IMPACT OF LIFE-ENZYME (*ZYMOMONAS MOBILIS* DEGRADED CORN COBS) ON GROWTH PERFORMANCE AND ECONOMIC ANALYSIS OF BROILER CHICKENS

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ABSTRACT

The fibrous nature of ground corn cobs limits their utilization in poultry production. *Zymomonas mobilis* derivable from fresh palm sap is proposed to ferment corn cobs to improve their nutritive values. An experiment was carried out to evaluate the impact of ground corn cobs inoculated with *Zymomonas mobilis* (CCZ) on growth response and economic analysis of broiler chickens. Five diets containing degraded and undegraded corn cobs were formulated to replace wheat offal at 0, 50 and 100% levels on weight for weight basis. A total of three hundred and seventy-five, day-old unsexed Marshall broiler chickens were randomly allotted to the five dietary treatments in a completely randomized design (CRD). Data were collected on growth performance and production cost. Data collected was subjected to the analysis of variance (ANOVA).The differences between the treatments means was separated using Duncan's Multiple Range Test. The biodegradation of corn cobs resulted in improved ($P<0.05$) nutrient composition, crude protein increased by 63.90% while the crude fibre decreased by 137.89%. The broiler chickens fed 100% CCZ had the lowest ($P<0.05$) values for feed conversion ratio (FCR) and highest ($P<0.05$) values of rate of return on investment, economic efficiency and relative cost-benefit. The study concluded that wheat offal could be replaced with 100% CCZ in the ration of broiler chickens with positive economic returns.

Keywords: Economic analysis, ground corn cobs, performance characteristics, *Zymomonas mobilis*

INTRODUCTION

The utilization of wheat offal as a major dietary fibre source in most parts of poultry producing areas of Nigeria has escalated its price, thereby necessitating a search for a cheaper and locally available alternative (Lamidi *et al*., 2008). The utilization of corn cob will reduce the competition between man and animals for conventional feedstuffs especially in monogastric animal nutrition (Oke *et al*., 2007). The use of fermentation procedures to improve the nutritive value, utilization of fibrous feeds as well as the generation of high protein had been reported by Cantner (1995).

Corn cobs can be defined as the waste products of maize grain shelling. They littered the surroundings, street, markets and constitute the public nuisance. They can block drainage canals and cause flooding (Ndubuisi *et al*., 2008). Alokan (1998) reported that corn cob is perhaps the most prominent cereal crop by-product in Nigeria. Several million tons of corn cobs that had no immediate use to humans accumulate on-farm processing units contributing to land and air pollution as a sizeable percentage are burnt to provide space for other useful purposes and ashes used as fertilizer in crop farming (Oladeinde, 2000).

Zymomonas mobilis has hetero-fermentative ability to produce gas from glucose, fructose and sucrose. It has a shorter fermentation time (300 – 400%) than yeast, and higher ethanol yield of 92 – 94% efficiency, high level of ethanol tolerance, non-toxic, locally available and its ability to be genetically and mutationally altered (Jeon et al., 2005). The treatment of fibrous feedstuffs with *Zymomonas mobilis* microbes is proposed to break down the polysaccharide and lignin contents into simpler carbohydrates, which the poultry birds can utilize for better productivity. Also, the utilization

of degraded fibrous feedstuffs for farm animals will reduce the cost of production, encourage the production of cheap animal protein for Nigerians, increase foreign reserve and greatly reduce environment hazards/pollution (Anigbogu and Anosike, 2010). Therefore, this study was carried out to determine the impact of life-enzyme (*Zymomonas mobilis* degraded corn cobs) on growth performance and cost-benefit of broiler chickens.

MATERIALS AND METHODS

Research station and test ingredients

The study was carried out at the Poultry Unit of Directorate of University Farms, Federal University of Agriculture, Abeokuta, Nigeria.

