International Journal of Food, Agriculture and Veterinary Sciences ISSN: 2277-209X (Online)
An Online International Journal Available at http://www.cibtech.org/jfav.htm
2012 Vol. 2(1) January-April, pp.153-161/Odukwe and Aniebo
Research Article

APPRAISAL OF PALM OIL AND METHIONINE AS DETOXIFYING AGENTS OF RESIDUAL CYANIDE IN CASSAVA-BASED BROILER STARTER DIETS

Odukwe C.A. and *Aniebo A.O.
Department of Animal Science, Anambra State University Igbariam PMB 6059 Awka, Nigeria
**Author for Correspondence*

ABSTRACT
A study was carried out to appraise the performance of Anak broiler birds placed on composite cassava root meal (CCRM) – based broiler starter diets supplemented with palm oil, methionine or palm oil plus methionine. Eight iso-caloric and iso-nitrogenous experimental diets each containing 18% CCRM were formulated, where diet 1 (control) contained no palm oil and methionine. Diets 2, 3, 4 contained 2.0%, 3.0%, 4.0% palm oil and no methionine respectively. Diet 5 contained 1.0% palm oil and 0.1% methionine while diets 6, 7 and 8 contained 0.2%, 0.3% and 0.4% methionine with no palm oil respectively. Each diet contained approximately 3,050 M.E. Kcal/kg and 21% crude protein. One hundred and ninety-two, one week old ANAK broilers averaging 0.11kg were randomly allotted to the 8 dietary treatments of 24 chicks each, replicated thrice in a completely randomized design experiment for duration of four weeks. Final body weight, average daily gain, average daily feed intake, feed conversion ratio and protein efficiency ratio were significantly affected by the treatments ($P<0.01$). The diet containing 1% palm oil plus 0.1% methionine was as effective as any of the methionine treatments and superior to all of the palm oil treatments in all parameters. The indication is that palm oil compliments DL-methionine as cyanide detoxification agent in CCRM-based broiler diets but is apparently ineffective as sole detoxification agent at 4% or lower inclusion level. This methionine sparring effect of palm oil has practical implications in least-cost diet formulations involving CCRM. The study thus, compared the efficacy of palm oil and methionine as detoxification agents of residual cyanide in CCRM-based broiler starter rations

Key Words: *Methionine, Palm Oil, Detoxification, Cassava, Cyanide, Broiler, Diet*

INTRODUCTION
Dietary energy is the most expensive nutrient in Nigerian manufactured poultry feeds because of the inclusion proportion (40-70%) of the main energy ingredient, maize (Oruwari *et al.,* 2003; Aderemi *et al.,* 2006). Moreover, pressure from population growth, industrialization, drought, inorganic fertilizer cost and intensive poultry production has made this conventional feed ingredient insufficient and therefore expensive (Chauynarong *et al.,* 2009). This has called for research to identify cheap and locally available alternative energy feed stuff in Nigeria such as cassava meal. Cassava root products are attractive substitutes for maize and sorghum. Very popular, abundantly produced and reduced feed cost when substituted for maize (Anyanwu *et al.,* 2008). It contains 2.66% crude protein, 77.13% NFE and 2680 $Kcal^{-1}$ M E. Aduku (1993). Muller *et al.,* (1975) reported that cassava meal has digestible energy level of 4000Kcal/kg, but low in protein, vitamins and minerals. While Gomez *et al.,* (2005) gave content of cassava starch as 17% amylase and 83% amylopectin as against 28% amylase and 70% amylopectin in maize. The use of cassava roots and leaves in poultry feeding is affected by external and internal factors. Buitrago *et al.,* (2002) observed that the age of animal, type of processing of the final product and the complimentary ingredients that will be included in diet are the most important external factors that affect the use of cassava roots and leaves as animal feed. Internal factors are related principally to the quality, availability and product price. Chauynarong (2009) identified low protein content as the major limitation in using cassava root as poultry feed. Udedibia *et al.,* (2004) reported that fresh cassava tubers contain 0.44mg HCN/g, whereas unfermented and fermented meals contain 0.15 and 0.08 mg HCN/g

