# Chemical composition and nutritional value of boiled Christmas bush fruit (*Alchornea cordifolia*) meal fed to starter broiler chickens

Ahiwe*, E. U., Emenalom, O. O., Etuk, E. B., Okehie, N. U., Iwuji, C. T. and Odoemelam, V.U.
Department of Animal Science and Technology, Federal University of Technology, P.M.B 1526,
Owerri, Nigeria.
*Corresponding author: email: mannyahisco@yahoo.co.uk

**Abstract**

*A study was conducted to determine the chemical composition and the nutritive value of boiled Christmas bush (Alchornea cordifolia) for starter broiler chickens. Dried Christmas bush fruits (Capsules + seed) were boiled for 30 minutes, sundried and ground into meal. The meal was analyzed for proximate composition and anti-nutritional factors and incorporated into broiler starter diet at 0%, 15%, 20% and 25% respectively. A total of 120 day old Marshall Strain broiler chicks were divided into 12 pens each containing 10 birds. Three pens were randomly assigned to each experimental diet. The boiled dried and ground Christmas bush (Alchornea cordifolia) fruit contained 19.9% crude protein and 4.7 mg/100 phytic acids which is an improvement when compared with raw Christmas bush fruits. Increase in inclusion level of boiled Christmas bush fruit in the diet caused a progressive reduction ($p < 0.05$) in final weight gain and feed intake of the birds. Birds on 15 and 20% BCBF had similar ($p > 0.05$) feed conversion ration ratio with birds on control diet. The cost of feed per Kg weight gain and mortality were not significantly ($p > 0.05$) different for all the treatments. Apart from Haemoglobin and serum phosphate, all other serum biochemical indices checked were not statistically ($p > 0.05$) different among the treatment groups. It was concluded that boiling of Christmas bush fruits decreased the anti-nutritional factors and improved the nutritive value of the fruit but could not improve the performance of broiler starter chickens.*

**Keywords:** Broiler starter, christmas bush, chemical composition, anti-nutritional factor.

## Introduction

It is a well-known fact that cereal grains and legumes constitute the major energy and protein sources in non-ruminant animal diets. However heavy demand for these items by industries, humans and animals has given rise to increase in their prices and consequently in the costs of livestock feeds. There is need therefore for the exploitation of other alternative non-competitive feed resources in other to replace cereal grains and legumes in livestock and poultry rations. Many tropical plants produce fruits/seeds that are little known or used in livestock and poultry nutrition. The identification, processing and use of such fruits/seeds in poultry diets will go a long way in reducing the dependence on conventional energy and protein feedstuffs. Christmas bush (*Alchornea cordifolia*) is a Tropical browse plant that yields heavily in fruits/seeds (Iwu, 1993). The leaves and other parts of the plant are used in local medicine, serves as fodder in zero-grazing systems Okoli *et al.*, (2002) and also used as leaf meal in poultry diets (Udedibie and Carlini, 1998). The proximate and anti-nutritional compositions of raw Christmas bush seeds were reported by (Emenalom et al., 2009 and Emenalom *et al.*, 2010). Among the possible anti-nutritional/toxic factors reported to be present in Christmas

bush (*Alchornea cordifolia*) fruits are phytic acid, tannin saponnin, steroid, flavonoid, alkaloid, anthraquinone and cardiac glycoside (Emenalom *et al.*, 2009). However, the use of unprocessed raw Christmas bush (*Alchornea cordifolia*) fruits in diets for broilers is often accompanied by poor growth and reduced feed intake (Emenalom *et al.*, 2009). Cooking is usually done before the use of legumes in diets. This improves the protein quality by the destruction or inactivation of the heat-labile anti-nutritional factors (Udedibie and Opara, 1998).

This study was there conducted to determine the chemical composition and the nutritive value of boiled Christmas bush (*Alchornea cordifolia*) for starter broiler chickens.

## Material and methods

*Site of experiment*

This study was carried out in the School of Agricultural and Agricultural Technology Teaching and Research Farm, Federal University of Technology, Owerri, Imo State, Southeast Nigeria. Imo State lies between latitude 5° 29' 0" North and longitude 7°2' 0" East. Owerri, the capital of Imo State, is located in the South – eastern agro-ecological zone of Nigeria. It is about 91m above sea level with annual rainfall, temperature and humidity ranging from 1,500mm to 2,200mm, 20.0 – 27.5°C and 75–90%, respectively (Google earth, 2015; Wikipedia, 2015; Accuweather, 2015).