The corn cobs used for the study were obtained from the maize shelling unit of Obasanjo Farm Nigeria Ltd., Breeder farms, Igboora, Nigeria. The corn cobs were crushed using a hammer mill and screened using 3.5 cm sieve before storage on pallets.

Pure strains of *Zymomonas mobilis* used in this study was extracted from fresh palm wine. The *Zymomonas mobilis* suspension was used to inoculate the ground corn cobs to obtain starter inoculum for the study. The corn cobs were biologically treated in the traditional setting according to Anigbogu *et al*. (2009) using 50 kg ground corn cobs placed in fermentation vat (Volume = 200 litres) with 100 litres of water added to 5 kg previously fermented dough containing *Zymomonas mobilis* which acted as starter inoculums. The sample was homogeneously mixed and kept to ferment for a period of 20 days at room temperature of between 23.1ºC to 24.6 ºC. After which, the fermented product was sun-dried, analysed and stored as life-enzyme (corn cobs degraded *Zymomonas mobilis* microbes) for the experimental study.

Management of broiler chickens and experimental diets

Three hundred and seventy-five 1-day old unsexed Marshal broiler chicks were obtained from Obasanjo Farms Nigeria limited, Lanlate, Nigeria. They were weighed and randomly allotted to five dietary treatments. A total of 75 birds were used per treatment and were replicated 5 times with 15 birds each. The chicks were brooded for 2 weeks. The birds were vaccinated against Gumboro disease on days 7 and 18 of life while the Newcastle disease vaccine was given to them on day 12. Coccidiostat was administered to the broiler chickens during the experiment.

Feed and water were supplied to the broiler chickens *ad libitum*. The birds were raised for eight weeks (0-4weeks for the starter phase and 4-8 weeks for the finisher phase). The test diets were actually formulated to include *Zymomonas mobilis* degraded corn cobs and undegraded corn cobs at varying levels of 0, 50 and 100% replacing wheat offal weight for weight basis (Table 1).

Data collection

Chemical analysis

The proximate composition of the feed samples and *Zymomonas mobilis* degraded corn cobs was determined according to the standard procedures of AOAC (2015).

Ingredients	Starter Diets					Finisher diets				
	0%	50% CCZ	100% CCZ	50% CC	100% CC	0%	50% CCZ	100% CCZ	50% CC	100% CC
Maize	53.60	53.60	53.60	53.60	53.60	54.60	54.60	54.60	54.60	54.60
Soyabean meal	29.50	29.50	29.50	29.50	29.50	23.50	23.50	23.50	23.50	23.50
Fish meal	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Groundnut	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50

cake										
Wheat offal	5.00	2.50	0.00	2.50	0.00	10.00	5.00	0.00	5.00	0.00
Corn cobs	0.00	2.50	5.00	2.50	5.00	0.00	5.00	10.00	5.00	10.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Broiler premix[ab]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine[c]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Toxin binder	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Metabolizable energy (MJ/Kg)	12.00	12.10	12.20	11.94	11.88	11.92	12.12	12.31	11.81	11.69
Determined analysis:										
Crude protein (%)	22.28	21.34	21.56	22.83	22.57	21. 27	20.79	20.52	21 .78	20.05
Crude Fibre (%)	4.81	5.24	6.16	5.85	5.89	5.34	6.69	7.54	5.91	6.49
Ether Extract (%)	4.17	4.13	4.09	4.18	4.20	4.67	4.35	4.02	4.21	4.74
Ash (%)	3.15	3.26	3.37	3.16	3.20	2.26	3.29	3.50	3.13	3.18

Proximate composition of CCZ	
Crude protein (%)	9.45
Crude fibre (%)	19.00
Ether extract (%)	8.50
Ash (%)	2.00
Gross energy (MJ/Kg)	41.39

Table 1: Ingredients and Chemical composition of Experimental broiler chicken diets (DM-basis)

