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NUTRITIONAL EVALUATION OF SOME NEW MAIZE VARIETIES: EFFECTS ON GROWTH PERFORMANCE AND CARCASS TRAITS OF ALBINO RATS

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ABSTRACT

A study was carried out to ascertain the effects some new maize varieties: Obatanpa (OB), Opeaburoo (OP), Honampa (HO), Aseda (AS), Tintim (TT), Owanwa (OW) and Odomfo (OD) on the growth performance and carcass traits of albino rats. Aseda, Opeaburoo and Tintim are all white varieties and have been described as being moderately tolerant to drought and good for domestic purposes. Owanwa, Odomfo and Honampa on the other hand are all yellow varieties. The OW and OD varieties have a pro-vitamin A content of 6µg/g whilst HO has a pro-vitamin A content of 7µg/g. Obatanpa (OB) is a white and an open-pollinated Quality Protein Maize (QPM) variety grown widely by farmers in Ghana. Thirty-five weanling Wistar® rats with an average initial live weight of 36g were randomly allocated to seven isocaloric dietary treatments in a completely randomized design (CRD). There were five rats on each treatment, housed individually in plastic cages and each rat served as a replicate. Their growth performance was monitored for 28 days, after which the rats were euthanized and dissected to collect carcass data. The mean daily feed intakes and weight gains were similar ($P>0.05$) for the rats on the various dietary treatments. The feed conversion ratios (FCR) as well as feed cost per 100g weight gain were not significantly ($P>0.05$) influenced by the variety of maize in the diets. The abdominal fat colour score was affected by the dietary treatments with HO, OD and OW scoring 2 while treatments OB, OP, AS and TT scored 1. The carcass characteristics of all the albino rats on the seven dietary treatments were similar ($P>0.05$) except for empty gastrointestinal tract (GIT) weights which were higher ($P<0.05$) for HO and OD treatments. It was concluded that since the growth performance indicators were similar for all the dietary treatments, farmers can utilize any of these new varieties in their feeding operations but where enhanced carcass colour is desired HO, OD and OW could be the varieties of choice.

Key words: Carcass, carotene, colour, drought tolerance, maize, obatanpa, variety, yield

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INTRODUCTION

Maize constitutes the predominant ingredient in most swine and poultry diets [1, 2] and is described as an indispensable cereal grain in the diets of monogastric farm animals in Ghana and several other countries where it forms about 50-60% of such diets. Maize is high in energy, low in fibre, palatable and easily digested [3]. The normal maize varieties used in Ghana and elsewhere have two major limitations, namely: low protein content (9-10%) and low levels of some essential amino acids, particularly lysine (0.23%) and tryptophan (0.06%). It is therefore, not an adequate protein source for monogastrics [4, 5]. This led to the development of the Quality Protein maize (QPM) varieties with the Opaque-2 gene which has a better balance of essential amino acids, making it nutritionally superior to the normal maize varieties [3]. In Ghana, the QPM material was used to develop an improved maize variety known as Obatanpa (OB). Since the release of Obatanpa, there have been the release of several maize varieties some of which have been nutritionally evaluated in monogastrics diets [6, 7, 8, 9, 10] but Obatanpa continues to be the most cultivated maize variety in Ghana [11]. Though, Obatanpa has a relatively higher yield than normal maize varieties (3.2 tons/ha verses 1.7 tons/ha [12]) it still falls below the country's demand for maize. The increase in demand for maize is mainly because of the competition between humans, industries and animals for this essential commodity [13]. Thus it has been stated that one of the ways to remedy this situation is by breeding for and growing maize varieties which are high yielding [11]. Also, changes in climatic conditions call for the development of varieties of crops which are high yielding but resistant to the adverse climatic conditions such as drought. The Crop Research Institute (CRI) in Ghana, in the year 2012 released 6 new high yielding maize varieties: Aseda, Opeaburoo, Tintim, Owanwa, Odomfo and Honampa. Aseda, Opeaburoo and Tintim are also known to be drought resistant whilst Owanwa, Odomfo and Honampa contains relatively higher levels of pro-vitamin A [14]. It is worth indicating that there is very scanty data on the effects of these varieties on the growth of farm animals.

