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Evaluation of the Nutritive Value of Quality Protein Maize on the Growth Performance and Carcass Characteristics of Weaner Rabbits

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Abstract: Quality protein maize (QPM) was used to substitute normal maize variety in intensive rabbit study in attempt to reduce the cost of production. Thirty-six weaner rabbits with age ranging between 6-8 weeks and weighing between 225-300g were assigned to six treatment groups in a completely randomized design; six rabbits per treatment were individually caged and fed. The ration involved a percent replacement of normal maize with Quality protein maize at 0, 25, 50, 75, 100 % levels of inclusion across the treatments. The control diet involves a 0% level of QPM supplemented with synthetic lysine. Water and feed was provided *ad-libitum* throughout the study period of 56 days. Feed intake, water consumption, weight gain and mortality were recorded. Results showed no significant difference (P > 0.05) in total feed intake, weight gain, feed efficiency, water consumption, mortality rate, feed cost/kg weight gain. However, there was significant difference (P < 0.001) in feed cost/kg feed across the treatments. Carcass characteristics showed significant difference (P < 0.05) with no established trends in live weight, length of small and large intestines, liver, legs and tail. There was no significant difference (P > 0.05) in carcass weight, dressing percentage, heart, shoulder, loin, thigh, lungs, kidneys, spleen and head. The results indicated that feeding QPM to rabbits without lysine supplementation could sustain rabbits without affecting their performance, health and reduced cost of production.

Key words: Quality protein maize, normal maize, performance, rabbits, cost (#/kg gain)

Introduction

The increase in human population in Nigeria over the last decades has greatly influenced the demand for food products of animal origin hence the livestock producers at large are having difficulties in meeting the demand for animal products by the ever-growing population. The Food and Agricultural Organization (FAO, 1985) recommended a minimum of 56g of animal protein intake per person per day. Many Nigerians cannot meet this requirement due to high cost of animal products (Fasuyi, 2005).

An effective and quick approach for balancing the demand and supply of animal products in Nigeria and other developing countries is through the expansion of the livestock industry especially through the use of animals with short generation intervals. Rabbit is one of such animal species. It is highly prolific with short generation intervals, early maturity and rapid growth rate (Cheeke, 1980). Baymen (1984) reported that rabbit meat rank highest in protein and lowest in fat content (cholesterol) and calories compared to beef, chicken, mutton and pork.

A major constraint of the livestock industry in meeting consumer demand for more meat, milk, egg and other livestock products is dependent to a major extent on the availability of regular supplies of appropriate, cost effective and safe animal feeds and as a result, animal feeds have become an increasingly critical component of the integrated food chain (FAO, 2004). Further more, among all the nutrients required for effective performance of monogastric and Pseudo-ruminant animals, energy has remained the most abundant nutrient to supply in a balanced diet constituting between 45-60% of finished feeds (Nestel, 1975; Machin, 1992). Maize has also remained the major source of energy supply in livestock diets. In several developed and developing countries, the highest proportions of maize produced are used for animal feed, hence maize has been and continues to be an indispensable cereal grain in the diets of monogastic and pseudo-ruminant animals and it typically form between 50-60% of such diets. The normal maize variety used in livestock diets has two significant flaws; like all cereals, firstly, it is low in protein (9-10%) and secondly, it does not provide the essential amino acids; (lysine and tryptophan) in sufficient quantities for the nutritional needs of farm animals, thus as far as protein quality is concerned, the normal maize variety has poor protein quality (Okai *et al.*, 2005; Vasal, 2006). Thus, livestock diets based on normal maize are supplemented with protein – rich feed ingredients such as soyabean meal, fishmeal and synthetic lysine to compensate for the deficient lysine.