CC: undegraded corn cobs; **CCZ**: *Zymomonas mobilis* degraded corn cobs

[a]Starter Vitamin-Mineral Premix: (Rotinol) based on 2.5 kg/ton (Thiamine, 2000 mg, riboflavin, 7000 mg, pyridoxine, 5000 mg, cyanocobalamine, 1700 mg, niacin, 30,000 mg, D-panthotenate, 10,000 mg, folic acid, 800 mg, biotin, 2000 mg, Retinyl acetate, 12,000 iu., cholecalciferol, 2,400,000 iu., tocopherol acetate, 35,000 iu., menadione, 4,000 mg, ascorbic acid, 60,000 mg, manganese, nill, iron, 70,200 mg, zinc, nill, copper, nill, cobalt, 200 mg, iodine, 400 mg, selenium, 80 mg, choline chloride, 500,000 mg.

[b]Finisher Vitamin-Mineral Premix: (Rotinol) based on 2.5 kg/ton (Thiamine, 1000 mg, riboflavin, 6000 mg, pyridoxine, 5000 mg, cyanocobalamine, 25 mg, niacin, 60,000 mg., D-panthotenate, 20,000 mg, folic acid, 200 mg, D-biotin, 8 mg, Retinyl acetate, 40 mg, cholecalciferol, 500mg, tocopherol acetate, 40,000 mg., menadione, 800 mg, ascorbic acid, 60,000 mg, manganese, nill, iron, 80,000 mg, zinc, nill, copper, nill, cobalt, 80 mg, iodine, 400 mg, selenium, 40 mg, choline chloride, 80,000 mg

[c]Methionine Hydroxyl Analog (MHA): (Novus International Inc.St. Charles, MO), feed supplement providing 84% Methionine activity

Performance characteristics
The weekly feed intake and the body weight were measured with a weighing scale in the morning before feeding and the average weight gain and feed conversion ratio were calculated. A record of mortality was kept as it occurred throughout the feeding trial.

Economic analysis
The prevailing market prices of the ingredients per kg at the time of the study was used to estimate the economic analysis. It was based on the methods applied by Anigbogu and Anosike (2010).

Experimental design and statistical analysis
The experimental design used for this study was a completely randomized design (CRD). All data collected were subjected to one-way analysis of variance (ANOVA) as outlined by Daniel (1995) with the aid of SAS (2001) and the significant means separated by Duncan's multiple range test at 5% level of significance (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

The chemical composition of the *Zymomonas mobilis* degraded corn cobs is shown in Table 1. The crude fibre of the fermented corn cobs of 19.00% was greater than the value of 6.83% reported by Olagunju *et al*. (2013) but lower than the value of 26.55% reported by Adeyemi *et al*. (2008) for fermented corn cobs. The difference between the reported value in the study and literature, may be due to the length of storage, drying period, the specie of maize from which the cobs was harvested and microorganisms used for fermentation.
The performance characteristics of broiler chickens (0 – 8 weeks) fed corn cobs based diets and economic analysis were shown in Table 2. The broiler chickens fed 100% CCZ had similar ($p>0.05$) value of final body weight and daily weight gain with the control group but lowest values ($p<0.05$) of average feed intake and daily feed intake. The dietary treatments did not influence ($p>0.05$) the feed conversion ratio and protein efficiency ratio. This might be attributed to the potential role of life-enzyme (*Zymomonas mobilis* degraded corn cobs) in making more nutrients available for growth response of the broiler chickens. This agreed with the observation of Alam *et al*. (2003) who reported an increase in growth rates, feed intake and better feed conversion ratio when broiler diet was supplemented with an exogenous enzyme. Although, the crude fibre of the dietary treatments was within the recommended range (NRC, 1994), the performance of the birds fed 100% CCZ may be due to the fact that as the birds grow older, they adapted to the high fibre diets, digested and utilized them better. A similar observation was reported by Sikka (1990). There was highest value of mortality in the control group with similar lowest values in 50% CC and 100% CCZ. The mortality might not, however, be related to the dietary treatments. Thus, further confirmed the nutritional adequacy of *Zymomonas mobilis* degraded corn cobs for broiler chickens.
Moreover, the cost of feed/kg lowest value recorded in 100% CC was similar to the values obtained in the control diet and 100% CCZ. This may be due to the cost of processing corn cobs compared to the cost of wheat offal. The highest cost of feed/kg observed in 50% CC and 50% CCZ may be due to the combination of wheat offal and degraded or undegraded corn cobs in the diets.
The value of gross profit/broiler obtained in 100% CCZ was greater than the value obtained in the control diet. This may be due to the nutritional adequacy of *Zymomonas mobilis* degraded corn cobs which supported the growth performance of broiler chickens. The additional cost of purchasing enzymes and incorporating them into feeds had been removed by the production of life-enzyme based feed.

