IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 8, Issue 3 Ver. II (Mar. 2015), PP 41-46
www.iosrjournals.org

Carcass Characteristics and Meat Quality of Broilers Fed Cassava Peel and Leaf Meals as Replacements for Maize and Soyabean Meal

*Abu O. A , †Olaleru,I. F. and *Omojola A. B.
*Department of Animal Science, University of Ibadan, Ibadan, Nigeria
†Faming Systems Research Programme, National Root Crops research Institute, Umudike, Abia State, Nigeria.

Abstract: *A 49-day feeding trial involving 180 1-day-old Abhor acre broilers was carried out to evaluate growth and carcass quality of broilers fed cassava leaf meal and cassava peel meals used as replacements of soya bean meal and maize at 20% respectively. Four groups of 45 birds per group of 15 birds per replicate consisting of three replicates per group. Group A served as control (cassava leaf meal (0%) and peelings meal (0%)), Group B (20% cassava peelings -20% leaf meal), C (20% leaf meal -0% cassava peelings) and group D (20% cassava peelings-0% cassava peelings). The cut parts of the carcass showed superior values (p<0.05) in the A (control) treatment and they differed significantly (p<0.05) from broilers on to the group on B (20 % cassava peelings-20 % leaf meal), C (20% leaf meal-0% cassava peelings), D (20% cassava peelings-0% cassava peelings). On the 49th day, the breast muscles of 36 birds were analysed for dry matter, proteins, fat and ash. The organoleptic values were not significantly influenced by the juiciness, taste, colour and overall acceptability among the dietary treatment levels. Up to 20% inclusion of cassava leaf meal and 20% cassava peelings as replacement for soya bean meal and maize respectively in both broiler starter and finisher, diets did not significantly affect growth and carcass yield of broilers.*

Keywords*: Cassava peels, Cassava leaf, Carcass yield, Meat qualities, Broiler.*

I. Introduction

Description of Problem

Feed accounts for 60-80% of the total cost of production in intensive poultry production (Tewe, 1997). The increasing cost of feed resources in livestock production have been identified as a serious impediment to meeting the demand for animal protein particularly in developing countries (Adejinmi et al., 2000). This challenge resulted in research focus that could reduce the cost of feeding without negatively influencing the performance of the birds. This approach involves compounding of feed in a way that all the required nutrients come from cheap alternative energy and protein sources. The search for such alternatives has been the focus Animal Nutritionists for over a decade (Onyimonyi and Okeke, 2005). Broiler, a meat-type of poultry; that has the ability to grow fast and reach market weight faster than ruminants (Madubuike and Ekenyem, 2001) has stirred up interest in many farmers, because it plays a significant role as animal protein source in human diets by supplying essential amino acids needed for growth, development, and repair of worn out tissues. Maize is the chief source of energy in diets for monogastric animals in Nigeria and may constitute up to 60% of a commercial poultry ration (FAO, 2004). The increasing pressure on the use of maize by the human population and other industrial users may result in an escalating price of maize in Nigeria. The search for alternatives to maize as a feed source led to the introduction of cassava plant (Manihot spp). Cassava peels are a major by-product of cassava processing and constitutes about 10-13 % of whole root weight (Tewe et al., 1976). Cassava leaves are farm residues of root production and comprise the leaves and petioles of cassava plants. Meat quality evaluation is important in improving meat production (Barbera and Tossone, 2006) and carcass quality is the measure of carcass palatability and acceptability to the consumer (Renand and Fisher, 1997). The objective of this study therefore was to determine the effect of feeding cassava peel and leaf meals as replacements for maize and soyabean meal respectively on carcass characteristics and meat quality of broilers

II. Materials And Methods

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, University of Ibadan.

Management of birds

A total of 180 day-old Abhor acre broiler were sourced from a commercial hatchery in Ibadan and allocated into four dietary treatments of fifteen birds per treatment in three replicates. The birds were brooded and fed a common diet for one week. The birds were raised on a conventional open-sided deep litter house. All vaccination schedules and management procedures were followed. Feed and water were provided ad-libitum and the experiment lasted for 49 days.

