable water. The experiment was conducted for 90 days. The feed intake and feed left over was recorded every day and the body weight was recorded every fortnight in the morning before feeding with the use of platform type electronic weighing balance. Average daily gain, daily feed intake, feed conversion ratio and feed cost were recorded during the growth trial. Feed conversion ratio (FCR) was calculated by using a standard formula. Feed cost per kg of body weight gain was calculated based on local prices of feed ingredients fixed at the time when experiment was conducted.

A digestibility trial was performed using chromic oxide (0.25 per cent) as an indicator. The piglets were fed diets mixed with chromic oxide on 67th day and faecal samples were collected from 72nd day to 74th day of trial. Faeces were collected at approximately 05:30 A.M. The faeces of individual piglets were collected during collection period, weighed and stored in a two-layer plastic bag to prevent loss of moisture. Samples were dried in hot air oven at 80 °C to constant weight and stored and ground with a 1 mm mesh Wiley mill for chemical analysis. Feed samples were also collected for chemical analysis. The energy of faeces was measured with an adiabatic calorimeter bomb (IKA C7000, Staufen - Germany).

The data were subjected to one-way analysis of variance (ANOVA) using (Snedecor and Cochran, 1994). Means showing significant differences in the ANOVA table were compared using the Duncan multiple range test (Steel and Torrie,1980). A p-value of 0.05 was considered statistically significant and 0.01 was considered as highly significant.

RESULTS AND DISCUSSION

Proximate composition and Digestible coefficients

The chemical composition and gross energy of the mash feed and extruded feed are shown in Table 1. The extrusion process significantly decreased (P<0.05) moisture from 9.64 per cent to 5.17 per cent, total ash from 7.77 per cent to 6.35 per cent, ether extract 2.04 per cent to 1.74 per cent and crude fibre 6.13 per cent to 5.04 per cent in extruded feed.Extrusion conditions can alter the nutritional value of feeds (Ohh *et al*., 2002). During the process, addition of heat and water by conditioning will alter components such as starch and fibre in the feed. However, the concentration of nitrogen free extract (69.51 per cent) in the extruded feed was found to be higher than in mash feed (P<0.01). During extrusion process, the chemical changes such as binding, cleavage, loss of native conformation, recombination of fragments and thermal degradation can occur and the composition of mash feed can be changed by physical losses, evaporation of water and volatile compounds due to heavy pressure at the die (Riaz, 2000).

Digestibility of individual nutrients have been presented in Table 2. The calculated digestibility coefficients of dry matter, CP, EE, CF and energy were increased significantly (P<0.05) in EF group. Chae *et al.* (1997) evaluated the effects of processing methods on nutrient digestibility in growing - finishing piglets and reported a slight increase in crude protein and fat digestibility. The energy digestibility of extruded feed was increased significantly (P<0.01) than that of mash feed**.** It was due to increase in the gelatinization and surface area of starch granules, which consequently improved the starch utilization present in the maize (Raiz, 2000), energy utilization and palatability of extruded feed (Hancock and Behnke, 2001).

Production performance

The effect of mash feed and extruded feed on growth performance of piglets after 90 days is presented in Table 3. The average feed intake (MF- 2417.43g/day and EF - 2106.97g/day), and average dry matter intake (2186.81g/day and 1998.04g/day) were recorded and it significantly (P<0.05) varied between MF and EF groups. The effects of extrusion were influenced by the chemical characteristics that are unique to each feed ingredient (Dust *et al.,* 2004) and improved the palatability of the feed. Hence, the feed intake was increased in the extruded feed fed piglets.

The average daily gain (MF- 446.02g and EF - 479.44g) and feed conversion ratio (MF- 5.42 and EF - 4.39) were highly significant (P<0.01) in EF group than MF group. The higher weight gain and FCR of extruded feed fed animals indicated its superior digestibility of energy. Feed processing may have a greater positive impact on digestibility of energy and nutrients (Fry *et al.,*2012). Extrusion of the entire diet compared with mash feed improved feed conversion by 8 per cent and DM and CP digestibility by 3 and 6 per cent, respectively, was recorded by Sauer *et al.* (1990). The improvement of growth rate was largely related to increase in the voluntary feed intake by Chae *et al.* (1997).

Table 1. Chemical composition and gross energy of mash feed and extruded feed on dry matter basis (Mean ± SE*) (n=6)

Parameters	MF	EF
Moisture (%)	9.54 ± 0.03 [b]	5.17 ± 0.02 [a]
Total ash (%)	7.77 ± 0.03[b]	6.35 ± 0.09 [a]
Crude protein (%)	18.14 ± 0.98	17.36 ± 0.87
Ether extract (%)	2.04 ± 0.11 [b]	1.74 ± 0.02 [a]
Crude fiber (%)	6.13 ± 0.02 [b]	5.04 ± 0.05 [a]
Nitrogen free extract (%)	65.05 ± 3.06[A]	69.51 ± 3.33[B]
Calcium (%)	0.07 ± 0.01	0.06 ± 0.01
Available Phosphorus (%)	0.44 ± 0.02	0.45 ± 0.02
Gross energy (kcal/kg)	3870.55 ± 172.53[a]	4105.75 ± 211.95[b]

*Mean of six samples

a, b- Means bearing different lower case alphabets in a row differ significantly (P<0.05)

A, B - Means bearing different upper case alphabets in a row differ significantly (P<0.01)

Table 2. Digestibility of nutrients in mash feed and extruded feed on dry matter basis (Mean ± SE*) (n=12)