CONCLUSION

The replacement of wheat offal with 100% *Zymomonas mobilis* degraded corn cobs (CCZ) improved feed conversion ratio, protein efficiency ratio, rate of return on investment, economic efficiency and relative cost benefit. Therefore, 100% CCZ can replace wheat offal on weight for weight basis in broiler chicken diets without deleterious effects on the growth response.

Table 2: Performance characteristics of broiler chickens (0 – 8weeks) fed diets containing *Zymomonas mobilis* degraded and undegraded corn cobs

Parameters	Dietary treatments 1 Control diet	2 50% CCZ	3 100% CCZ	4 50% CC	5 100% CC	SEM
Performance characteristics:						
Initial body weight (g/bird)	43.00	43.00	44.00	43.00	44.00	0.35
Final body weight (g/bird)	2133.00^{a}	1913.00^{d}	2130.00^{a}	1963.00^{b}	1920.00^{c}	26.53
Average weight gain (g/bird)	2090.00^{a}	1870.00^{e}	2086.00^{b}	1920.00^{c}	1876.00^{d}	26.50
Daily weight gain (g/bird)	37.32^{a}	33.39^{c}	37.25^{a}	34.29^{b}	33.50^{c}	0.48
Average feed intake (g/bird)	5509.00^{a}	4983.00^{d}	4823.00^{e}	5211.00^{b}	5207.00^{c}	62.17
Daily feed intake (g/bird)	98.38^{a}	88.98^{c}	86.13^{d}	93.05^{b}	92.98^{b}	1.11
Feed conversion ratio	2.64	2.66	2.31	2.71	2.78	0.09
Protein efficiency ratio	1.94	1.75	2.12	1.84	1.94	0.09
Mortality (%)	5.60^{a}	3.20^{b}	0.80^{d}	0.80^{d}	2.40^{c}	0.48
Cost-benefit analysis:						
Cost of the feed/Kg (₦/Kg)	174.89^{bc}	175.64^{ab}	174.39^{c}	176.39^{a}	173.89^{c}	0.27
Price/Kg live weight (₦)	900.00	900.00	900.00	900.00	900.00	0.00
Cost of production/broiler (₦/broiler)	1413.25^{a}	1315.12^{c}	1312.34^{c}	1369.24^{b}	1365.90^{b}	10.13
Gross revenue/broiler (₦/broiler)	1917.00^{a}	1719.00^{c}	1917.00^{a}	1764.00^{b}	1728.00^{c}	24.08
Gross profit (₦)	503.75^{b}	403.88^{c}	604.66^{a}	394.76^{d}	362.10^{e}	23.82
Rate of return on Investment (%)	35.64^{b}	30.71^{c}	46.07^{a}	28.83^{d}	26.51^{e}	1.86
Economic efficiency	0.71^{b}	0.66^{b}	0.99^{a}	0.59^{b}	0.55^{b}	0.05
Relative cost benefit (%)	0.00^{d}	1.24^{c}	13.92^{a}	0.73^{cd}	5.14^{b}	1.39

Means on the same row having different superscripts are significantly different (P<0.05)
SEM: Standard Error of Mean; n = 5; **CC**: undegraded corn cobs; **CCZ**: *Zymomonas mobilis* degraded corn cobs

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