Experimental diets and design

Fresh cassava peels and leaves (sweet variety) were collected from` a farm in Eruwa in Oyo State. The cassava peel were sun- dried for 4 days before being packed in bags and stored properly after which they were ground to powdery for easy incorporation and preservation. Four experimental diets were formulated for the starter phase. Diet one (T1), the control diet contained no cassava peels and no cassava leaf meal. Dietary treatments T2, T3 and T4 has replacement of cassava peels and leaves. In treatment two (T2), 20% of maize is replaced with cassava peels and 20% of soya bean is replaced with cassava leaves. In treatment three (T3) 20% of soya bean meal is replaced with cassava leave meal. In treatment four (T4) 20% maize replaced cassava peel while the soya bean is kept constant. The finisher diets had same replacements as described for the starter diets. The gross compositions of the starter and finisher diets are in Tables 1 and 2.

Parameters measured

Carcass characteristics

At the end of the finisher phase, three birds in each replicate (close to the mean of the group) were starved for 12 hours but water was available to them before slaughter in post absorptive state. The birds were taken to a slaughter slab, the throats were cut, and the birds were hung upside down to ensure near complete bleeding. The slaughtered birds were properly bled, defeathered and eviscerated, dissected and all internal organs and external offals (head, shank and neck) were carefully removed. The hot carcasses were weighed to obtain the dressed weight and later chilled before primal cuts were made and the weight taken (Omojola et al., 2004). The thighs, breast muscle and back were also be separated and weighed. Fasted weight, Live weight of each bird, defeathered weight, eviscerated weight, thigh, breast, shank, head, neck, wings, drumstick and back weight were recorded.

Water holding capacity

The water holding capacity was determined in triplicates by the press method (Tsai and Ockerman 1981), while percentage bound water or WHC was calculated as 100% minus % free water

Percentage cooking loss

Samples of about 2g were taken from the breast and thigh muscles of each carcass and cooked in a moist-heat to an internal temperature of 72^{o}C. The water released after cooking and cooling was manually separated and the weight of the cooked meat taken to obtain the cooking loss. Cooking loss = [wt of sample before cooking – wt after cooking] / [Wt before cooking] x 100

Sensory evaluation

Ten semi-trained panelist were selected from the Department of Animal Science, Faculty of Agriculture, University of Ibadan, Oyo State, Nigeria for the sensory evaluation of boiled meat samples from the breast muscle. Samples were washed individually in clean water, packed in a transparent double layer polythene bag and tagged for identification. Thereafter boiled in water for 30 minutes and were cooled under room temperature and served to a panel of seven assessors previously trained in basic organoleptic assessment procedure. Each panelist masticated one sample per treatment with ranked preferences in the following categories: colour, taste, texture and flavor. A 9-point hedonic scale was used, 1 referring to extremely dislike, and 9 as extremely like.

Analyses

Proximate analysis: Proximate composition of the experimental diets were carried out using the procedure of AOAC (1995).

Statistical analysis: All analytical determinations were done considering the replicates. Data was subjected to a two-way statistical analysis of variance (ANOVA) using SAS (2001).

III. Results And Discussion

Data on the primal cut is shown in Table 3, physical properties are shown in Table 4 and Table 5 shows the sensory evaluation of the broiler meat. The dressed weight of the broilers expressed as percentage live weights were similar between treatment groups.The cut parts of the carcass followed the same pattern. The birds on the T1 (control) treatment showed superior values (p<0.05) in the weight of the cut parts of the carcass. The values differed significantly (p<0.05) from T2, T3 and T4 groups. The depressed weights of the carcass cut parts may be as a result of low feed intake, Esonu et al. (2002); the inability of the birds to convert the feed into meat Nwoche et al. (2006). Evaluation of carcass and meat quality parameters in table 6 were similar in all the dietary treatment in line with the findings of Nwokoro and Obasi (2006). The dressed weight of the broilers expressed as percentage live weights were similar between treatment groups. This is in line with the findings of Nwoche et al. (2006); in broiler finisher birds. The cut parts of the carcass followed the same pattern. The birds on the T1 (control) treatment showed superior values ($p<0.05$) in the weight of the cut parts of the carcass. The values differed significantly ($p<0.05$) from T2, T3 and T4 groups. The results of the primal cut up parts on breast, thigh, drumstick, shanks, head and neck though significantly different fell within the level reported by Isikwenu et al. (2010). The highest ($p>0.05$) percentage of the back and wings and ($p<0.05$) weight of the drumstick is recorded by the broilers placed on 20%of cassava leaf meal and cassava peelings is a good indication that tissue synthesis for those parts were at the best at the particular dietary level.