However, improving maize varieties to possess an improved balance of essential amino acids can reduce the dietary inclusions of protein - rich ingredients such as fishmeal and synthetic lysine and thereby provide savings on the cost of feed and production, thus making animal products more affordable. “Opaque-2 variety is an example of such improved maize with high protein content and the lysine and tryptophan levels are better than those of the normal maize. Animals (chicken and pigs) fed this variety of maize (Opaque-2) have significantly performed better than their counterparts fed on normal maize (Asche *et al*., 1985; Sullivan *et al*., 1989; Okai *et al*., 2005;).

However, the development of high lysine mutant maize "Opaque -2-mutant through intensive breeding have succeeded in producing Quality protein maize (QPM) which is richer in lysine, tryptophan and other amino-acids than the existing maize lines. QPM contain twice the amount of essential amino acids than in normal maize (Showemimo *et al*., 2005; Babu, 2005) and it yield 10% more grain than the traditional varieties of maize (Surinder and Evangelina, 1999). Okai *et al*. (2005) reported that a particular variety of QPM known as Obatamppa in Ghana contained 0.36% lysine in contrast to the 0.23% in normal maize and that except for methionine; the levels of six other indispensable amino acids were also high. Although these levels of lysine are lower than that in the conventional protein sources such as soyabean (4.00%) and Blood meal (7.00%), but the fact that maize constitutes about 50-60% of the diets of rabbits and monogastric animals makes the contribution of lysine in maize to be of great importance. Supplementation of QPM in the diets of rabbits and monogastric animals is therefore very important as QPM could be seen to substitute for high protein but rather costly sources like soyabeans, fishmeal and Blood meal (Vasal, 2006). QPM is relatively cheap and an excellent source of lysine and other essential amino acids such as tryptophan since the quantity of the maize is very high in the ration. Thus most of the benefits of using QPM as an animal feed are likely to be through economic savings, in addition to being superior in protein quality and higher in feed efficiency.

The Objectives of the Study are to:

1. Determine the proximate composition of both local maize and Quality Protein Maize.
2. Determine the effects of QPM on the performance and carcass characteristics of weaner rabbits.
3. Determine the economic implication of feeding rabbits with QPM as replacement for the normal maize.

Materials and Methods

Experimental location: The research was carried out at the livestock unit of the Teaching and Research unit of the Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna State, Nigeria.

Laboratory analysis: The laboratory studies involved the determination of proximate composition of the local maize, QPM and formulated diets according to A.O.A.C (1990) procedures.

Table 1: Proximate analysis of quality protein maize and normal maize

Parameters		Quality Protein Maize	Normal Maize
Dry Matter	(%)	96.84	92.70
Crude Protein	(%)	3.33	4.80
Ether Extract	(%)	15.86	14.00
Total Ash	(%)	2.95	1.76
NFE	(%)	66.45	64.72

Biological study: Growth trials were conducted using 36 weaner rabbits in a completely randomized experimental design to evaluate the percent replacement of normal maize with QPM in rabbit diets using groundnut cake as protein source. There were six treatments with six rabbits per treatment. The rabbits were individually caged. Diets were formulated to meet the NRC (1995) nutrient requirements for rabbits. The experiment lasted for eight weeks. Table 2 shows the composition of diets for the study.

The rations involved a percent replacement of normal maize with QPM as follows:

Treatment 1: Maize – Groundnut cake base diet (100% Normal Maize)
Treatment 2: Maize – Groundnut cake based diet (75% Normal Maize + 25% QPM)
Treatment 3: Maize – Groundnut cake based diet (50% Normal Maize + 50% QPM)
Treatment 4: Maize – Groundnut cake based diet (25% Normal Maize + 75% QPM)
Treatment 5: Maize – Groundnut cake based diet (100% QPM)
Treatment 6: Maize – Groundnut cake based diet (100%Normal Maize + Synthetic Lysine)

Management of experimental animals and data collection: The rabbits were fed for two days with the feed under test to remove residues of previously fed feeds from their digestive tract. The rabbits were dewormed before the experiment commenced, and proper sanitary conditions were maintained to avoid disease outbreak. The rabbits were weighed at the start of the experiment; the initial weights was recorded and subsequently weighed on a weekly basis. Feed intake, weight gain, feed efficiency, water consumption, mortality rate, cost per kg feed (N) and cost per kg weight gain (N) were computed. The rabbits were weighed at the end of the experiment to get the final live weight.