respectively. Studies have shown that residual cyanide in cassava meal has adverse effects on growth and feed utilization in chicken (Tiemoko, 1992). Tewe (1981), Ravindra and Rajaguru, (1981) reported that residual cyanide in cassava-based rations interfered with energy utilization via egg-shell gland and thyroid systems; phosphorylation and cytochrome oxidase systems. Panigrahi *et al.*, (1992) stated that presence of HCN below 40mg/kg feed is safe for broilers. However Panigrahi *et al.*, (1996) recommended lower level. Obikonu and Udedibie (2006) reported poor FCR by sundried cassava peel meal. Onjoro *et al.*, (1998) observed lower weight gain on total replacement of maize with cassava, while Osei (1992) reported that feed intake tended to increase with increasing levels of cassava meal. Oyebimpe *et al.*, (2006) replaced maize with 200g/kg cassava peel meal without reduction in growth performance. Method of processing and use of detoxification agents have been found to improve cassava-based rations. Chauynarong *et al.*, (2009) reported superior chicken performance when the cassava root meal was prepared using artificial drying system against sun-drying probably due to high temperature and better sanitation control. On the other hand, palm oil, methionine or a combination of the two has been used as a detoxification agent in cassava based chicken rations (Obiola *et al.*, 1983 and Gomez *et al.*, 1987). These detoxification agents are now very expensive and their use at arbitrary levels may not be justified unless their efficacy and the cost-effectiveness of their use are determined.

This study was aimed at comparing the efficacy of palm oil and methionine as detoxification agents of residual cyanide in composite cassava root meal (CCRM)-based broiler starter rations. Great care must be taken to ensure a balance of the limiting amino acids, essential fatty acids basic minerals, micro elements (such as zinc and iron) and vitamins.

MATERIALS AND METHODS

One hundred and ninety-two, one day old ANAK 2000 broiler chicks were mass brooded and maintained, on a commercial broiler starter ration for seven days. At one week old, they were randomly divided into eight treatment groups of 24 birds each. The 24 birds in each treatment were subdivided into three replicates of eight birds each. The birds were housed in concrete floor pens 3 x 1.8m^2 in an open-sided tropical-type deep litter house. Absorbent wood shavings were used as litter.

Eight experimental diets were formulated based on CCRM prepared from whole unpeeled freshly – harvested cassava root after washing, splitting and slicing into chips, soaking in water for 12 hours, sun-drying for 21 days and milling (Figure 1). The meal was found to contain approximately 88% DM, 4968 Kcal GE/kg, 3.86% CP and 108 ppm HCN using the methods of AOAC (23).

The eight experimental diets were isocaloric and isonitrogenous (Table 1) each contained 3050 Kcal/kg ME and 21% CP. Diet 1 which served as control diet contained no palm oil and methionine, diets 2, 3, 4 contained 2.0, 3.0, and 4.0 palm oil. Diet 5 contained 1.0% palm oil and 0.1% methionine and diets 6. 7 and 8 contained 0.2, 0.3 and 0.4% methionine respectively. Each diet contained 30% CCRM and other ingredients namely: maize, soybean meal, fish meal, bone meal, vitamin/mineral premix and salt. Proximate analyses of the diets are shown in Table 1. The experimental diets and water were provided *ad libitum*

The birds were weighted just before introducing them to the experimental diets. Body weights and feed consumption were recorded on weekly basis and were used to compute average final weight, average daily weights gain, average daily feed intake, feed conversion ratio and protein efficiency ratio (Table 2). The experiment lasted for 28 days.

At the termination of the experiment one bird per replicate, making a total of 24 birds were selected, weighed and housed individually in metabolism wire cages, fitted with separate feeders and drinkers and trays for collecting droppings. The trays were covered with polythene sheets sprayed with 1.0% boric acid. The birds were allowed two days to adjust to cage environment before feeding with known weights of the diets, and water for seven days. Droppings were collected, sun-dried and later used to determine the dry matter digestibility coefficient and nitrogen retention (Table 3)

