GARI AND *GARICO*: REPLACEMENT FOR MAIZE IN THE DIETS OF ALBINO RATS – A MODEL FOR PIGS

Boateng, M[1]., Amoah, K. O[1,2]., Frimpong, Y.O[1]., Atuahene, P. Y[1]., Okai, D.B[1]. and Cudjoe, E[1].

[1]*Department of Animal Science, Faculty of Agriculture,*
College of Agriculture & Natural Resources,
Kwame Nkrumah University of Science & Technology (KNUST), Kumasi-Ghana
[2]*Animal Research Institute, Council for Scientific and Industrial Research, Accra, Ghana*

ABSTRACT

Preliminary research focused on the production and nutrient composition of local Gari and Garico (a by-product of Gari production) proved that these food/feed resources are potential energy sources. This current study, sought to ascertain the effect of total replacement of dietary maize with Gari and Garico on the growth performance and weights of some internal organs of albino rat. Eighteen (18) albino rats (12 males and 6 females) were randomly allotted to three isonitrogenous dietary treatments: T0 (maize diet), T1 (Gari diet) and T2 (Garico diet) in a RCBD based on weight and sex. Each treatment had six rats and each rat served as a replicate. Feed and water were provided ad libitum. The rats were euthanized and their internal organs were weighed at the end of the 28-days feeding trial. Growth performance data and weights of internal organs were analysed by the General Linear Model of ANOVA using Minitab (version 18). Tukey's Pairwise Comparison was used to separate the treatment means at p<0.05. No significant differences were observed for daily feed intake (DFI) (p=0.301), average daily gain (ADG)(p=0.173), and feed conversion ratio (FCR) (p=0.339) for the various treatments. All the weights of the internal organs measured recorded no significant differences (p>0.05). In summary, the replacement of maize with Gari or Garico in the diets of albino rats did not result in any deleterious effect on the growth performance and absolute weights of rats. However, feed cost and feed cost/100g gain did not favour the use of these two ingredients under the conditions of this experiment. It was concluded that even though farmers can safely include Gari and Garico in the diets of monogastric farm animals, was necessary for a definitive cost-benefit analysis to be done especially when Gari and Garico prices are relatively high.

Keywords: *Albino rat, by-product, cassava, Gari, Garico, maize*

INTRODUCTION

Cassava (*Manihot esculenta Crantz*) is the most important staple root and tuber crop in Ghana, followed by yam, cocoyam and sweet potato (Adjei-Nsiah and Sakyi-Dawson, 2012). Usually, whenever, there is a shortage of cereals particularly maize, these root crops especially cassava and its by-products can act as a cushion in supplying carbohydrates/ energy in the diets of humans and livestock. Cassava contributes substantially to about 46% of the agricultural gross domestic product (GDP) of Ghana's agricultural economy and represents 30% of daily calorie intake (Bayitse *et al.*, 2017). As a result of its importance, it is grown by almost every household that is into crop farming and is consumed in all the 16 regions of Ghana (Oppong-Anane, 2013). In Ghana, the entire cassava production available for human and other uses was approximately 9,453,000 metric tonnes, with estimated net consumption of 3,704,000 metric tonnes in 2010 (MOFA, 2011). This implied that there was a net surplus of about 5,749,000 tonnes which could be used for industrial purposes and as animal feed.

