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Original Paper

Growth response, cost benefit, carcass characteristics and organoleptic properties of pigs fed biscuit dough as a replacement for maize

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The growth performance, economic indices, carcass cuts and organoleptic properties of pigs (large white × landrace, $n = 30$) fed biscuit dough as a replacement for maize was examined in a 49-day feeding trial. Weaned pigs were randomly allotted to five dietary groups of six pigs each. A maize-soybean meal based diet served as the control (D1) while diets D2, D3, D4, and D5 had 12.5%, 25.0%, 37.5% and 50.0% biscuit dough respectively as a replacement for maize. The feed conversion ratio (FCR), feed cost per kg, feed cost per kg weight gain, profit per kg weight and economic efficiency of gain (EEG) were significantly influenced (P <0.05) by the dietary treatments. The feed cost per kg and feed cost per kg weight gain reduced linearly from D1-D5, unlike the profit and EEG which increased linearly. The carcass primal cuts including jowl, boston butt, loin, spare rib, belly, ham, trotters, head and picnic shoulder were significantly different (P <0.05). The organoleptic properties (meat colour, texture and overall acceptability) were significantly influenced (P <0.05) by the dietary treatments. In conclusion, feeding up to 37.5% biscuit dough as a replacement for maize improved the feed conversion ratio. Nevertheless, the use of biscuit dough up to 50% would result in reduced cost of production, higher profit margin, economic efficiency of gain, greater loin, belly, ham and overall consumer acceptability. Therefore, the use of biscuit dough by pig farmers would improve pig performance and enhance profitability up to 50.0% replacement for maize.

Keywords: biscuit dough, carcass characteristics, cost, growth performance, sensory properties

1 Introduction

Pig production holds a prominent place in the economy of many developing countries (Steinfeld, 2003), especially where there is no religious taboo or sentiments as it represents one of the means of correcting animal protein shortage because of their fast rate of production and quick return on investment. Pig production, unfortunately, is adversely affected by fluctuations in the supply of good quality feed due to the inadequate local production of feedstuffs, cost of conventional feedstuffs and unavailability of some ingredients year round.

In view of this, research efforts have been geared towards the search for available alternatives (Arowora and Tewe, 2003) including discarded cashew nut meal (Akande et al., 2015), *Jatropha curcas* seed and kernel meal (Oladunjoye et al., 2014; Ojediran et al., 2014), cassava peels, brewer's dried grain, rice husk, pineapple waste, palm kernel meal, sorghum spent grains, among others (Shittu et al., 2016). However, the attendant anti-nutritional factors, cost of processing and seasonal availability (Ojediran et al., 2017) of some of these alternatives have prompted the possibilities of using industrial wastes devoid of anti-nutrients such as biscuit dough.

Biscuit dough is an agro-industrial waste product found in substantial quantities in biscuit producing industries. According to Shittu et al. (2016), biscuit dough, a palatable, high energy feedstuff is made up of biscuit components such as wheat flour, skimmed milk powder, vegetable fat, sugar, salt and flavour material but failed to raise the first time and are yet to undergone baking. Biscuit dough could be an economical feed source for monogastrics, because it is not been used in the bakery for production of cookies. Bakery by-products including biscuit dough has been identified to be one of the non-conventional feed resources, however, biscuit waste has been given attention by various researchers (Eniolorunda

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et al., 2011 and Adeyemo et al., 2013) because it has higher metabolizable energy (ME) than corn grain (NRC, 1998).

Biscuit dough is relatively cheap compared with maize because it is considered a waste product from the bakery. The use of biscuit dough as a replacement for maize has potential to reduce the competition between man and animal for conventional feed sources and also to reduce agro-industrial waste. Meanwhile, information on the potential of biscuit waste as a good ingredient for monogastric animals is available, but, there is dearth of information on the potential of biscuit dough (Shittu et al., 2016).

This study examined the growth response, economic indices, carcass characteristics and organoleptic properties of weaned pigs fed graded levels of biscuit dough as a replacement for maize.

2 Material and methods

2.1 Experimental Site, Birds and Management

The experiment was carried out at the Piggery Unit of the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso. Ogbomoso lies on longitude 4° 15[1] East of the Greenwich Meridian and Latitude 8° 07[1] North of the equator. The latitude is between 300 and 600 meters above sea level. The mean annual temperature is about 27 °C while that of average rainfall is 1,247mm. The vegetation of the study area is in the derived savannah zone (Ojedapo et al., 2009).

2.2 Experiment pigs and management

Thirty (30) male weaned pigs (Large white × Landrace) weighing 4.09 ±0.21kg were acclimatized and fed with weaner ration of 22% CP for a week prior to the commencement of the experiment. The weaned pigs were randomly allotted to five dietary groups of six pigs each. Each weaned pig was housed individually in a concrete pen. The animals had access to feed and water *ad libitum*. The experiment was conducted for a period of 49 days.