Table 1: Composition of CCRM-based broiler starter diets

	Diet							
Ingredient %	1	2	3	4	5	6	7	8
Maize	42	36	30	30	43.2	44.2	44.2	44.2
CCRM	18	18	18	18	18	18	18.0	18.0
Brewers Dry Grains	2.7	6.7	11.7	10.7	0	0	0	0
Palm oil	0	2.0	3.0	4.0	1.0	0	0	0
DL-methionine	0	0	0	0	0.1	0.2	0.3	0.4
Soybean meal	26.7	26.7	26.7	26.7	27.1	27.0	26.9	26.8
Fish meal	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Bone meal	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vit/Trace Minerals[1]	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Calculated								
ME (Kcal/kg)	3030	3095	3050	3081	3078	3040	3037	3034
Crude Protein (%)	21.38	21.62	21.77	21.56	21.08	21.14	21.10	21.08
Mehtionine+ Cystine (%)	0.72	0.74	0.75	0.75	0.81	0.91	1.01	1.11
Analyzed:								
GE (Kcal/kg)	3924	3962	4020	4037	3932	3882	3874	3880
Crude Protein (%)	22.4	22.2	22.3	22.3	22.1	22.1	23.0	22.1
Ether Extract (%)	6.50	6.58	6.59	6.60	6.65	6.64	6.57	6.64

Roche Zoodry: Vit. A 5000,000 iu, vit. D3 1000, 000 IU, vit. E 16.00g, Vit.K 1.00g, vit.B 0.30g, Riboflavin 2.4mg, Pyridoxine 0.35mg, Niacine 3.5mg, Biotin 0.005mg, Choline chloride 30.00mg, Folic acid 0.10mg, Vit.B12 0.002mg, Vit.C 2.5mg, Mn 10.00mg, Cu 0.20mg, Fe 5.00mg, Methionine 20.00mg, Zn bacitracin 2.00mg, Avatec (Lasolocid) 9.00mg

The experiment was conducted using the Completely Randomized design. The data obtained were subjected to Analysis of variance (ANOVA) and separation of means where applicable, were done according to the procedure of SAS (2007)

Research Article

RESULTS
The results of the performance parameters namely; final live weight, daily weight gain, feed intake, feed conversion ratio, protein efficiency ratio and feed cost per kg weight gain of birds fed on the 8 treatment diets are summarized in Table 2.

Table 2: Effect of palm oil and methionine on the performance of CCRM-based broiler starter diets

	Diet (D)								
	1	2	3	4	5	6	7	8	SEM
Palm oil (%)	0.0	2.0	3.0	4.0	1.0	0.0	0.0	0.0	
Methionine (%)	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	
Parameters									
Initial live weight (kg)	0.10	0.12	0.11	0.11	0.11	0.10	0.10	0.10	
Final live weight (kg)	0.91^{def}	0.94^{bcd}	0.93^{cde}	0.90^{ef}	0.97^{a}	0.95^{abc}	0.96^{ab}	0.88^{f}	1.12**
Daily gain. (g)	28.84^{b}	29.37^{ab}	29.43^{ab}	28.26^{b}	30.66^{a}	30.49^{a}	30.58^{a}	28.12^{b}	0.34*
Daily feed intake (g)	59.67^{bc}	58.86^{c}	59.66^{bc}	59.94^{abc}	61.52^{a}	60.96^{ab}	61.22^{ab}	56.73^{d}	0.51**
FCR	2.06^{b}	2.00^{b}	2.03^{b}	2.12^{a}	2.01^{b}	2.00^{b}	2.00^{b}	2.03^{b}	0.04**
PERo	2.16^{b}	2.25^{a}	2.21^{a}	2.11^{b}	2.16^{b}	2.26^{a}	2.17^{b}	2.24^{a}	0,02**
Feed cost/ kg wt. gain (₦)	140.84^{c}	150.08^{bc}	155.96^{b}	182.00^{a}	147.00^{bc}	147.28^{bc}	152.04^{bc}	157.36^{b}	0.15*

*a, b, c, d, e, f = Means within each row and without a common superscript are significantly different *= (P<0.05) **= (P<0.01)*
SEM = Standard error of means