The foremost constraint on livestock production in Ghana has been their feeding, specifically availability of energy sources. Several scientists have reported that cassava and its by-products are good sources of energy for livestock production and potential replacements for maize in monogastric farm animal diets (Okai, 1995; Phuc *et al.,* 2000, Damisa and Bawa, 2007). Different cassava products and by-products have been used as feed ingredients by farmers and other stakeholders of the animal industry (Mettle *et al*., 2010; Mosobalaje, 2012; Rhule *et al.,* 2012). These include; cassava root products (i.e., cassava pellets, cassava grits, cassava flour, whole/broken root, cassava meal, cassava chips, cassava pulp and dried cassava wastes including peels) and cassava shoot products (i.e., cassava leaf meal). It is worth noting that, *Gari* is a major processed product of cassava. *Garico*, on the other hand can best be described as a by-product or co-product of *Gari* manufacture. Both of these have not received much attention with regard to their use as ingredients in the diets of monogastric farm animals. *Gari* has, for long, been cherished by many Ghanaians because it sustains one from hunger for some time and also eliminates the probabilities of constipation due to the fibre content. The chemical composition of *Gari* has been reported as; 84.55% carbohydrate, 1.27% crude protein (CP), 1.08% ether extract (EE), 1.24% crude fibre (CF), 0.12% ash and 11.74% moisture (Ojo and Akande, 2013). As stated earlier, *Garico* is a by-product from the production of *Gari*. There is evidence that some pet owners especially, dog keepers and breeders in Ghana are feeding these materials. The authors are also aware that *Garico* is also cherished by some humans in Ghana. Our earlier studies on *Garico* had focused on its production, particle size and nutrient composition (Boateng *et al*., 2020 in press). It had a mean particle size of 2mm compared to *Gari* which ranged from 500µm - 1mm. The nutrient composition indicated that it had CP, CF, ash, moisture and metabolizable energy values of 1.44%, 2%, 1.16%, 9.50% and 3060.13 kcal/kg respectively. This implies that *Garico* has a high energy content and could be used as an alternative to conventional energy feed resource in human, livestock and poultry nutrition. There is a paucity of scientific data on the effects of the inclusion of *Gari* or *Garico* in the diets of monogastric livestock in Ghana. In this study, the effects of total replacement of the maize in a typical monogastric diet with *Gari* and *Garico* on the growth performance and weights of some internal organs of albino rats were studied.

MATERIALS AND METHODS

Study location and duration

The experiment was conducted at the Livestock Section of the Department of Animal Science, Kwame Nkrumah University Science and Technology, Kumasi, Ghana and it lasted four weeks.

Source of feed ingredients

The *Gari* and *Garico* were obtained from Gari producers at Anloga, a suburb in the Oforikrom Municipality in the Ashanti Region. The other ingredients were purchased from Aduse-Poku Agro-processing Limited at Ejisu also in the Ashanti Region of Ghana.

Design and management of experiment

Eighteen albino rats (12 males and 6 females) with an average weight of 43g were randomly allotted to three dietary treatments in a randomised complete block design based on sex and live weight. The diets (Table 1) were designated as; Control (T0) with no *Gari* or *Garico*, T1 with 58% *Gari* and T2 with 58% *Garico*. *Gari* and *Garico* replaced equal amounts of maize. Poultry by-product meal, soya bean meal and wheat bran levels were adjusted to obtain similar levels of crude protein in all the diets.

Each treatment had 6 rats and a rat represented a replicate. The rats were housed individually in rectangular plastic containers (i.e., 25 x 20.5 x 15 cm) fitted with feed troughs and covered with wire mesh which were placed randomly on well-ventilated shelves. Feed and water were provided *ad libitum* using metal troughs and overhead nipple drinkers respectively.

Parameters measured

Weekly feed intake and live weight changes were recorded and used to calculate the daily feed intake, daily weight gain and the feed conversion ratio (FCR). The cost of all the ingredients used including *Gari* and *Garico* were evaluated using the open market prices to calculate the feed cost per 100g of each diet. Feed cost per 100g weight gain was calculated by multiplying the cost of 100g of feed by the FCR. At the end of the experimental period, the rats were euthanized and dissected for subsequent carcass analysis.

The weights of the viscera, heart, kidneys, lungs, spleen, liver and full and empty gastrointestinal tract (GIT) were measured using an electronic scale (KERN & Sohn GmbH, Balingen, Germany). The corresponding relative weights of these organs were also determined as the percentage of the weight of the organ to the total weight of the rat.

Statistical analysis

All the data collected were subjected to Analysis of Variance (ANOVA) as described in Minitab 18.1 Statistical Software (2017). Differences between means were separated using Tukey's range test and declared significant at an alpha level of $p < 0.05$.