2.3 Collection of test ingredients and the experimental diets

The test ingredient was purchased from a reputable feed mill. It was sun-dried and milled before been mixed with other feed ingredients. Five experimental diets were

Table 1 Gross composition of the experimental diets

Ingredients (%)	D1	D2	D3	D4	D5
Maize	56.00	49.00	42.00	35.00	28.00
Biscuit dough	0.00	7.00	14.00	21.00	28.00
Soybean meal	25.50	24.50	23.50	21.70	19.50
Fish Meal	5.50	4.00	2.80	2.00	1.00
Cassava peel meal	9.00	9.00	9.00	9.00	9.00
Palm kernel cake	2.00	4.50	6.70	9.30	12.50
Limestone	0.60	0.60	0.60	0.60	0.60
DiCalcium phosphate	0.60	0.60	0.60	0.60	0.60
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.05	0.05	0.05	0.05	0.05
Premix	0.20	0.20	0.20	0.20	0.20
Salt	0.50	0.50	0.50	0.50	0.50
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrients					
Metabolizable energy (Kcal/kg)	3,014.04	2,966.49	2,919.54	2,873.39	2,826.83
Crude Protein	21.03	20.70	20.54	20.38	20.02
Ether Extract	3.78	3.72	3.68	3.68	3.68
Crude Fiber	3.77	4.16	4.51	4.87	5.29
Calcium	0.59	0.56	0.54	0.53	0.50
Lysine	1.42	1.30	1.19	1.08	0.96
Methionine	0.45	0.42	0.38	0.35	0.32

formulated with a crude protein content of between 20–21% and metabolizable energy ranging from 2,800–3,000 ME/Kcal/kg in a Maize-soybean meal based diet as shown in Table 1. Biscuit dough was used to replace maize in the control (D1) diet at 12.5%, 25%, 37.5% and 50% in treatments D2, D3, D4 and D5 respectively.

2.4 Data collection

Data were collected on growth parameters including feed intake and weight gain while the feed conversion ratio was calculated. Feed intake was measured individually on a daily basis as the differential between feed offered and feed left while the weight gain was taken weekly using a sensitive electronic scale. The feed to gain ratio was calculated as average feed intake divided by average weight gain. Economic indices were calculated thus (as described by Ojediran et al., 2017):

- Feed cost/kg = sum (quantity of each ingredient × unit cost of each ingredient) % / 100.
- Feed cost per kg weight gain = feed cost/kg × total feed intake (kg)/total weight gain.
- Income per kg weight gain = Selling price/kg × final weight per pig/total weight gain (kg).
- Profit per kg weight gain = Income per kg weight – feed cost/kg weight gain.
- Economic efficiency of growth (EEG) = (profit per kg weight gain/feed cost per kg weight gain) × 100.

At the end of the experiment, 3 pigs were randomly selected from each treatment for carcass evaluation and were starved overnight for 12 hours but allowed access to water *ad libitum*. The pigs were slaughtered by severing the jugular veins. The carcasses were later cut into primal cuts and weighed using Kerro electronic compact scale, model BL30001E. The weights of cut parts were expressed as the percentages of live weight of each pig.

Organoleptic evaluation was carried out on colour, flavour, tenderness, juiciness and overall acceptability of meat samples from each slaughtered pig per replicate. It involved 10 untrained panelists but usual meat consumers. Meat samples were taken from the ham of the carcasses. They were served to the panelist as coded samples. The descriptor was quantified on a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely).

2.5 Statistical analysis

Data were subjected to analysis of variance (ANOVA) in a completely randomized design using SAS (2000) software package and means were separated using Duncan multiple range test of the same package.

3 Results and discussion

The proximate composition and metabolizable energy of biscuit dough were shown in Table 2. The biscuit dough had a dry matter content of 91.02%, 19.40% crude protein, 4.18% crude fibre, 3.87% ether extract, 7.00% ash, 65.55% nitrogen-free extract and 2808.61 Kcal/kg metabolizable energy. The proximate composition of the biscuit dough meal obtained was similar to that reported by Shittu et al. (2016). This may be because of the similar source of the biscuit dough. The biscuit dough had not been baked into biscuit and this may be responsible for the difference in proximate values when compared to the report of Adeyemo et al. (2013) for biscuit waste. Although, Eugene et al. (2008) had earlier reported that heat processing could decrease dry matter, crude protein, ash, ether extract, carbohydrate and energy values.