Carcass evaluation: At the end of the study, three rabbits per treatment were randomly selected, weighed, slaughtered and eviscerated for carcass evaluation. The rabbits were skinned, the head, tail, skin and legs were cut off and weighed, each animal was cut open, the alimentary canal, heart, liver, lungs, kidneys and spleen were removed and weighed individually. The weight of the warm carcass devoid of internal organs was

Table 2: Composition of the experimental Diets

	Treatments					
Ingredients	1	2	3	4	5	6
Normal Maize	39.50	29.62	19.75	9.88	-	39.50
QPM	-	9.88	19.75	29.62	39.50	-
GNC	19.20	19.20	19.20	19.20	19.20	19.05
Wheat offal	27.90	27.90	27.90	27.90	27.90	27.90
Maize offal	9.60	9.60	9.60	9.60	9.60	9.60
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Lysine	-	-	-	-	-	0.15
DL-Methionine	0.30	0.30	0.30	0.30	0.30	0.30
*Vitamin mineral Premix.	0.20	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00
Cost/kg feed (#/kg)	25.20	25.20	25.20	25.20	25.20	25.25
Calculated analysis						
M.E.Kcal/kg	2690	2690	2690	2690	2690	2684
Crude protein (%)	18.00	18.00	18.00	18.00	18.00	18.00
Crude fiber (%)	9.50	9.50	9.50	9.50	9.50	9.50
Calcium (%)	1.19	1.19	1.19	1.19	1.19	1.19
Available Phosphorus (%)	0.75	0.75	0.75	0.75	0.75	0.75
Lysine	0.75	0.76	0.77	0.78	0.79	0.87
Methionine	0.60	0.60	0.60	0.60	0.60	0.60

*A Vitamin mineral premix provides per kg of diet: Vitamin A, 13.340 i.u; D_3, 2680 i.u; Vitamin E, 10 i.u; Vitamin K, 2.68 i.u; Calcium pantothenate, 10.68mg, Vit B_{12} 0.022mg; Folic acid, 0.668mg; choline chloride 400mg; chlorotetracycline, 26-28mg; Manganese, 133.34mg; Iron, 66.68mg; Zinc, 53.34mg; copper, 3.2mg; Iodine, 1.86mg; Cobalt, 0.268mg, selenium, 0.108mg.
*QPM: Quality Protein Maize. * ME: Metabolizable energy. *GNC: Groundnut cake, *i.u: International Unit.

recorded. The skinned carcass was dissected into retail cuts of loin, shoulder and thigh, which were then weighed individually. The weight of each of these organs was expressed as a percentage of the live weight.

Data analysis: Data collected were subjected to analysis of variance as described by Steel and Torrie (1980). Significance difference was determined by applying the Duncan's Multiple Range Test (Duncan, 1955) across the treatments.

Results

The proximate composition of quality protein maize and normal maize variety: The proximate composition of Quality Protein Maize and Normal Maize are presented in Table 1. The average dry matter content is 96.84%, crude protein 8.25%, crude fiber 3.33%, ether extract 15.86%, total ash 2.95%, NFE 66.45% for QPM and dry matter content of 92.70 %, crude protein 7.42 %, crude fiber 4.8 %, ether extract 14.00% and total ash 1.76%, NFE 64.72% for normal maize.

Effects of graded levels of quality protein maize on weaner rabbits: The effects of the treatments on the performance of weaner rabbits are presented in Table 3. There was no significant difference ($P > 0.05$) in initial weight (g), final weight (g), daily feed intake (g), daily weight gain (g), feed efficiency, daily water consumption (ml), mortality rate and feed cost/kg weight gain (#) across the treatments.