Therefore, the purpose of this current study was to evaluate the effect of these six (6) high yielding maize varieties on the growth performance and carcass traits of albino rats with Obatanpa as control.

MATERIALS AND METHODS

Study Area and Duration of Experiment

The study was conducted at the Livestock Section of the Department of Animal Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana over a 4 week period. The climatic condition during the study was dry, cold and hazy, as the country was experiencing the Harmattan. The ambient temperature during the period of the experiment ranged between 24°C and 31°C (Agro-Meteorological Station KNUST).

Maize and other ingredients used for the study

The maize varieties were sourced from the Alpha Seed Limited, Kumasi. Other ingredients used in the study such as soya bean meal, fish meal and wheat bran were

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bought from the open market in Kumasi. Table 1 gives a detailed description of the maize varieties used in this study.

Experimental Animals, Management, Housing and Feeding

Thirty-five (21 males and 14 females) weanling Wistar rats of an average initial weight of 36g were randomly allotted to seven isonitrogenous diets (Table 2), labeled: OB, OP, HO, AS, TT, OD and OW in a completely randomized design with 5 replicates per treatment. Each replicate consisted of one rat. Thus there were 3 male and 2 female rats in each treatment. The rats were housed individually in rectangular plastic containers measuring 27 × 21.5 × 15cm$^{3.}$ Feed was provided in a metal trough fitted to a corner of the plastic containers whilst water was supplied by means of overhead nipple drinkers. The plastic containers were cleaned daily whilst feeding troughs were cleaned weekly after the quantity of feed consumed has been measured. Feed and water were provided *ad libitum*.

Parameters measured

Total feed intake and total weight gain of each rat were recorded weekly and the corresponding daily feed intake, daily live weight gain and efficiency of feed utilization were calculated. At the end of the 4 weeks of feeding, rats were euthanized and dissected for the collection of carcass data. Rats were not starved before they were put away. Data taken on the carcasses included the weight of the entire viscera, the lungs, spleen, heart and kidney. Also, the weight of the GIT and its content / digesta (Full GIT) was taken after which it was emptied by washing and reweighed (Empty GIT). The relative weights of the internal organs were also taken [Relative weight = organ weight/body weight × 100]. Finally, a yolk colour fan was used to categorize the colour of abdominal fat so as to assess the deposition of carotenes in the body.

Chemical and Statistical analyses

The crude protein content of the seven diets was determined using procedures outlined by AOAC [15]. All data collected for the growth performance and carcass components of the rats were subjected to analysis of variance (ANOVA) using GenStat Discovery Edition [16] and differences between means were separated by the Least Significant Difference (LSD). Differences were deemed significant at $P < 0.05$.

RESULTS

Growth Performance of the Rats

The effects of the seven dietary treatments on the growth performance of rats are as shown in Table 3. The quantities of feed consumed by the rats on the various treatments were not significantly ($P = 0.95$) different and the average daily weight gains (ADG) were also similar ($P > 0.05$).

Feed Cost and Economy of gain

The feed cost/100g of the various diets was the same i.e. GH₵0.092 (Table 3). This was so because the ingredient composition of the diets was the same and the different maize varieties were assumed to be of the same price. The feed cost per 100g live weight gain values were not significant ($P>0.05$) among all treatment means.

Carcass characteristics

The summary of the mean carcass traits for the rats on the seven dietary treatments is as shown in Table 4. There were no significant (P > 0.05) differences among the various carcass traits except for the absolute empty GIT weights where rats on treatments OP, AS, TT and OW recorded significantly (P = 0.038) lower weights compared to those on treatments HO and OD. The relative weight of the full GIT for rats on the treatment labeled OP was significantly lower (P < 0.05) than the values for the rest of the treatments. The relative weight of the empty GIT for treatments OB, OP and OW were similar (P<0.05). These weights were significantly different (P<0.05) from those recorded for treatment HO and OD.

It can also be seen from Table 4 that the abdominal fat colour was affected by the dietary treatments when the fats were compared to a yolk colour fan. Dietary treatments HO, OD and OW scored 2 while treatment OB, OP, AS and TT scored 1.