*Source of Seeds and Processing*

Dried Christmas bush (*Alchornea cordifolia*) fruits were harvested from the wild around the Federal University of Technology, Owerri, Imo State Nigeria around September when the temperature was 32°C. The seeds were put into a big metallic pot containing boiling water and then allowed to boil for 30 minutes, sun dried and ground into meal. The meal was sieved using a 2mm sieve mesh and then bagged as boiled Christmas bush fruit meal. Samples of the fruit meal were then analysed for proximate composition, phytic acid, L-Dopa and tannin contents respectively.

*Experimental Diet*

Four experimental diets were formulated. . Diet 1 which served as control did not contain Boiled Christmas bush seed (BCBF) while in Diets 2, 3 and 4, (BCBF) replaced part of the maize in the control at 15, 20, and 25% levels respectively. Broiler starter rations were formulated for use during 0-28 days (Table1). Feed and water were offered *ad libitum*. Animal performance was measured in terms of live weight gain, feed intake, and feed conversion ratio. The experiment lasted for 28 days.

*Experimental Birds and Design*

One hundred and twenty day old marshal broilers were used for the experiment. The birds were divided into 4 groups of 30 birds each and further subdivided into 3 groups of 10 birds each. Each treatment group was randomly assigned to a treatment diet in a completely randomized design (CRD). The birds were housed in 12 pens of 1.5 x 1.2 m ($1.8m^2$) dimension with wood shavings as litter material. Each pen had a source of light and heat, a feeder and drinker and was covered with black polythene for the first two weeks to control heat and wind.

*Data collection*

The birds were weighed at the beginning of the experiment and weekly thereafter. Feed intake was determined daily by subtracting the left over from the quantity of feed offered the previous day. Feed conversion ratio was calculated from the value of feed consumed and weight gained. Cost per kg gain was computed. Number of mortality

**Table1: Gross composition of the experimental diet (%)**

| Ingredients (%) | 0 | 15 | 20 | 25 |
|---|---|---|---|---|
| Maize | 50.00 | 42.50 | 40.00 | 37.50 |
| Christmas bush seed meal | 0.00 | 7.50 | 10.00 | 12.50 |
| Soya bean meal | 28.00 | 28.00 | 28.00 | 28.00 |
| Brewer dry grain | 5.00 | 5.00 | 5.00 | 5.00 |
| Fish meal | 4.00 | 4.00 | 4.00 | 4.00 |
| Wheat offal | 6.00 | 6.00 | 6.00 | 6.00 |
| Palm kernel cake | 3.00 | 3.00 | 3.00 | 3.00 |
| Bone meal | 2.00 | 2.00 | 2.00 | 2.00 |
| Oyster shell | 1.00 | 1.00 | 1.00 | 1.00 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Vit/Tm premix[1] | 0.25 | 0.25 | 0.25 | 0.25 |
| L-Lysine | 0.25 | 0.25 | 0.25 | 0.25 |
| L-Methionine | 0.25 | 0.25 | 0.25 | 0.25 |
| **Total** | 100 | 100 | 100 | 100.00 |
| **Calculated Analysis** | | | | |
| Phosphorus (%) | 0.89 | 0.88 | 0.87 | 0.83 |
| Calcium (%) | 1.31 | 1.32 | 1.32 | 1.33 |
| Ether extract (%) | 3.27 | 3.59 | 4.12 | 4.32 |
| Crude fiber (%) | 4.74 | 4.88 | 4.99 | 5.20 |
| Crude protein (%) | 22.07 | 22.18 | 22.24 | 22.33 |
| Energy (kcal/kg/ME) | 2833.69 | 2887.09 | 2799.04 | 2764.09 |
| Lysine (g/100g) | 1.36 | 1.35 | 1.33 | 1.33 |
| Methionine(g/100g) | 0.65 | 0.63 | 0.68 | 0.58 |

[1]Guranted chemical analysis per kg fee of feed: Vit. $D_3$ 400g, Vit E 8g, Vit. K 30.4g, Vit. $B_6$.32g, Vit. $B_2$ 0.56g, Vit. $B_6$ 4g, Calpathonerate 1.6g, Folic acid 0.16g, Biotic 8mg, Chlorine 18g, zinc 7.2g, Copper 0.32g, BHT 32g, Iodine 0.25g, Cobalt 36mg, Selenium 16mg, Oxytetracycline 100mg and Vit.C 25g.

was also recorded. At 28 days of age, blood sample were drawn from bronchial wing vein of 30% of the treatment into a heparinized tube, centrifuged to obtain plasma and plasma protein for later analysis. Samples were taken to biochemistry Department, Federal Medical Centre, Owerri, for blood analysis. The heamoglobin content of the blood sample were determined according to the method of cable (1995). Other blood parameters such as urea, creatine, uric acid, total protein, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), calcium and blood phosphate, were separately determined using guideline on standard procedure for clinical chemistry (WHO,2006).