Final Live Weight (FLW)
There were significant differences in the final live weights of five-weeks old broilers fed CCRM-based starter ration supplemented with methionine, palm oil or both (P<0.01). Generally average live-weights of broilers fed methionine supplemented diets were significantly superior (P<0.01) to those on palm oil supplemented diets. Highest final live-weight of 0.97kg was obtained from birds on diet 5 with 1.0%palm oil and 0.1% methionine. However, there were no significant differences (P>0.01) between those fed the control diet (D1) and those of diets 4 and 8. While D1, D3 and D4 produced comparable FLW at five weeks. The best result of 0.97g (D5) was however not significantly different from those fed D6 and D7,which produced comparable weights of 0.95g and 0.96g respectively.
Daily Weight Gain (DWG)
Results of average daily gain followed similar trend as in FLW save that D5 with the highest daily gain of 30.66g was not significantly different (P<0.05) from those on D2, D3, D6 and D7 with gains of 29.37g, 29.43g, 30.49g and 30.58g respectively. Lowest DWG was produced by D4 with the highest levels of palm oil (4%) and methionine (0.4%) supplementation and D1 with 0% supplementation.
Average Daily Feed Intake
Diet 5 (1% palm oil +0.1% methionine) that produced the highest weight gain was the most consumed (61.52g), followed by D7 (0.3% meth.) and D6 (0.2% meth.) in decreasing order of 61.22g and 60.96g

respectively. The least consumed diets were D8 (0.4% methionine) and D2 (2% palm oil), in increasing order of 56.73g and 58.86g respectively.

Feed Conversion Ratio

Diet 4 was the least converted with a ratio of 2.12 which was significantly different (P<0.01) from the rest diets. Although there were slight differences among the conversion ratios of the rest diets, they were not significant. (P>0.01)

Protein Efficiency Ratio

Protein efficiency of broilers fed CCRM-based starter diets supplemented with palm oil, methionine or palm oil plus methionine showed significant differences (P<0.01). The highest PER of 2.26 was obtained from D6 which contained 0.2% methionine. This value was however comparable with 2.25 (D2), 2.24 (D8) and 2.21 (D3). No significant differences existed in the PER of diets 1, 4, 5 and 7.

Table 3: Dry matter (DM) digestibility and daily nitrogen retention of the diets

	Diet								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**SEM**
Palm oil (%)	0.0	2.0	3.0	4.0	1.0	0.0	0.0	0.0	
Methionine (%)	0.0	0.0	0.0	0.0	0.1	0.2	0.3	0.4	
				Parameters					
DM intake (g)	70.0^{abc}	68.0^{abc}	73.0^{a}	63.33^{bcd}	66.0^{cd}	70.0^{abc}	72.0^{ab}	61.67^{d}	1.22^{**}
DM output (g)	19.97^{bcd}	18.1^{cd}	20.93^{bc}	23.2^{ab}	16.63^{d}	18.87^{cd}	21.33^{bc}	25.87^{a}	0.97^{*}
DM Dig. Coef. (%)	71.47^{ab}	73.38^{ab}	71.33^{ab}	65.02^{c}	74.8^{a}	73.04^{ab}	70.38^{b}	58.05^{d}	1.84^{**}
Nitrogen intake(g)	2.51^{abc}	2.42^{bc}	2.60^{ab}	2.37^{cd}	2.44^{bc}	2.48^{abc}	2.65^{a}	2.18^{d}	0.05^{*}
Total N output (g)	0.81^{bcd}	0.69^{cd}	0.83^{bcd}	0.94^{ab}	0.65^{d}	0.78^{bcd}	0.85^{abc}	1.02^{a}	0.04^{*}
N retention (g)	1.70^{a}	1.73^{a}	1.78^{a}	1.43^{b}	1.79^{a}	1.70^{a}	1.80^{a}	1.16^{c}	0.07^{**}
N retention (%)	67.93^{a}	71.75^{a}	68.41^{a}	60.29^{b}	73.12^{a}	68.50^{a}	67.93^{a}	53.26^{c}	2.15^{**}

*a, b, c, d = Means within each row and without a common superscript are significantly different * = (P<0.05), ** = (P<0.01)*
SEM = Standard error of means

Feed Cost per kg Weight Gain

Diet 1, the reference diet gave the least cost of ₦140.84 /kg weight gain. This was however not significantly different (P>0.01) from diets 2, 5, 6 and 7 which cost ₦150.08, ₦147.00, ₦147.28 and ₦152.04 Expectedly, the diets that contained highest levels of palm oil or methionine cost highest for each factor at ₦182.00 and ₦157.36 per kg gain respectively. Both values were significantly different (P<0.01) from each other and the highest palm oil diet was significantly different (P<0.01) when compared with the rest diets.