Table 2 Proximate composition and metabolizable energy of biscuit dough

Parameters (%)	Biscuit dough
Dry matter	91.02
Crude protein	19.40
Crude fibre	4.18
Ether extract	3.87
Ash	7.00
Nitrogen free extract	65.55
Metabolizable energy (Kcal/kg)	2,808.61

The growth parameters of weaned pigs fed graded levels of biscuit dough as a replacement for maize is shown in Table 3. There were no significant differences (P >0.05) in the growth parameters except the feed conversion ratio (FCR). The FCR of pigs fed D3 and D5 were significantly different (P <0.05) while those fed other diets were comparable. Pigs fed D3 had the least FCR while those on D5 had the highest. The non-significant final weight, average daily gain and feed intake suggests that the test ingredients were well tolerated. This corroborates the report of Adeyemo et al. (2013) that biscuit waste has no anti-nutritional factor and could make a good replacement for maize and other cereal grains in livestock feed. This is similar to the observation of Ajasin et al. (2010). Contrary, to the report of Shittu et al. (2016), the pigs had better feed conversion ratio at diet 3 (25% inclusion of biscuit dough), although, comparable to those fed up to diet 4 (37.5% BD).

The economic indices (Table 4) showed that feed cost per kg, feed cost per kg weight gain, profit per kg weight and economic efficiency of gain (EEG) was significantly

influenced (P <0.05) by the dietary treatments. The feed cost per kg and feed cost per kg weight gain reduced linearly from D1–D5, unlike the profit and EEG which increased linearly. The cost of producing a kilogramme of the control diet is highest (₦179.03) while that of D5 is the lowest (₦116.04). The feed cost per kg weight gain is least for pigs on D5 (₦214.25), while those fed D1 (₦353.83) had the highest. Although, values obtained for pigs on D3–D5 were not significantly different (P >0.05). On the contrary, the profit per weight gain ranges from ₦251.23 (D1) to ₦368.80 (D5). Similarly, the economic efficiency of gain was least (72.89) for pigs fed D1 while those fed D5 (152.07) had the highest, although, a significant difference was not observed for pigs fed D3–D5.The result on economic indices is similar to the report of Ojediran et al. (2016) who fortified low crude protein (LCP) diets with lysine. As also observed by Shittu et al. (2016), it costs more to produce the control diet than other diets. Although, a linear decrease across the dietary treatment showed that feed cost per kg reduced as the biscuit dough increases. Hence, reduced cost of feed ingredients will improve production by resource-poor farmers and impact significantly on the will to purchase livestock products by consumers (Nkukwana, 2014). Similarly, feed cost per kg weight gain also had a similar trend as feed cost per kg. Moreover, the profit per kg weight gain and economic efficiency of gain increased with increased biscuit dough. This showed that the use of biscuit dough bears an important and applied implication for a commercial investment in pig production.

Primal cuts of grower pigs fed graded levels of biscuit dough are shown in Table 5. The jowl, boston butt, loin, spare rib, belly, ham, trotters, head and picnic shoulder were significantly different (P <0.05). Pigs fed the control diet (D1) had the highest value (2.88) for jowl while those fed D5 (1.72) had the least similar (P >0.05) to those fed D3. The boston butt of pigs fed D3 (12.75) was highest and comparable to those fed D1 (11.94) and D4 (11.34). The loin and spare rib of pigs fed D4 was highest while those fed D1 had the least. The belly of pigs fed D2–D5 was significantly different from those. The values obtained for Ham ranges from 12.95 (D1) to 14.11 (D2). Pigs fed T1 had the highest value for Trotters (2.33) and head (10.44). The earlier report by Manu et al. (2015) indicated that primal cuts of grower-finisher pigs were not influenced by feeding diets containing biscuit dough. This is also similar to the observation of Adeyemo et al. (2013) when broilers were fed biscuit waste. Conversely, both reports were contrary to the observations in this study.

Table 6 shows the organoleptic properties of grower pigs fed biscuit dough. The analysis of the panellist response showed that the colour, texture and overall acceptability were significantly influenced (P <0.05) but

Table 3 Growth Performance of weaned pigs fed graded levels of biscuit dough

	Dietary treatments					
Parameters	D1	D2	D3	D4	D5	SEM
Initial weight (kg)	4.09	4.11	4.08	4.11	4.06	0.21
Final weight (kg)	23.25	22.92	24.33	23.17	23.00	0.62
Total weight gain (kg)	19.16	18.81	20.26	19.05	18.94	0.46
Average daily gain (kg)	0.39	0.38	0.41	0.39	0.39	0.01
Average daily feed intake (kg)	0.76	0.75	0.77	0.75	0.80	0.01
Feed conversion ratio	1.97^{ab}	1.96^{ab}	1.86^{b}	1.92^{ab}	2.08^{a}	0.03

a–b mean within the row lacking common superscript differ (p <0.05); SEM – standard error of means; kg – kilogram