Table 1: Gross Composition of Experimental Starter Diet

Ingredients (%)	**T1**	**T2**	**T3**	**T4**
Maize	50	40	50	40
Cassava peel	0	10	0	10
Soya bean meal	35	28	28	35
Cassava leaf meal	0	7	7	0
*others	15.0	15.0	15.0	15.0
Total	**100**	**100**	**100**	**100**
Calculated values				
Crude protein (%)	22.9	21.9	21.7	22.7
ME(kcal/kg)	2974	2791	2931	2835
Crude fibre (%)	3.9	3.3	3.5	3.8
DL-Methionine (%)	0.34	0.52	0.54	0.34
L-lysine (%)	1.0	0.92	0.99	0.96

* Wheat offals (7.23); Di calcium phosphate (1.5); Oyster shell (0.5); Palm oil (2.5); Premix (0.25); Table salt (0.25); DL-Methionine (0.15); L-Lysine (0.06); Avatec (0.06); Fish meal (2.5)

Table 2: Gross Composition of Experimental finisher Diet

Ingredients (%)	**T1**	**T2**	**T3**	**T4**
Maize	50	40	50	40
Cassava peels	0	10	0	10
Soya bean meal	30	24	24	30
Cassava leaf meal	0	6	6	0
*others	20.0	20.0	20.0	20.0
Total	**100**	**100**	**100**	**100**
Calculated values				
Crude protein (%)	20.87	19.24	19.61	20.50
ME (kcal/kg)	3023.7	2846.9	2986.5	2884.1
Crude fibre (%)	4.83	4.35	4.51	4.87
DL-Methionine (%)	0.27	0.27	0.26	0.26
L-lysine (%)	0.83	0.82	0.78	0.76

*Wheat offals (11.24); Di calcium phosphate (1.5); Oyster shell (1.0); Palm oil (2.5); Premix (0.25); Table salt (0.25); DL-Methionine (0.10); L-Lysine (0.06); Avatec (0.06); Fish meal (1.5)

Table 3: Primal cuts of chicken fed cassava peel and cassava leaf meal based diets.

	Treatments				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Live Weight (kg)	2.51^{a}	2.01^{c}	2.23^{b}	2.29^{b}	0.07
Slaughtered weight (kg)	2.25^{a}	1.85^{c}	1.93^{bc}	2.06^{b}	0.06
Fasted weight (kg)	2.39^{a}	1.92^{c}	2.07^{bc}	2.11^{b}	0.06
Defeathered weight (kg)	2.14^{a}	1.74^{c}	1.81^{bc}	1.96^{b}	0.06
Hot Carcass (kg)	1.58^{a}	1.38^{b}	1.39^{b}	1.48^{ab}	0.05
Dressing percentage	76.22	66.92	67.17	70.40	2.00
*Breast	20.49^{a}	20.42^{b}	18.55^{b}	20.42^{ab}	1.97
*Back	12.94	13.69	12.98	12.50	1.69
*Thigh	12.67^{a}	11.06^{b}	10.76^{b}	12.11^{ab}	1.12
*Drumstick	10.59^{ab}	10.96^{a}	9.76^{b}	9.65^{b}	0.83
*Wings	8.43	9.23	8.66	8.75	1.04
*Shanks	3.73^{ab}	4.04^{a}	3.72^{ab}	3.67^{ab}	0.39
*Head	2.35^{a}	2.18^{b}	2.26^{ab}	2.24^{ab}	0.34
*Neck	4.28^{ab}	4.61^{a}	4.39^{ab}	4.69^{ab}	0.52

a, b, c: Mean within rows having different superscripts are significantly different ($p<0.05$)
*expressed as % Live Weight

Table 4: Physical properties of breast muscles of broiler chicken fed rations with cassava peels and leaves