There was significant difference ($P < 0.001$) in feed cost/kg feed (#/kg) across the treatments.

Carcass analysis: The result of carcass yield is shown in Table 4.

Live-weight was significantly ($P < 0.05$) lowest at 50% level of supplementation and highest at 100% level. However, there was no significant difference ($P > 0.05$) in live-weight between rabbits offered the diet at 0, 25, 50, 75% and control. Slaughter weight followed similar pattern as live-weight. There was no significant difference ($P > 0.05$) in carcass weight across the treatments.

Length of small intestine was significantly ($P < 0.05$) lowest in control and 100% level of supplementation and highest at 0% level of supplementation. However, there was no significant difference ($P > 0.05$) in the length of small intestine in the rabbits offered the diets at 25, 50 and 75% levels of supplementation.

The length of large intestine was significantly ($P < 0.05$) lowest at 0 and 25% level of supplementa-tions and highest in the control diet. However, there was no significant difference ($P > 0.05$) in the length of large intestine at 50, 75 and 100 percent levels of supplementation. There was no significant difference ($P > 0.05$) in the dressing percentage across the treatments.

There was no significant difference ($P > 0.05$) in the heart, shoulder, loin, thigh, lungs, kidneys, head, skin, spleen, weight of full stomach, weight of empty stomach,

Table 3: Performance of weaner rabbits fed graded levels of Quality Protein Maize (QPM) based-diets

Parameters	1	2	3	4	5	6	SEM	L O S
Initial weight (g)	375.00	375.00	375.00	375.00	375.00	375.00	33.81	NS
Final weight (g)	854.92	1029.08	1024.60	1176.92	1337.64	1154.20	98.53	NS
Daily feed intake (g)	37.46	40.18	41.08	45.68	50.88	47.23	4.88	NS
Daily wt gain (g)	8.57	11.68	11.60	14.32	17.19	13.91	1.77	NS
Feed: Gain	4.37	3.44	3.54	3.19	2.96	3.63	0.51	NS
Daily water Consumption (ml)	91.64	96.25	131.29	137.20	147.46	158.71	26.25	NS
Mortality	1.07	1.00	1.07	1.00	1.00	1.07	0.041	NS
Feed Cost/kg weight Gain (#/kg).	84.26	82.96	82.45	82.88	76.77	113.36	11.57	NS

a, b, c, d, e, f, means with different superscripts within the same row differ significantly. NS: Not Significant (P > 0.05). LOS: Level of Significance. SEM: Standard Error of the Mean.

weight of full small intestine, weight of empty small intestine, weight of full large intestine and weight of empty large intestine.

There was significant difference (P < 0.05) in the liver, legs and tail but there was no specific trend established. At 0% level of supplementation, the liver is significantly (P < 0.05) highest and lowest at 25%, 75% levels of supplementation and control diet. However, there was no significant difference (P > 0.05) at 50 and 100% levels.

At 50% level of supplementation, the percent weight of legs is significantly highest and lowest at 100% level. However, there was no significant difference (P > 0.05) at 0, 75% levels of supplementation and control diet.

The tail was significantly (P < 0.05) highest in rabbits fed control diet and lowest at 100% level of supplementation. However, there was no significant difference (P > 0.05) at 0, 25, 50 and 75% levels of supplementation.

Discussion

There were slight variations among most of the nutrients in both the normal maize and Quality Protein Maize. The protein content in QPM is not far different from those of normal maize. This agrees with the report of Prasanna *et al.* (2001), although some studies showed higher levels for QPM (Rostango *et al.* 1990). Differences in comparison with other literature may be due to varietal, soil and climatic conditions (Soh *et al.*, 1994)

The crude protein value of 8.25% for Quality protein maize and 7.42% for normal maize, obtained in this study agrees with the reports of other workers (Prasanna *et al.*, 2001). 3.33% and 4.80% for QPM and regular maize were obtained respectively as values of crude fiber.