**Statistical analysis**

Data on weight gain, feed intake, feed conversion ratio, cost per Kg gain and mortality collected were analyzed using the General Linear Model (GLM) procedure of (SAS, 1999) and the student Newman Keul's Test ($p<0.05$).

## Results

Table 2, shows the results of the proximate and anti-nutritional compositions of raw and boiled Christmas bush fruit meal.

The result of the proximate and anti-nutritional compositions shows that BCBF contains 89.60% dry matter, 19.90% crude protein, 13.0% crude fibre, 16.5% ether extract, 1% ash, 64.50% ether extract, 4.7mg/100g phytic acids, 9.7mg/100g tannins while L-Dopa was 8.80% mg/100g. The values for boiled BCBF is an

**Table 2: Proximate and anti-nutritional compositions of raw and boiled Christmas bush fruit meals**

| Components | Compositions | Compositions |
|---|---|---|
| | Raw CBFM | Boiled CBFM |
| Dry matter (%) | 89.20 | 89.60 |
| Crude protein (%) | 13.70 | 19.90 |
| Crude fibre (%) | 16.00 | 13.00 |
| Ether extract (%) | 4.90 | 16.50 |
| Ash (%) | 4.90 | 1.00 |
| Nitrogen free extract (%) | 60.70 | 64.5 |
| Phytic acid (mg/100g) | 9.70 | 4.70 |
| Tannins (mg/100g) | 99.07 | 97.05 |
| L-Dopa (mg/100g) | 14.75 | 8.80 |

improvement on the raw seed which contains 89.20% dry matter, 13.70% crude protein, 16.00% crude fibre, 4.90 ether extract, 4.90% ash, 60.70% nitrogen free extract, 9.07mg/100g phytic acids tannins and 14.75% mg/100g L-Dopa . Adding 15, 20 and 25% levels of the processed fruit meal to broiler rations caused a progressive reduction ($p < 0.05$) in weight gain with birds on the control, 15%, 20% and 25% recording a mean value of 774.7, 566.7 , 560.0, 500.0 respectively (Table 3).

Feed intake also declined progressively ($p<0.05$) among the treatment group. With the control and 15%, 20%, 25% BCBF having a mean value of 1563, 1314, 1372, and 1370 respectively.

In terms of the feed conversion ratio for birds consuming boiled Christmas bush fruit (BCBF) meal compared to birds on the control group, there were no significant ($p> 0.05$) differences between birds on 15% and 20% compared to birds on control diet. Birds on 25% BCBF meal recorded the poorest feed conversion ratio while birds on 15% BCBF meal recorded the least and best feed conversion ratio.

The cost of feed per Kg weight gain was not significantly different for all the treatments. Birds on 25% BCBF had the lowest cost of feed per kg weight gain compared to other treatment groups.

Values for mortality were not significantly different among treatments. With all the treatments recording similar mortality rate.

Compared with control group, urea, creatine, calcium, and uric acid, total protein alkaline phosphatase and alanine aminotransferase levels did not show statistical ($p> 0.05$) differences. Haemoglobin and serum phosphate concentration were significantly ($P<0.05$) influenced by dietary treatments. Birds on the control diet had the highest haemoglobin concentration of 11.60 g/dl compared to birds on 15, 20, 25 % with a mean value of 9.67, 9.40 and 8.53 g/dl respectively. Similarly, there was a progressive increase in the phosphate concentration as the inclusion level of boiled Christmas bush fruit meal in the diet increased.

**Discussions**

There was an improvement in the crude protein and reduction in anti-nutritional value when the dried fruits were boiled compared to the raw fruit/seed in the present study. This result is in agreement

**Table 3: Effect of Boiled Christmas Bush (Alchornea *cordifolia*) fruit on weight gain, feed intake, feed conversion and mortality of broilers.**

| Parameters | Starter (0 – 4 weeks) 0% Control | 15% BCBF | 20% BCBF | 25% BCBF | SEM |
|---|---|---|---|---|---|
| Initial weight (g) | 41.67 | 40.00 | 40.00 | 43.33 | 1.18 |
| Final weight (g) | 774.70[a] | 566.70[b] | 560.00[b] | 500.00[c] | 27.61 |
| Average daily weight gain (g) | 25.04[a] | 18.88[b] | 18.58[b] | 16.35[b] | 0.97 |
| Average daily Feed intake (g) | 55.82[a] | 49.93[b] | 49.00[b] | 48.92[b] | 0.98 |
| FCR | 2.23[b] | 2.65[b] | 2.64[b] | 2.99[a] | 0.01 |
| Feed cost/kg gain(₦/Kg) | 230.00 | 227.00 | 223.00 | 219.00 | 14.49 |
| Mortality (%) | 3.00 | 3.00 | 3.00 | 3.00 | 0.28 |