RESULTS AND DISCUSSION

Health and Growth performance

A total of 7 rats out of the 18, 3 from the Control (T0) group and 2 each from dietary treat-

Table 1: Composition of experimental diets (%, as-fed)

Feed ingredients (%)	Dietary treatment Control (T0)	*Gari* (T1)	*Garico* (T2)
Maize	58	0	0
Gari	0	58	0
Garico	0	0	58
Poultry by-product meal	6.5	13	14.5
Soyabean meal	13	14	14
Wheat bran	20.5	13	11.5
Oyster shell	1	1	1
Dicalcium phosphate	0.5	0.5	0.5
Common salt	0.25	0.25	0.25
Vitamin-trace mineral premix*	0.25	0.25	0.25
Total	**100**	**100**	**100**
Calculated nutrient composition			
Crude protein, %	18.05	18.13	17.85
Crude fibre, %	3.59	3.87	3.81
Calcium, %	0.51	0.64	0.63
Phosphorus, %	0.46	0.53	0.51
Metabolizable energy, kcal/kg#	3027.36	2987.17	2986.53

**Vit-min. premix per 100kg diet: Vitamin A ($8x10^5$ U.I); Vitamin D3 ($1.5x10^4$ U.I); Vitamin E (250mg); Vitamin K (100mg); Vitamin B2 ($2x10^2$mg); Vitamin B12 (0.5mg); Folic acid (50mg); Nicotinic acid ($8x10^2$mg); Calcium panthotenate (200mg); Choline ($5x10^3$mg). Trace elements: Mg ($5x10^3$mg); Zn ($4x10^3$mg); Cu ($4.5x10^2$mg); Co (10mg); I (100mg); Se (10mg). Antioxidants: Butylated hydroxytoluene ($1x10^3$mg). Carrier: Calcium carbonate q.s.p (0.25kg).*

#Metabolizable energy was calculated using Pauzenga (1985) equation (i.e., ME = 37 x % CP + 81.8 x % EE + 35 x % NFE)

ments T1 and T2 died in the first week of the experiment. There was no evidence that these deaths were treatment related. There was a trend ($p>0.05$) with the feed intake and weight gain values across the dietary treatments. It could be noticed from Table 2 that, rats on the *Garico* diet had the highest feed intake and weight gain followed by those on the Gari diet and then the Control diet. Generally, feed consumption increases with a decrease in the energy content of the feed, that is, the rats would tend to eat more of a lower energy diet in order to meet their energy requirement. With the FCR values, the *Garico* diet was the most efficiently utilised in terms of feed: gain ratio followed by the Gari and Control diets. However, it is worth noting that, there was no significant difference ($p>0.05$) in the feed intake, average daily gain and FCR for rats on the *Garico*, *Gari* and Control treatment diets.

Esiegwu (2017) reported similar ($p>0.05$) results in terms of final body weight, average daily feed intake and feed conversion ratio when *Gari* replaced maize at graded levels of 0%, 10%, 20% and 30% in the diets of broiler finisher birds. However, there was a decrease in feed intake ($p=0.024$), the body weight of layers at first lay ($p=0.027$) and cumulative egg weight/hen ($p=0.049$) of local barred-chicken when maize was completely substituted with cassava root meal in the diet of the laying birds (Raphaël *et al*., 2013).

The cost per kg of *Garico*, *Gari* and maize in Kumasi in the Ashanti Region during the time of the experiment were ¢3.29, ¢3.53 and ¢2.27 respectively. However, the corresponding prices in a major *Gari* and *Garico* production centre namely in the *Kpo Kɔʃe-Mafi* in the Volta Region were ¢2.76, ¢2.00 and ¢3.60 (Boateng *et al*., 2020 in press). Hence the higher cost (per 100g) of the *Garico* and *Gari* diets in this study compared to the Control diet (Table 2) is attributable to the higher costs of the *Garico* and *Gari* in Kumasi, in the Ashanti Region where the experiment was conducted and the need to ensure that all the diets are iso-nitrogen and therefore the need to use higher levels of some other more expensive protein sources. This implies that one's location determines the cost of *Garico* or *Gari* and their affordability in the diet of livestock. Also, the higher inclusion rates of the poultry by-product meal in the *Garico* and *Gari* diets compared to the Control diet (Table 1) could have accounted for the higher cost per 100g of the cassava products diets (T2 and T3). It has been reported that usually protein per unit kg basis is the most expensive ingredient of all the macronutrients in livestock production (Boateng *et al*., 2019) and therefore there is a linear relationship between the increased percentage of dietary protein and the cost of feeding.