Parameters	MF	EF
Digestible Dry matter (%)	84.19 ± 2.93	87.28 ± 2.51
DigestibleCrude protein (%)	91.29 ± 2.28	93.21 ± 2.36
Digestible Ether extract (%)	69.21 ± 1.85 [a]	74.31 ± 2.01 [b]
Digestible Crude fibre (%)	81.44 ± 2.02 [a]	87.54 ± 4.05 [b]
Digestible energy (%)	77.94 ± 3.16[A]	83.36 ± 4.89[B]

*Mean of twelve samples

a, b- Means bearing different lower case alphabets in a row differ significantly (P<0.05)

A, B- Means bearing different upper case alphabets in a row differ significantly (P<0.01)

Table 3. Effect of mash feed and extruded feed on growth performance of pigs (Mean ± SE*) (n=12)

Parameters	MF	EF
Average feed intake (gm/day)	2417.43 ± 122.35 [b]	2106.97 ± 103.65 [a]
Average dry matter intake (gm/day)	2186.81 ± 106.70 [b]	1998.04 ± 97.50 [a]
Average initial body weight (kg)	47.14 ± 2.38	46.85 ± 2.06
Average final body weight (kg)	87.28 ± 3.89[a]	90.00 ± 4.62[b]
Average daily gain (gm)	446.02 ± 23.24[A]	479.44 ± 28.43[B]
Feed conversion ratio	5.42 ± 0.27[B]	4.39 ± 0.21[A]
Average Feed cost (Rs/kg body weightgain)	108.40 ± 5.22[B]	92.29 ± 4.26[A]

a,b - Means bearing different lower case alphabets in a row differ significantly (P<0.05)
A,B - Means bearing different upper case alphabets in a row differ significantly (P<0.01)

The average feed cost for every kg of body weight gain was Rs.108.40/- in MF group and Rs. 92.29/- in EF group. The feed wastage was minimum in the extruded feed fed group animals throughout the trial when compared with the mash feed fed animals. Chae *et al.* (1997) reported that the reduction of feed wastage improved the feed efficiency and feeding cost.

CONCLUSION

Extrusion technology could change the nutrient composition and digestibility. Extruded feed could increase the feed conversion ratio and reduce the feed cost. It is concluded that extruded feed can be recommended for feeding piglets to improve the growth performance.

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REFERENCES

AOAC, (2012). Official Methods of Analysis (19thedn.) Association of Official Analytical Chemists, Washington DC.

BIS (2016). IS 7472:1986, reaffirmed 2016, Specifications for pig feeds, Beaureu of Indian standard, New Delhi

Chae, B.J., Han, I.K., Kim, J.H., Yang, C.J., Ohh, S.J., Rhee, Y.C. and Chung, Y.K. (1997). Effect of feed processing and feeding methods on growth and carcass traits for growing-finishing pigs. *Australian Journal of Animal Science,* **2**: 164-169.

Dust, J. M., Gajda, A.M.,Flickinger, E.A.,Burkhalter, T.M.,Merchen, N.R. and Fahey Jr, G. C. (2004).

Extrusion conditions affect chemical composition and *in vitro* digestion of select food ingredients. *Journal of Agriculture Food Chemistry,* **52**: 2989–2996. doi:10.1021/jf049883u.

Fry, R.S., Hu, W., Williams,S.B., Paton,N.D. and Cook, D.R. (2012). Diet form and by-product level affect growth performance and carcass characteristics of grow-finish pigs. *Journal of Animal Science,* **90:**380.

Hancock, J.D. and Behnke,K.C. (2001). Use of ingredient and diet processing technologies (grinding, mixing, pelleting, and extruding) to produce quality feeds for pigs. In: A.J. Lewis and L.L. Southern, editors, Swine nutrition. 2nd ed. CRC Press, Washington, DC. p. 469–497.

ICAR. (2013). Nutrient Requirement of Domestic Animals. Indian Council of Agricultural Research, New Delhi.

Lerdsuwon, S. and Attamangkune, S. (2008). The Effect of Feeding Extruded Corn on the Growth Performance of Nursery Pigs Reared under Tropical Conditions. *Kasetsart Journal (Natural Science),* **42**: 632 – 639.

Ohh, S.K., Han, K.N., Chae, B.J.,Han, I.K. and Acda, S.P. (2002). Effects of feed processing methods on growth performance and ileal digestibility of amino acids in young pigs. *Asian-Australian Journal of Animal Science,* **15:** 1765-1772.

Riaz, M.N. (2000). Extruders in Food Applications. Technomic publishing company, Inc, U.S.A. 225 p.

Sauer, W.C., Mosenthin R. and Pierce, A.B. (1990). The utilization of pelleted, extruded, and extruded and repelleted diets by early weaned pigs. *Animal Feed Science Technology,* **31:**269–75.

Snedecor, G.W. and Cochran, W.G.(1994). Statistical Methods,8thedn; Oxford and IBH Publishing Company, New Delhi, India.

Steel, R.G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics. A Biometrical Approach. 2nd ed. McGraw Hill Book Co., New York, NY, USA.

Urriola, P.E., Shurson, G.C. and Stein, H.H. (2010). Digestibility of dietary fiber in distillers co-products fed to growing pigs. *Journal of Animal Science,* **88**:2373–81.

Wondra, K.J., Hancock, J.D., Behnke, K.C., Hines, R.H. and Stark, C.R. (1995). Effects of particle size and pelleting on growth performance, nutrient digestibility, and stomach morphology in finishing pigs. *Journal of Animal Science,* **73**:757–63.