DISCUSSION

The similarities recorded in average daily feed intake and average daily weight gain were in accordance with what was earlier reported [17] when four different varieties, two QPM and two normal maize, were fed to pigs. Again there were no significant (P =0.57) differences among the means for the seven dietary treatments with regards to how efficiently the rats used them. A previous report [18] had asserted that feeding QPM-based diets reduced growth rate of starter pigs compared to normal maize-based diets. On the other hand there were no significant differences (P > 0.05) in the average daily weight gained by pigs fed the different maize varieties [1, 7, 19, 20]. However, other researchers reported similar (P > 0.05) ADG in pigs fed diets containing different maize varieties [5, 17].

Improvement in the FCR has also been realized in pigs fed diets containing Obatanpa [5, 10]. In an earlier study [21], pigs fed QPM-based diets had as much as 3.5 times faster growth rate than those on normal maize diets. The authors [21] explained that the inconsistencies in the results could be attributed to variations in nutrient composition among the QPM cultivars and the normal maize varieties used in the different research studies.

Similar trends in carcass weight and organ characteristics were observed when grower-finisher pigs were fed QPM–based diets [21]. The differences in abdominal fat colour could be due to the fact that HO, OW and OD contained higher levels of carotene than the other varieties. Carotene which contains cryptoxanthin and xanthophyll has been responsible for the rich yellow colour of the egg yolk in poultry [22, 23].

CONCLUSIONS

From the results of the experiment, it can be deduced that the various dietary treatments did not influence growth performance, carcass characteristics, except for full, empty GIT and abdominal fat colour, of the albino rats.

RECOMMENDATIONS

The results indicate that these newly released maize varieties (OP, HO, AS, TT, OD and OW) are good nutritionally and could be used by farmers in the monogastric livestock industry. However, where enhanced carcass colour is desired HO, OD and OW could be the varieties of choice.

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Table 1: Details of maize varieties used in this study

Release Name (Accession No.)	Type of variety	Maturity period (days)	Seed colour	Potential yield (tons/ha)
Aseda (MO826-4)*	Three way hybrid	110-115	White	6.7
Opeaburoo (MO826-7)*	Top cross hybrid	110-115	White	7.5
Tintim (MO826-12)*	Top cross hybrid	110-115	White	7.9
Owanwa (A0804-5)[1]	Single cross hybrid	110-115	Yellow	7.9
Odumfo (A0806-2)[1]	Single cross hybrid	110-115	Yellow	6.5
Honampa (PVASyn6)[2]	Open pollinated variety	110-115	Yellow	5.2
Obatanpa (SRC1-F3)	Open pollinated variety (QPM)	95	White	3.8

** Drought tolerant variety, [1] Contains 6µg/g provitamin A, [2] Contains 7µg/g provitamin A*

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Table 2: Percentage Composition of the Seven (7) Diets

Ingredient	OB	OP	HO	AS	TT	OD	OW
Obatanpa (PB)	60	-	-	-	-	-	-
Opeaburoo (OB)	-	60	-	-	-	-	-
Honampa (OB)	-	-	60	-	-	-	-
Aseda (AS)	-	-	-	60	-	-	-
Tintim (TT)	-	-	-	-	60	-	-
Odomfo (OD)	-	-	-	-	-	60	-
Owanwa (OW)	-	-	-	-	-	-	60
Fishmeal	8	8	8	8	8	8	8
Soyabean meal	6	6	6	6	6	6	6
Wheat bran	24.5	24.5	24.5	24.5	24.5	24.5	24.5
Oyster shell	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin –trace mineral	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Calculated nutrient composition (%, as fed)							
CP	17	17	17	17	17	17	17
Ca	0.86	0.86	0.86	0.86	0.86	0.86	0.86
P	0.76	0.76	0.76	0.76	0.76	0.76	0.76
CF	2.27	2.27	2.27	2.27	2.27	2.27	2.27
D.E (Kcal/kg)	2918.9	2918.9	2918.9	02918.9	2918.9	2918.9	2918.9
Analysed Crude protein (% DM)							
CP, %	18.05	18.15	18.00	17.95	18.10	19.20	18.10