[abc] within rows with different superscript are significantly different (P<0.05).

with the reports of Emenalom *et al.*,(2009) who also reported an in improvement of crude protein and a reduction in anti-nutritional factors in fermented Christmas bush (*Alchornea cordifolia*) seed meal. The outcome of this result indicates that boiling has a positive effect on the nutritive value as well as reduced the anti-nutritional factors present in the fruits. The progressive reduction in weight gain in broiler chickens fed diets containing boiled Christmas bush fruit meal tends to agree with earlier reports by (Emenalom *et al.*, 2009, 2011) who reported a reduction in growth and weight gain of broiler birds fed raw and fermented Christmas bush fruit/seed meal. The marked reduction in weight gain for starter broiler birds fed diets containing Alchornea cordifolia fruit/seed meal compared to birds on the control group, indicates that the

**Table 4: Serum biochemical indices of broilers starter chickens fed graded levels of graded levels of boiled Christmas bush fruit meal.**

| | 0% BCBF Control | 15% BCBF | 20% BCBF | 25% BCBF | SEM |
|---|---|---|---|---|---|
| Haemoglobin(g/dl) | 11.60[a] | 9.67[b] | 9.40[b] | 8.53[c] | 1.73 |
| Urea(umol/l) | 17.41 | 14.21 | 16.82 | 10.20 | 2.46 |
| Creatine(umol/l) | 0.51 | 0.31 | 0.67 | 0.32 | 0.08 |
| Calcium (mg/dl) | 9.77 | 11.09 | 11.99 | 10.09 | 1.60 |
| Phosphate (mg/dl) | 3.96[b] | 4.07[ab] | 4.10[ab] | 4.49[a] | 0.13 |
| Uric acid (mg/dl) | 6.04 | 5.63 | 6.02 | 5.27 | 0.32 |
| Protein (g/dl) | 5.22 | 5.25 | 5.09 | 4.82 | 0.13 |
| ALT (iu/L) | 3.67 | 2.33 | 6.33 | 4.67 | 1.59 |
| AST(u/l) | 25.33 | 24.33 | 29.00 | 24.00 | 2.17 |
| ALP(u/l) | 2210.70 | 1938.80 | 1855.30 | 1542.00 | 345.2 |

[abc] within rows with different superscript differ significantly (P<0.05).

digestive system of the starter broiler birds was not able to effectively handle and utilize the diet containing boiled Christmas bush fruit meal (BCBF) meal to effectively furnish the much needed nutrient to achieve optimum growth as did birds on the control group. The reduced weight gain among starter broilers consuming BCBF meal could also be blamed on the higher fibre content and anti-nutritional factors present in the Christmas bush fruit that were not significantly reduced by the boiling process. Anti-nutritional factors present in raw seeds and hulls have been reported to cause marked reduction in growth of broiler birds (Emenalom *et al.*, 2010).

The depressive effect observed in the feed intake among broiler starter birds as dietary inclusion levels of BCBF increased have also been reported in broiler chicks fed raw and fermented Christmas bush fruit/seeds (Emenalom *et al.*, 2009, 2011). The most striking effect of the increased inclusion of boiled Christmas bush fruit was the decreased palatability caused by the presence of anti-nutritive factor that led to the observed low feed intake compared to the control group. The response of older broiler birds fed boiled CBF meal in terms of feed intake is worth investigating to determine the effect of age of the birds as well as the effect of fibre on the utilization of boiled Christmas bush fruit meal by broiler finisher birds compared broiler starter birds.

The better feed conversion ratio for birds on 15% BCBF meal may be due to the significant reduction of some anti-nutrients present in the seed. However with higher dietary inclusion of the test material, there tends to be a drop in the feed conversion ratio probably due to reduced palatability of the diet leading to reduced feed intake and a consequent reduction in weight gain which was observed as the inclusion levels of CBF increased. This result tends to agree with the report of (Uchegbu *et al.*, 2015). The author reported a poor feed conversion ratio with an increase in dietary inclusion of raw and cooked *napoleona imperialis* seed meal fed to broiler starter birds.

From the present study, it was observed that there was no significant difference in the cost of feed per kg gain. This result is in agreement with the report of Oladipo *et al.*,2015 who reported no significant difference in terms of cost of feed per Kg gain among broiler starter and finisher birds fed Kaura variety of sorghum (*sorghum bicolor*) based diet supplemented with enzyme.