	Treatment				
Parameters	**1**	**2**	**3**	**4**	**SEM**
Cooking loss (%)	33.2	33.5	33.0	32.6	1.79
Chilling Loss (%)	5.2	4.8	3.1	2.5	0.99
Thermal shortening (%)	29.6	26.0	35.1	27.1	3.79
WHC (%)	58.4	58.5	58.1	57.3	1.39
Carcass colour	1.2^{d}	1.4^{c}	2.4^{a}	1.9^{b}	0.04
Skin colour	1.5^{b}	2.2^{a}	2.3^{a}	1.4^{b}	018

a, b, c: Mean within rows having different superscripts are significantly different (p<0.05)

Table 5: Sensory Evaluation of broilers meat

	Treatment				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Colour	6.2	5.8	4.8	5.9	0.61
Flavour	3.1^{b}	5.1^{a}	4.3^{a}	5.1^{a}	0.26
Texture	5.3^{b}	5.2^{b}	6.0^{a}	6.3^{a}	0.16
Juiciness	4.3	3.8	5.3	5.8	0.53
Taste	5.0	5.0	6.2	5.1	0.49
Overall Acceptability	5.1	5.3	5.8	5.9	0.54

a, b, c: Mean within rows having different superscripts are significantly different (p<0.05)

Experimental diet did not interfere with the organoleptic qualities of the broiler birds. This also confirmed that muscle composition, ageing before cooking, heat coagulation of muscle, fibre proteins and partial hydrolysis of the connective tissue, which in turn is dependent on the internal temperature, and duration of heating (Joseph et al., 1998) were the same across the groups. However, the significant difference in the flavor and texture of the broiler meat among the dietary treatment could not be attributed to any reason. However, since the water holding capacity (WHC) measures the fraction of bound water retained in the muscle, T4 samples with the lowest percentages of cooking losses had the highest WHC, and thus its meat is considered of a better quality, since the lower the water holding capacity the better the meat quality (Navid et al., 2010). In the same vein, the low cooking loss of the breast meat of broiler birds fed with cassava peeling meal/leaf meal indicated that the meat is of high quality due to low loss of protein into the water during cooking. Proteins are lost into the water due to proteolysis. Proteolysis is low in tougher meats with lower fat content. This agreed with Oko et al., 2012, that had earlier reported that meat with low cook loss has higher quality and protein content. Chilling loss, water holding capacity, cooking loss and thermal shortening of broiler meat were not statistically different (p>0.05). The carcass of birds across all dietary treatments recorded higher ultimate pH, which declined gradually with time. The cooking loss is a combination of liquid and soluble matter lost from meat during cooking. At increasing centre temperatures, the water content of the meat decreased, and the fat and protein content to increase indicating that the main part of cooking loss is water (Heymann et al., 1990). Thus, water loss is of economic concern because it affects weight loss along distribution chain during cooking (Okubanjo et al., 2003). The least cooking loss was observed for birds fed diets dietary T4, this therefore shows that the anti-oxidation effect of the cassava peelings resulted into the reduction in the cooking loss. This will however affect the optimal eating quality and is of great importance to the catering industry. The cooking loss depends on the raw meat quality as reported by Asalyng et al, (2003), meat with high cooking loss will have lower water holding capacity (WHC) as shown in this result. The WHC fell within the ranges of 42.22% to 66.97% values reported by Omojola and Adeshinwa, 2006 for scalded, singed and conventionally dressed rabbit carcasses.

The low cooking loss of the breast meat of broiler birds fed with cassava peeling meal-leaf meal indicated that the meat is of high quality due to low loss of protein into the water during cooking.