Vitamins, Provitamins (per kg of diet): Vitamin A (8000 I.U); Vitamin D3 (150 U.I); Vitamin E (2.5mg); Vitamin K (1mg); Vitamin B (2mg); Vitamin B12 ($5x10^{-3}$mg); Folic acid (0.5mg); Nicotimic acid (8mg); Calcium Pantothenate (2mg); Choline cloruro (50mg), Trace Elements: Mg (50mg); Zn (40mg); Co (0.1mg); Cu (4.5mg); Se (0.1mg). Antioxidants: Butylated Hydroxytoluene (10mg). Carrier: Calcium carbonate q.s.p (2.5kg)

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Table 3: Growth Performance and Economy of Production

Parameters	Treatments							SED	*P*
	OB	OP	HO	AS	TT	OD	OW		
Initial weight ,g	35.8	38.2	35.2	36.8	35.8	35.4	37.0	7.14	1.00
Final weight, g	98.2	98.2	110.6	112.8	94.2	103.0	102.6	15.10	0.87
Total feed intake, g	243.8	241.0	261.6	261.4	234.8	246.4	246.0	27.53	0.95
Daily feed intake, g	8.71	8.61	9.34	9.34	8.38	8.80	8.79	0.98	0.95
Total weight gain, g	62.4	60.0	75.4	76.0	58.4	67.6	65.6	12.25	0.68
Daily weight gain, g	2.23	2.14	2.65	2.71	2.09	2.41	2.34	0.44	0.72
FCR (intake/gain)	4.02	4.72	3.56	3.50	4.58	3.68	3.96	0.76	0.57
Feed cost/100g GH₵	0.092	0.092	0.092	0.092	0.092	0.092	0.092	-	-
Feed cost/100g weight, GH₵	0.370	0.396	0.327	0.322	0.421	0.338	0.364	0.06	0.63

P-probability, SED-Standard error of difference of means

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Table 4: Mean Carcass traits of the rats fed the seven diets

Parameters	Treatments							SED	*P*
Absolute weight, g	OB	OP	HO	AS	TT	OD	OW		
Viscera	21.94	18.64	26.00	24.56	21.15	24.14	22.25	3.219	0.357
GIT(Full)	13.36	10.17	15.02	15.20	12.84	14.76	14.16	1.890	0.152
GIT(Empty)	6.93^{ab}	6.45^{b}	8.78^{a}	6.43^{b}	6.30^{b}	8.72^{a}	6.31^{b}	0.980	0.038
Heart	0.382	0.465	0.488	0.484	0.380	0.478	0.382	0.079	0.522
Lungs	1.056	0.782	0.870	0.930	0.846	0.900	0.866	0.168	0.793
Spleen	0.318	0.333	0.438	0.444	0.324	0.380	0.338	0.059	0.171
Kidneys	0.908	0.965	1.054	1.088	0.906	0.722	0.922	0.146	0.277
Liver	4.99	4.94	6.34	5.85	4.92	5.65	5.00	0.904	0.587
Abdominal fat colour$^{\beta}$	1	1	2	1	1	2	2	-	-
Relative weights, %									
Viscera	22.5	18.8	39.1	22.3	22.6	23.3	21.4	7.930	0.242
GIT(Full)	13.74^{a}	10.22^{b}	13.74^{a}	13.01^{a}	13.64^{a}	14.56^{a}	13.61^{a}	1.180	0.030
GIT(Empty)	7.06^{c}	6.60^{c}	7.95^{ab}	5.88^{c}	6.73^{bc}	8.50^{a}	6.38^{cs}	0.622	0.004
Heart	0.386	0.492	0.454	0.422	0.380	0.472	0.368	0.059	0.268
Lungs	1.060	0.828	0.846	0.874	0.942	0.856	0.794	0.145	0.607
Spleen	0.310	0.365	0.365	0.440	0.372	0.374	0.328	0.059	0.471
Kidneys	0.924	0.740	0.978	0.48	1.058	0.906	0.926	0.131	0.399
Liver	5.04	5.02	5.87	6.13	5.12	5.55	4.60	0.738	0.403

$^{\beta}$Abdominal fat colour1=white, 2=slightly yellow; P-probability; ^{abc} Means in a row with the different superscripts are significantly different (P<0.05), SED-Standard error of difference of means

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