Dry Matter Digestibility (DMD) and Daily Nitrogen Retention (NR)

Results of dry matter digestibility (DMD) and Nitrogen Retention (NR) are presented in Table 3.

Dry Matter Intake (DMI):

Dry matter digestibility was significantly affected by treatments. The highest daily DM intake of 73 0g was obtained from diet3 with 3.0% palm oil. This value was however comparable with the reference diet1, D2, D6,and D7 with 70.0g, 68.0g, 70.0g, and 72.0g respectively.D8 with 0.4% methionine produced the lowest DMI of 61.67g/bird/day which was significantly different from other diets save D4 andD5.

Dry Matter Output (DMO):

Result showed that D4and D8, which contained the highest levels of palm oil and methionine respectively, gave the highest values of 23.20g and 25.87g per bird. There were significant differences ($P<0.01$) between them and the rest diets. D5 with 1.0% palm oil and 0.1% methionine gave the least DMO of 16.63g which was comparable to diets 1, 2, and 6 that recorded 19.97g, 18.10g and 18.87g/bird/day DMO respectively.

Dry Matter Digestibility Coefficient (DMDC):

Diet 5 gave the highest DMDC of 74.80% while D8 gave the lowest value of 58.05%. This value was significantly inferior ($P<0.01$) to the DMDC of other diets. This is an indication that highest levels of palm oil and methionine depressed digestibility of CCRM-based starter diets.

Nitrogen Intake (NI), Nitrogen Output (NO) and Nitrogen Retention (NR):

Nitrogen intake ($P<0.05$), nitrogen output and nitrogen retention were all significantly affected by treatments ($P<0.01$). D7 gave the highest NI of 2.65g, comparable with ($P>0.05$) with 2.51g, 2.60g and 2.48g obtained from diets 1, 3 and 6 respectively. D8 and D4 recorded the least NI of 2.18g and 2.37g respectively. The least NO of 0.65g/bird was recorded by D5 which was comparable ($P>0.05$) to diets 1, 2, 3 and 6 with 0.81g, 0.69g, 0.83g and 0.76g respectively. D8 with the highest NO of 1.02g was significantly different ($P<0.01$) from D5, but comparable with D4 (0.94g) and D7 (0.85g). NR was highest in bids fed with D7 which was however not significantly different ($P>0.01$) from the values obtained from other diets except D4and D8. Difference ($P<0.01$) existed between NR of D8 (1.16g) and those of other diets. However, D4 and D8 with the highest levels of palm oil and methionine recorded the least NR.