Table 4 Economics indices of weaned pigs fed graded levels of biscuit dough

	Dietary treatments					
Parameters	D1	D2	D3	D4	D5	SEM
Feed cost/kg (₦)	179.03^{a}	160.17^{b}	144.16^{c}	131.23d	116.04e	5.96
Feed cost/kg wt gain (₦)	353.83^{a}	313.54^{b}	268.37^{c}	252.01^{c}	241.25^{c}	12.00
Income/kg wt gain (₦)	605.17	609.08	600.79	607.56	607.05	4.65
Profit/kg wt gain (₦)	251.34^{c}	295.54^{bc}	332.42^{ab}	355.56^{ab}	365.80^{a}	13.61
EEG	72.89^{b}	94.19^{b}	124.12^{a}	141.30^{a}	152.07^{a}	8.57

a–b mean within the row lacking common superscript differ (p <0.05); SEM – standard error of means; kg – kilogram; wt – weight; ₦ – Naira (₦360 – 1USD$); EEG – economic efficiency of gain

Table 5 Primal cuts of growing pigs fed graded levels of biscuit dough (% live weight)

	Dietary treatments					
Primal cuts	D1	D2	D3	D4	D5	SEM
Jowl	2.88^{a}	2.28^{b}	1.77^{c}	2.38^{b}	1.72^{c}	0.12
Buston butt	11.94^{ab}	10.56^{b}	12.75^{a}	11.34^{ab}	10.57^{b}	0.32
Loin	11.30^{b}	13.04^{ab}	13.21^{ab}	13.60^{a}	13.15^{ab}	0.31
Spare rib	2.39^{c}	3.62^{ab}	2.73^{bc}	3.92^{a}	2.89^{bc}	0.19
Belly	3.57^{b}	4.43^{a}	4.81^{a}	4.65^{a}	4.62^{a}	0.13
Ham	12.95^{b}	14.11^{a}	13.88^{ab}	13.12^{b}	13.36^{ab}	0.16
Trotters	2.33^{a}	1.80^{c}	1.94^{bc}	2.12^{ab}	1.81^{c}	0.06
Head	10.44^{a}	9.32^{b}	9.69^{b}	9.09^{b}	9.47^{b}	0.15
Picnic shoulder	11.01	11.04	9.89	10.48	11.17	0.21

a-b-c Mean within the row lacking common superscript differ (p <0.05); SEM – standard error of means

Table 6 Organoleptic properties of weaned pigs fed graded levels of biscuit dough

	Dietary treatments					
Parameters	D1	D2	D3	D4	D5	SEM
Colour	6.80^{ab}	7.00^{a}	6.00^{ab}	6.40^{ab}	5.60^{b}	0.19
Flavour	5.40	4.40	5.80	4.80	4.20	0.24
Tenderness	5.00	4.40	6.20	6.20	6.40	0.33
Juiciness	5.60	5.00	6.80	5.20	5.00	0.31
Texture	4.60^{b}	5.40^{ab}	7.20^{a}	5.00^{b}	6.0^{ab}	0.32
Overall acceptability	5.80^{b}	6.50^{ab}	7.80^{a}	7.20^{a}	8.00^{a}	0.27

a-b Mean within the row lacking common superscript differ (p <0.05); SEM – standard error of means

they were indifferent (p >0.05) to the flavour, tenderness and juiciness of samples provided. The sensory panel rating for colour (P <0.05) ranged from 5.60–7.00 where D5 (5.60) had the lowest grade and D2 (7.00) had the highest grade for colour. In this study, the colour of the meat had significantly been affected by the different level of biscuit dough in the diets of weaned pigs. There was also a significant difference in the texture and overall acceptability between the various treatment although high score was given to treatment 3 (25% biscuit dough) for texture and overall acceptability. This study shows that meat texture and overall acceptance steadily improved from D1–D3, after which they slightly deteriorated at D4 with a subsequent increase at D5. The organoleptic properties of the weaned pigs fed biscuit dough showed that the meat colour, texture and overall acceptance were influenced. Meat colour is an important property that influences consumer preference. Karthika et al. (2016) reported that colour could be influenced by myoglobin content, composition, muscle physical state and meat structure. Meat overall acceptability reflects the consumers preference. The palatable nature and composition (Shittu et al., 2016) of the biscuit dough may have influenced the overall rating by the panellist because increased acceptability correlates with the linear increase of biscuit dough.

4 Conclusions

Conclusively, the best feed conversion ratio was observed at 25.00% biscuit dough replacement for maize though comparable to those fed 37.50%. Nevertheless, the use of biscuit dough up to 50% would result in reduced cost of production, higher profit margin, economic efficiency of gain, greater loin, belly, ham and overall acceptance.

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