Proteins are lost into the water due to proteolysis. Proteolysis is low in tougher meats with lower fat content. This agreed with Oko et al., 2012, that had earlier reported that meat with low cook loss has higher quality and protein content. Chilling loss, water holding capacity, cooking loss and thermal shortening of broiler meat were not statistically different (p>0.05). The least cooking loss was observed for birds fed diets dietary T4, this therefore shows that the anti-oxidation effect of the cassava peelings resulted into the reduction in the cooking loss. This will however affect the optimal eating quality and is of great importance to the catering industry. The cooking loss depends on the raw meat quality as reported by Asalyng et al, (2003), meat with high cooking loss will have lower water holding capacity (WHC) as shown in this result. The WHC fell within the ranges of 42.22% to 66.97% values reported by Omojola and Adeshinwa, 2006 for scalded, singed and conventionally dressed rabbit carcasses. The birds across the dietary treatments had higher cooking loss values. It was also observed that the higher the WHC the lower the cooking loss and vice versa. The higher cooking loss in the broiler could therefore be due to the low ability of meat from the broiler to hold on the water on application of external force. The different dietary treatments do not exert any undesirable effect on organoleptic characteristics, colour, odour and juiciness of meat. Colour mainly influenced by the myoglobin content and nature, the composition and physical state of muscle (Giddings, 1977 and Renerre, 1986) and the meat structure. For the carcass colour, significant differences were recorded across the dietary treatment ($p<0.05$). T3 had the highest value of 2.43 followed by T4 with a value of 1.90 followed by T2 with 1.37 with T1 with the least value of 1.23 this was in line with Wyllie and Chamanga (1979) that reported that with Additions of leaf meal caused large changes in broiler skin colour so that birds fed diets containing 15% leaf meal were very yellow. While birds of this colour were perfectly acceptable in Tanzania, this could be less so elsewhere. The results of the primal cut up parts on breast, thigh, drumstick, shanks, head and neck. Though significantly different fell within the level reported by Isikwenu et al. (2010). The highest ($p>0.05$) percentage of the back and wings and ($p<0.05$) weight of the drumstick is recorded by the broilers placed on 20% of cassava leaf meal and cassava peelings is a good indication that tissue synthesis for those parts were at the best at the particular dietary level. The organoleptic values were not significantly influenced by the juiciness, taste, colour and overall acceptability among the dietary treatment levels. This indicates that the difference in the experimental diet did not interfere with the organoleptic qualities of the broiler birds. However, the significant difference in the flavor and texture of the broiler meat among the dietary treatments could not be explained.

IV. Conclusion And Application

From the result of this study, it appear that up to 20% of cassava leaf and 20% cassava peeling meals can be incorporated in a single diet of broilers both in the starter phase and the finisher phase without a marked detrimental effect on the growth as well on the carcass quality and attributes. Further research is necessary to determine how to increase the nutritive value of cassava peeling and leaf meal for monogastric animals in view of its cheapness and abundance.

References

[1]. Adejinmi, O. O., Adejinmi J. O., and Adeleye I. O. A. (2000). Replacement value of fish meal

[2]. with soldier fly larvae meal in broiler diets. Nigerian Poultry Science Journal. 1:52– 60.

[3]. AOAC (1995). Official Methods of Analysis, 15th Edition, Washington, DC

[4]. Aslyng, D. N., Berjerholm, C., Ertbjerg, P, Bertram C. H and Andersen H. J. (2003). Cookinglossand juiciness of pork in relation to raw meat quality and cooking procedure and food quality preference Meat Science14: 277-288

[5]. Barbera, S. and Tassone S. (2006). Meatcooking shrinkage. Measurement ofa new meatqualityparameter. Meat Science. 39: 234-238.

[6]. Esonu, B.O., F.C. Iheukwumere, O.O. Emenalom, M.C. Uchegbu and E. B. Etuk, 2002. Performance, nutrient utilization and organ characteristics ofbroilers. Hitt: //www, cipavorg. Co/Ird//Irrd14/6/eson/146 htn.

[7]. FAO. (2004). Online Statistical Database. Food and Agriculture Organization of the United in

[8]. Giddings, G. G., (1977). Symposiums; The basis of quality in muscle foods; the basis of colour muscle foods. J. food Sci., 4: 288-297.

[9]. Gomez, G., M. Vadic Viso, J. Santos and C. Hoyos, (1985). Evaluation of cassava root meal prepared from low and high cyanide containing cultivars in pig and broiler diets. Nutr. Report Int., 28: 693-704.

[10]. Heymann, H. J., Hedrick, H. B., Karrasch, M.A., Eggeman, M. K and Ellersieck, M. R. (1990). Sensory and chemical characteristics of fresh pork roasts cooked to different centre temperature. Journal of food science 55: 613-617.

[11]. Isikwenu, J. O, O. J. Akpodiete, S. I. Omeje and G. O. Okagbare, (2010). The effect of replacing groundnut cake and urea treated and ferment brewer's dried grains on nutrientdigestibility, retention and carcass characteristic of broilers finishers. Nig. J. Animal Prod. 37:1-12

[12]. Joseph, J. K, B. Awosanya, A. A. Adegbola, F.O, Alarapon and K.T. Akinremi,(1998). The effect of internal end point temperatures on meat quality attributes of selected, Nigeria wild Life, meat sources, Nig. J. Anim.Prod.25:180-186

[13]. Madubuike, F. N. and Ekenyem, B. U. (2001). Non-ruminant livestock production in the Tropics. Gust Graphics Centre, Owerri, Nigeria. Pp 120-145.