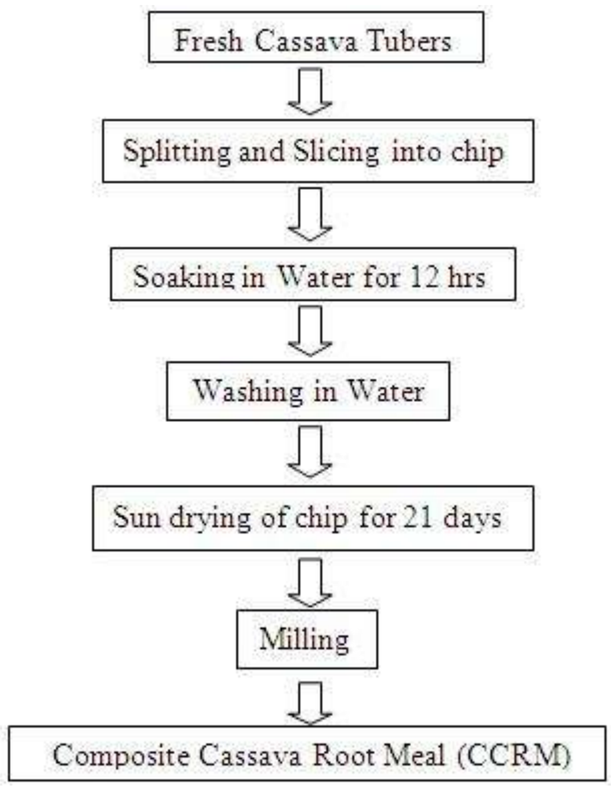
DISCUSSION

Results of this experiment showed that live performance of broilers on cassava- based diets are improved when palm oil or methionine or a combination of both is supplemented at appropriate levels. Methionine-supplemented CCRM-based broiler starter diets supported average live weights at five weeks and were superior to palm oil-supplemented diets ($P<0.01$). Gomez *et al.,* (1987) reported that supplementary vegetable oil or animal tallow did not affect growth rate of broilers fed sundried cassava meal-based diets. The superiority of CCRM-based diets over maize diet at i%, 2% and 3% palm oil supplementation as well as 0.1%, 0.2% and 0.3% methionine supplementation has confirmed the findings of Butrago *et al.,* (2002) that weight gain and FCR of cassava flour /soybean based diets were similar or superior to maize/soybean based diets. However no significant differences were seen between the average daily weight gain of birds on 2.0 and 3.0% palm oil and 0.2 and 0.3% methionine. There was no significant disadvantage ($P>0.05$) of supplementing palm oil at 4.0% or methionine at 0.4% levels over un-supplemented diet in average daily weight gain. However palm oil at levels of 2.0 and 3.0% produced better but not significant gains in weight than un-supplemented and highest levels of palm oil and methionine.

Palm oil as a detoxification agent, supplemented in starter diets did not have any significant effect on the average final weight, average daily weight gain, feed conversion ratio and protein efficiency ratio of birds that received the diets ($p<0.01$) as they compared favorably with the reference diet. However performances of those birds fed diets supplemented with different levels of methionine alone or a combination of 0.1% palm oil and 0.1% methionine were significantly superior to those that received different levels of palm oil alone in their diets ($p<0.01$). These results agree with those of (Obioha *et al.,* 1984; Odukwe and Obioha, 2000) who reported that the performances of broilers and layers were enhanced by supplementing methionine alone or methionine plus palm oil in cassava-based diets. Obioha *et al.,* (1984) however showed that there was no advantage in supplementing methionine plus palm oil over methionine alone contrary to Hew and Hutagalung (1972) and Maner (1974) who reported that there were added advantages in combining palm oil and methionine as detoxification agent of residual cyanide in cassava-based diets for poultry and pigs. In this experiment both assertions were found to be true.

Feed intake was stimulated by the supplementation of palm oil and methionine at 1.0 and 0.1%. This could be responsible for the average daily weight gain of 30.66g. 0.4% methionine depressed average daily feed intake and this could be as a result of amino acid imbalance. Super -fortification of amino acids in poultry diets is known to induce amino acid imbalance that may result in lowered egg production and depression in growth (Wilburn and Fuller, 1975 and Crawshaw, 1994). Supplementation of palm oil or methionine or a combination of the two did not affect feed conversion ratio except at palm oil supplementation level of 4.0% which increased the amount of feed required to gain one unit of body weight ($P<0.01$).

Figure 1: Flow chart of CCRM Preparation



Feed cost per kg body weight gain was highest in diet 4 at N6.50 and was significantly different ($P<0.01$) from other diets. The diets supplemented with 0.2 and 0.3% methionine cost less though not significantly, to produce 1kg of body weight than those supplemented with 2.0 and 3.0% palm oil respectively. This trend may have been caused by the fact that birds on methionine diets at the two levels recorded higher daily weight gains. The feed cost per kg body weight gain was affected by the market prices of the detoxifying agents.

Protein efficiency ratio values of palm oil and methionine supplemented diets showed that palm oil at 2.0 and 3.0% and methionine at 0.2 and 0.4% were superior to the PER of other diets ($P<0.05$). This shows that the efficiency with which protein is utilized can be improved by the supplementation of palm oil and methionine. The combination of palm oil and methionine and the un-supplemented diet, diets 5 and 7, palm oil or methionine supplemented CCRM based diets supported protein efficiency ratios that were superior to the reference diet. This is in agreement with an earlier work, where it was concluded that even up to 40% cassava meal had no adverse effect on broiler performance when the diet was supplemented with methionine, lysine and palm oil (Phua and Hutagalung, 1978).