The results of the performance of rabbits showed that there was no significant effect of diets on any of the performance parameters measured.

Feed intake was numerically highest in the 100% and lowest in 0% levels of inclusion of QPM. Daily feed intake was observed to increase with increase in the dietary levels of QPM. However, higher levels of feeding QPM resulted in higher total feed intake.

There was no significant difference (P > 0.05) among the treatments for weight gain, although rabbits fed 75 and 100% QPM diets had a numerical faster rate of gain than those fed the control diet. The highest weight gain was observed at 100% level of inclusion. Body weight gains increase with increased level of QPM in the diet. This can be explained by increase in nutrient intake and utilization. This can be seen in the trend in feed to gain ratio, which improved with higher levels of QPM in the diets. This agrees with the reports of Asche *et al.* (1985); Sullivan *et al.* (1989); Lopez-Pereira (1992); Okai *et al.* (2005), that animals (chicken and pigs) fed this variety of maize (QPM) gained more weight than their counterparts fed on normal maize. The decline in weight gain at 50% level of inclusion can be attributed to faster rate of passage of the feed through the gastro-intestinal tract (GIT) and therefore less retention time for digestion and utilization.

Level of supplementation of QPM had no significant difference (P > 0.05) in feed efficiency among all the treatments. The efficiency with which feed was converted to gain showed a trend indicating that the higher the level of QPM fed the better the fed efficiency. A lower fed conversion ratio implies more feed being retained in the animal and less waste into the environment (Gebhart, 2001). Feed to gain ratios was better on the QPM-based diets, indicating that lower amounts of the QPM diets were consumed and converted to meat. This suggests that QPM is superior in feed efficiency than normal maize variety. Lopez-Pereira (1992) reported similar efficiency of feed utilization for chicken and pigs.

Level of feeding QPM had no significant (P > 0.05) effect on the quantity of water consumed, but the higher the level of inclusion of QPM the higher the quantity of water consumed, even though the quantity consumed was not significantly different from that of rabbits on control diet and normal maize variety. The highest water consumption was observed in the control diet.

In this experiment, differences among treatments were not significant (P > 0.05) for feed cost per unit of weight gain, but values were numerically lower for QPM diets. The highest feed cost per unit of weight gain was observed in the control diet, indicating that the rabbits in this treatment ate more to gain less weight. The results suggest therefore that QPM based-diets reduce cost of production though not significantly.

Table 4: Carcass characteristics of weaner rabbits fed graded levels of Quality Protein Maize expressed as percentage of live-weight