[14]. Nations, Rome, Italy. www.fao.org.

[15]. Navid, S., Hilmi, M., Sazili, A. Q. And Sheikhlar, A. (2010). Effect of papaya leaf meal and vitamin D_3 supplementation on meat quality of spent layer hen. Jour. Of Anim. And Veterinary Advances, 9 (22): 2873-2876.

[16]. Nwoche, G. N., E. C. Ndubuisi and F. C. Iheukwumere (2006). Performance of finisherbroilers andcost implication of feeding palm oil as energy supplement. Niger Agri. J., 37: 44-49.

[17]. Nwokolo, E.(1987). Leaf meal of cassava (Manihot esculenta Crantz) and Siam weed Chromolaenaodoratum) as a nutritional source in Poultry. Nutr. Reports Int., 36: 819-826.

[18]. Nwokoro, S. O and J. O. I. Obasi, (2006). Effects of partial replacement of soya bean meal withbreadfruit seed meal in broiler finisher diets on the performance, water consumption,

[19]. Nitrogen retention and carcass characteristic Int. J. Poult Sci., 5:404-407

[20]. Oko, A. O., Nwoba, S. T., Idenyi, J. N., Ogah, O., Ugwu, O. O and Ehihia, L. U. (2012). Effects of Substituting Some Components of Broilers' Feed with Aqueous Extract of FreshLeaves of Mucuna poggei. Journal of Biology and Life Science, 3, 243-253.

[21]. Okubanjo, O. A., Omojola, A. B., Ogunsola, O. O., Adewumi, M. K., Ajiboro, G., Alabi, G. F. and Babayemi, O. J.(2003). Meat characteristics of Bunaji, Gudali and Keteku breeds of cattle. Tropical Anim. Prod. Invest. 6: 185

[22]. Omojola, A. B. and Adesehinwa, A.O.K (2006). Meat characteristics of scalded, signed and conventionally dressed rabbit carcasses. At international Digital Organisation Scientific information, online Vol.1 No 1:CCC-CCC

[23]. Omojola, A. B., A. O. K. Adesehinwa, H. Madu and S. Attah, (2004). Effect of Sex and Slaughter Weight on Broiler Chicken Carcass. J. Food Agri. Environ., 2: 61-63.

[24]. Onyimonyi, A. E. and Okeke G. C. (2005). Carcass, Organ and Pathological characteristics of grower pigs fed cassava peel meal. J. Agric. Food Environ. Ext., 1: 1-4.
[25]. Renard, G and Fisher, A. V. (1997). Comparison of methods for estimation carcass fat content of young Charolis bull in performance testing station. Livestock Production Science: 51: 205-213
[26]. Renerre, M. (1986). Influence de facteursbiologiques et technologiques sor 19 couleur de laviande borine.Bulletin Technique C. R. Z. V. TheixINRA, 65: 41-45 in: M. Abril, M.M.Campo, A. Onenc, C. Sanudo, P. SAS (2001).
[27]. SAS (2001). SAS/STAT Guide for Personal Computers, Version and Edition, Cary, North Carolina SAS Institute.
[28]. Tewe, O. O., T. A. Job, J. K. Loosli and V. O. Oyenuga (1976). Composition of two local cassava varieties and the effect of processing on their hydrocyanic content and nutrient utilization by rat. Nigerian Journal of Animal Production 3 (2): 60-66.
[29]. Tewe, O. O. (1997). Sustainability and Development Paradigm from Nigeria's Livestock Ind. Inaugural Lecture delivered on behalf of faculty of Agriculture and Forestry, U. I. Pg 50.
[30]. Tsai, T. C. and H. W. Ockerman1 (1981). Water binding measurement of meat. J. Food Sci., 46: 697-707.
[31]. Wyllie D. and P. J. Chamanga (1979), cassava leaf meals in broiler diets. Trop Anim Prod 1979 4:3