Dry matter digestibility which was depressed in diets 4 and 8 with 65.04 and 58 .06% respectively showed that high level of palm oil or methionine does not support optimum digestibility as palm oil and methionine exceeded 3.0 and 0.3% respectively ($P<0.01$). Dry matter digestibility coefficient and nitrogen retention of birds that received methionine alone and palm oil plus methionine were significantly higher than those that were fed with difference levels of palm oil in CCRM- based broiler finisher diets ($p<0.05$). However the un-supplemented diet and 3.0% palm oil diets gave nitrogen retention values (g) that were statistically comparable to palm oil plus methionine and different levels of methionine treatment. The advantage of methionine supplementation over oil supplementation in nitrogen retention was probably because of added role of methionine in improving the quality and utilization of dietary protein (Adegbola, 1977 and Piva *et al.,* 1987).

Nitrogen retention was depressed at the highest levels of palm oil and methionine in CCRM based broiler starter diets. The birds fed diet 7 followed by diet 5 gave the highest nitrogen retention but compared statistically with the un-supplemented diet and with 2.0 and 3.0% palm oil and 0.2 and 0.3% methionine. This agrees with Chou *et al.*, (1976), Omole, (1977) and Obioha *et al.*, (1983) who confirmed that supplementation of palm oil and methionine in cassava based diets improved the performance of chickens. However, on the whole, inclusion of methionine supported better overall performance than palm oil inclusion. This was probably because of better amino acid balance at appropriate levels of supplementation, and the fact that methionine will not only donate sulphur for detoxification but also contribute its methyl group for protein synthesis (Adegbola, 1977).

It is concluded from this study that DL-methionine is a more effective detoxifying agent than palm oil in CCRM diets for broilers and palm oil levels up to 4% of the diet do not appear to be effective. However the superior performance of birds on the 0.1% methionine + 1.0% palm oil treatment suggests a complimentary and methionine-sparing role of palm oil. Considering also that this methionine + palm oil treatment was statistically similar in performance to the 0.2% and higher levels of methionine, it seems logical to uphold the 0.2% methionine.

REFERENCES

AO AC (1990). Association of Official Analytical Chemists. *Official Methods of Analysis* **15 (**Washington DC).

Adegbola AA (1977). Methionine as an additive to cassava based diets. In: *Cassava as Animal Feed* edited by Nestel B and Graham M (Proc. Workshop University of Guelph Ottawa Canada IDRC) 9-17.

Ademosun AA and NO Eshiett (1980). Feeding Cassava Root Meal to Starter Grower and Layening Chickens *Tropological Agriculture* **57**(3) 277-284**.**

Aderemi FA, Alabi OM and Lawal TE (2006). Utilization of whole cassava meal by egg laying type chicken. *Proceeding of the 11th Annual Conference Animal Science Association Nigeria 18-21 IAR and T Ibadan Nigeria* 73-75.

Aduku AO (1993). *Tropical Feedstuff Analysis Table.* Department of Animal Science Ahmadu Bello University (Samaru Zaria, Nigeria) 4.

Anyanwu GA, Etuk EB, Okoli IC and Udedibie ABI (2008). Performance and egg quality characteristics of layers fed different combinations of cassava root meal and Bambara groundnut offals. *Asian Journal of Poultry Science* **2**(1) 36-41.

Buitrago JA, Ospino B, Gils JL and Aparicio H (2002). Cassava root and leaf meals as the mainingredcient in poultry feeding: Some experience in Colombia. *Technical Report 2000-2001*. Latin American and Caribbean Consortium to support cassava Research ans Development.

Chauynarong N, Elangovan AV and Iji PA (2009). The potential of cassava products in diets for poultry. *World's Poultry Science Journal* **65** 23-36.

Chou KC, Muller Z and Nah KC (1976). High levels of tapioca meal in poultry rations. *Indian Journal of Animal Science* **44**(9) 97-702.

Crawshaw R (1994). Blood meal: A review of nutritional qualities for pig's poultry and ruminant animals. *National Renderers Association* London UK 1-6.

Gomez G, Tellez G and Caicedo J (1987). Effects of the addition of vegetable oil or animal fallow to broiler diets containing cassava meals. *Poultry Science* **66** (4) 725-731.

Gomez E, Souza SR, Grandi RP and Silva RD (2005). Production of thermostable glucoamylase by newly isolated Aspergillus Flavus A1.1 and thermomyces Lanuginose. *Brazilian Journal of Microbiology* **36** 75-82.