	Treatments							
Parameters	1	2	3	4	5	6	SEM	LOS
Live-wt	1216.67^{ab}	1250.00^{ab}	1125.00^{b}	1288.67^{ab}	1433.33^{a}	1275.00^{ab}	68.72	*
Slaughter Wt (g)	1166.67^{ab}	1168.33^{ab}	1093.33^{b}	1200.00^{ab}	1383.33^{a}	1171.67^{ab}	65.42	*
Carcass wt (g)	573.33	578.33	473.00	590.00	620.00	583.33	46.32	NS
Length SI (cm)	351.00^{a}	323.33^{ab}	317.00^{ab}	306.67^{ab}	300.00^{b}	290.00^{b}	15.04	*
Length LI(cm)	95.33^{b}	92.00^{b}	107.00^{ab}	108.00^{ab}	108.00^{ab}	138.33^{a}	11.01	*
Dressing (%)	48.38	47.82	42.05	46.56	44.25	45.44	3.75	NS
Heart (%)	0.25	0.21	0.21	0.19	0.23	0.21	0.02	NS
Liver (%)	3.83^{a}	2.98^{b}	3.49^{ab}	3.00^{b}	3.39^{ab}	2.89^{b}	0.20	*
Shoulder (%)	16.81	12.57	14.44	14.28	13.29	15.11	1.82	NS
Loin (%)	14.13	10.96	11.39	11.44	13.77	13.05	1.15	NS
Thigh (%)	14.26	13.32	12.86	14.14	13.21	15.39	0.80	NS
Lungs (%)	0.80	0.57	0.65	0.76	0.59	0.73	0.12	NS
Kidneys (%)	0.82	0.72	0.75	0.72	0.82	0.69	0.04	NS
Head (%)	8.29	7.70	8.64	7.06	6.94	7.55	0.77	NS
Legs (%)	3.04^{bc}	3.48^{ab}	3.85^{a}	3.16^{bc}	2.58^{c}	3.15^{bc}	0.19	*
Skin (%)	8.04	6.29	7.66	7.00	8.16	8.23	0.61	NS
Tail (%)	0.42^{ab}	0.40^{ab}	0.45^{ab}	0.40^{ab}	0.35^{b}	0.51^{a}	0.05	*
Spleen (%)	0.10	0.06	0.06	0.09	0.06	0.05	0.01	NS
Wt of FS (g)	5.77	6.22	5.79	4.88	5.37	5.31	0.99	NS
Wt of ES (g)	1.67	1.06	1.49	1.58	1.18	1.03	0.22	NS
Wt of FSI (g)	7.11	5.66	5.93	5.39	6.27	5.05	0.71	NS
Wt of ESI (g)	2.38	2.14	1.79	2.10	2.22	1.83	0.27	NS
Wt of FLI (g)	10.33	9.30	9.76	9.10	8.12	10.70	0.94	NS
Wt of ELI (g)	3.35	2.69	2.97	3.43	3.06	3.12	0.38	NS

a, b, c means with different superscripts within the same row differ significantly.
NS: Not significant (P > 0.05). *: Significant (P < 0.05). LOS: Level of Significance. SEM: Standard Error of the Mean.
FS: Full Stomach. ES: Empty Stomach. FSI: Full Small Intestine. ESI: Empty Small Intestine. FLI: Full Large Intestine.
ELI: Empty Large Intestine. Wt: Weight.

Level of feeding QPM had no significant (P > 0,05) effect on carcass traits of the weaner rabbits. Pre-slaughter weight increased as level of feeding QPM increased except at 50% level of inclusion. However, at higher levels of feeding QPM (75 and 100%), there were no significant differences (P > 0.05) in pre-slaughter weight. Increased level of feeding resulted in increased intake and nutrient utilization. Rabbits fed 100% level of QPM have the highest live-weight and were significantly (P < 0.05) higher than those fed 50% level of QPM, but no significant difference (P > 0.05) was observed in pre - slaughter weight in rabbits fed 0, 25, 75, 100% and control diet.

There were significant difference (P < 0.05) in slaughter weight, but it follows similar trend as pre - slaughter weight, indicating that level of feeding did not affect the quantity of drainable blood.

There were no significant (P > 0.05) variation in carcass weight of rabbit fed QPM diet and those fed on 0% and control diets. 100% QPM inclusion had the highest carcass weight, though not significantly different (P > 0.05) from the other treatments.

There were no significant (P > 0.05) variations in the dressing percentage of rabbits fed with or without QPM. Level of feeding had significant (P < 0.05) effect on the size of the liver, length of the intestines (small and large), legs and tails. The size of the liver was highest in the rabbits fed 0% level of QPM and lowest in rabbits fed 25, 75% QPM and control diet. However, there were no significant difference (P > 0.05) in rabbits fed 25, 50, 75, 100% and control diet.

There were no significant difference (P > 0.05) in the size of the heart, shoulder, loin, thigh, lungs, kidneys, head, skin, spleen, weight of stomach (full and empty), and weight of intestines (full and empty).

Conclusion: The results obtained from this study indicated that:

I) Rabbits could be raised on QPM-based diets without lysine supplementation.
II) QPM-based diets improved feed: gain ratio and feed cost per kg weight gain, indicating a reduction in cost of production.

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