Feed cost/100g weight gain values were also similar ($p=0.077$) for rats on all dietary treat-

Table 2: Growth performance of rats and economics of production

Parameter	Treatment			P-value
	Control (T1)	*Gari* (T2)	*Garico* (T3)	
Initial weight, g	43.17	43.00	42.83	0.998
Final weight, g	84.21	108.71	125.96	0.447
Total weight gain, g	37.73	62.48	84.85	0.173
Daily weight gain, g	1.35	2.23	3.03	0.173
Total feed intake, g	192.63	313.13	350.88	0.301
Daily feed intake, g	6.88	11.18	12.53	0.301
FCR	5.48	4.82	4.37	0.339
Feed cost/100g, GH¢	0.17	0.31	0.30	-
Feed cost/100g wt. gain, GH¢	0.92	1.53	1.28	0.077

ments. Contrary to the outcome of this study, there was a significant difference (p>0.05) in the feed cost/kg weight gain when *Gari* at graded levels (0, 10, 20, 30, 40%) substituted maize in the diets of pullets beyond 20% (Vantsawa, 2009).

Carcass traits

No significant differences (p>0.05) were recorded in the absolute and relative carcass characteristics for all the rats in the various dietary treatments (Table 3). This implies that *Gari* and *Garico* had the same nutritional or no detrimental effects on the carcass traits of the rats. The processing of cassava into *Gari* or *Garico* could have eliminated or reduced the level of hydrogen cyanide (HCN) present which could have affected the internal organs. According to Eruvbetine (2003), feeding processed cassava leaf meal or cassava products or a combination of both has been shown to result in no negative impact on carcass characteristics of broilers. Also, the internal organs of broiler finishers such as gizzard, liver, heart and intestinal length, were not affected when processed cassava (*Gari*) was used to replace maize at 30% in their diets (Esiegwu, 2017). However, Adeyemi and Akinfala (2019) attributed a significant change (P<0.05) in the weight of some organs (i.e., kidney, lungs, heart, spleen and empty stomach) of growing pigs fed with cassava meal as a replacement for maize at different levels (i.e., 0, 25, 50, 75 and 100%) to the level of HCN present in the cassava variety used.

Table 3: Absolute and relative weight of internal organs of rats fed the experimental diets

Parameter	**Treatment**			**P-value**
Absolute weight, g	**T1**	**T2**	**T3**	
Viscera	24.70	23.85	26.03	0.706
Full GIT	11.50	13.34	14.32	0.633
Empty GIT	8.99	9.62	10.80	0.504
Full stomach	1.38	2.91	3.16	0.312
Empty stomach	1.17	1.18	1.38	0.582
Heart	0.34	0.45	0.47	0.513
Kidney	0.74	1.26	1.29	0.208
Spleen	0.44	0.84	0.75	0.727
Liver	4.90	4.92	5.04	0.578
Respiratory tract	0.75	1.29	1.34	0.437
Relative weight, %				
Viscera	33.49	23.68	20.91	0.191
Full GIT	14.48	12.22	11.39	0.305
Empty GIT	11.18	8.83	8.83	0.349
Full stomach	2.28	2.60	2.43	0.880
Empty stomach	1.48	1.08	1.13	0.571
Heart	0.42	0.42	0.37	0.669
Kidney	0.94	1.16	1.03	0.322
Spleen	0.56	0.74	0.58	0.743
Liver	4.90	5.05	5.05	0.913
Respiratory tract	1.00	1.17	1.06	0.740

CONCLUSION

Complete replacement of maize with *Gari* or *Garico* in the diets of albino rats did not result in any negative effect on the growth performance, economics of production and weights of internal organs of rats. However, there was a trend towards higher feed costs and costs/ gain in the cassava-based diets. Farmers can therefore safely include *Gari* and *Garico* in the diets of monogastric farm animals especially pigs wherever maize is not available in sufficient quantity and/ or very expensive. The need to do a thorough cost-benefit analyses on the use of *Gari* or *Garico* as feed ingredient cannot be overemphasised.

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