Hew V F and Hutagalung RI (1972). The utilization of cassava root meal for swine. *Male Agriculture Research* **1** 124- 130.

Maner J H (1974). Management and feeding of pigs in the tropics. *Proceedings of the International Symposium Animal Production University of Ibadan.* Nigeria: Heinemann Books (Nigeria) 107- 111.

Research Article

Muller Z, Chou KC and Nah KC (1975). Cassava as a total substitute for cereals in livestock and poultry rations. UNDP/SF Project 37-44.

Obikonu HO and Udedibie ABI (2006). Comparative evaluation of sun-dried and ensiled cassava peel meals as substitute for maize in broiler starter diets. *International Journal of Agriculture and Rural Development* **7** 52-55.

Obioha FC, Okeke GC, Onua EC and Oboegbunam SI (1983). The effect of varying Protein and energy levels on the utilization of processed cassava peels. *By mice Nutrition Reports International* **28**(3) 531-545.

Obioha FC, Azubuike GO, Ene LSO, Okereke HE and Okoli OO (1984). The effect of partial replacement of maize with cassava peel on layer performance. *Nutrition Reports International* **30** 1423-1429.

Odukwe CA and Obioha FC (2000). Comparison of palm oil and methionine as detoxicants of residual cyanide in cassava-based broiler finisher diets. *Natural and Applied Science Journal* **3** 115-128.

Omole TA (1977). Cassava in the nutrition of layers In: Nestel B & Graham M (Eds) Cassava as Animal Feed 51-55.

Onjoro PA, Bhattacharjee M and Ottaro JM (1998). Bioconversion of cassava tuber by fermentation into broiler feed of enriched nutritional quality. *Journal of Root Crops* **24** 105-110.

Oruwari BM, Aniebo AO and Nkanta DM (2003). Effects of replacing maize with cassava brewers dried yeast blend (cassayeast) on performance of broiler chicks and feed cost in southern Nigeria. *Nigerian Journal of Animal Production* **30**(2) 169.

Osei SA (1992). Sun-dried cassava peels meal as a feed ingredient in broiler diets. *Tropical Agriculture* **69** 273-275.

Oyebimpe K, Fanimo AO, Oduguwa OO and Biobaku WO (2006). Response of broiler chickens to cassava peel and maize offal in cashew nut meal-based diets. Archivos *de Zootecnia* **55** 301-304.

Panigrahi S, Rickard J, Obrien GM and Gay C (1992). Effects of different rates of drying cassava root on its toxicity to broiler chicks. *British Poultry Science* **33** 1025-1042.

Panigrahi SA (1996). Review of the potential for using cassava root meal in poultry diets. Tropical tuber crops: problems, prospects and future strategies 416-428.

Phuah CH and Hutagalung RI (1978). Zinc and iodine supplementation for chicken. Effect of zinc and iodine supplementation in cassava-based diets on performance and body composition of broiler chicken. *Malaysian Agricultural Journal* **51**(3) 311-317.

Piva G, Petri A and Speroni M (1987). Alternatives for poultry diets. 2nd Regional seminar of the Near East Poultry and Development Center Amman Jordan. *Feed International* 26-28.

Ravindran VG and Rajaguru ASB (1981). Nutrient content of some unconventional poultry feeds**.** *Indian Journal of Animal Sci*ence **55**(1) 58-61.

SAS (2007). Statistical Analysis Systems *Institute SAS/STAT User's guide* statistics version 9-13. SAS Institute Inc Cary North Carolina USA.

Tewe OO (1981). Use of cassava peel as feed supplement for poultry. *The 5th Annual Conference World's Poultry Science Association Nigerian Branch Akure*.

Tiemoko YO (1992). The use of cassava in broiler diets in Coted'ivoire. Effect on growth performance and feed costs. *Proceedings of the llTA/ILCA/U.l. Workshop on the potential utilization of cassava as livestock feed in Africa* 121-126.

Udedibie ABI, Anyaegbu BC, Onyechekwa GC and Egbuokporo OR (2004). Effect of feeding level of fermented and unfermented cassava tuber meals on performance of broilers. *Nigerian Journal of Animal Production* **31** 211-219.

Wilburn DR and Fuller HB (1975). The effect of methionine and lysine levels on the arginine requirement of the chick. *Poultry Science* **54**(1) 248-256.