The mortality recorded for birds on BCBF meal was not significantly different from birds on the control diet, this is an indication that the mortality recorded cannot be attributed to feeding of boiled Christmas bush fruit meal as birds consuming 15% BCBF did not record any mortality. This result tends to be an improvement on the report by (Emenalom et al., 2010) who reported that raw and fermented CBFM increased the mortality rate of birds fed with the meal. Anti-nutritional factors have been reported to lead to high rate of mortality in broiler birds. The author also reported that adequate processing can reduce the anti-nutrients in seeds; thereby reducing its deleterious effect on birds consuming diets formulated using such seed meal when used to formulate broiler starter diet.

The values for urea, creatine, calcium, and uric acid, total protein, alkaline phosphatase and alanine aminotransferase were within the normal range recommended in Merck Veterinary Manual (2005) for healthy broiler chicken. Birds on the control diet had higher haemoglobin concentration compared to other treatments. The progressive decrease in

haemoglobin value could indicate some nutritional in-adequacies as the level of Christmas bush fruit meal in the diet increased. This result is in agreement with reports by Emenalom *et al.,* (2011), who reported similar decrease in haemoglobin value for broiler chickens fed fermented Christmas bush seed. However in this present study, the haemoglobin values obtained for broiler starter chickens on the control and other treatments were within the range reported in Merck Veterinary Manual (2005) for healthy bird. The haemoglobin values in this present study were higher than (7.67g/dl) reported by Kwari *et al.*(2011) when broiler chickens were fed raw sorrel seed meal. This is a clear indication that the birds were all in healthy condition throughout the experimental period. Haemoglobin is an important determinant of anemia and may probably lead to reduction in performance (Medugu *et al.,* 2010). Ewuola *et al.*(2004), reported that blood parameters are reflection of the effects of dietary treatments on animals in terms of the type, quality and amount of the feed ingested and available for the animal to meet it's physiological, biochemical and metabolic necessities. There was a progressive increase in the phosphate concentration as the inclusion level of boiled Christmas bush fruit meal in the diet increased. The higher blood phosphate witnessed with increased inclusion level of boiled Christmas bush fruit meal in this study is in agreement with earlier reports by Emenalom *et al.,* 2011 who reported an increased in the serum blood phosphate content for broiler chickens fed a diet containing fermented Christmas bush seed at 56 days of age. Blood phosphate helps in blood clotting, it is necessary for the activity of several enzyme systems, essential for energy metabolism and also needed for the growth of starter chickens (Olomu, 2011). The serum phosphate concentration in this present study is also within the range reported in Merck Veterinary Manual (2005) for healthy birds.

**Conclusions**

Boiling of Alchornea cordifolia seed tends to improve the protein content and reduce the anti-nutritional content of the fruit. However the inclusion of boiled Christmas bush fruit meal in broiler diet could not improve starter broiler performance but had a better cost of feed per kg gain than the control group. Furthermore, boiled Christmas fruit did not have any detrimental health effect on broiler starter chickens as indicated by the mortality rate and serum biochemical indices tested.

**References**

**Accuweather, 2015.** Accuweather.com for Owerri, Nigeria. www.accuweather.com/en/ng/owerri/253317/weather-forecast/253317. November 15, 2015.

**Cable R. G. 1995.** Haemoglobia Determination in Blood Donors. *Transfusion Med. Rev.* 9:131-44.

**Emenalom, O.O, Udedibie, A.B.I, Okehie N.U. and Onwuka B.I. 2009.** Preliminary Evaluation of Raw *Alchornea* Seeds as Feed Ingredients for Broilers. Livestock *R. Rural Dev.* 21(8): 12-19.

**Emenalom, O.O., E.B. Etuk, B.O Esonu and L.C Nwaiwu.2010.** Phytochemical and nutritional evaluation of raw and fermented *Alchornea cordifolia* seed meals on the performance of broiler chicks. *Nig. J. Anim. Prod.* 38(1)79-85.

**Emenalom, O.O., A.B. Obiora, U.N Okehie. 2011.** Anti-nutrient factors, performance and serum biochemistry

of broiler chicks fed raw and fermented *Alchornea cordifolia* seeds. *Online J. Anim. Feed Res.* 2(1): 17-22.

**Ewuola, E.O., Falayan., O.A., Gbore, F.A., Adebunmi, A.J., Akanji, R.A., Ogunlade, J.T. and Adenaye, J.A. 2004.** Physiological response response of growing West African goats fed groundnut shell-based diets as the concentrate supplements. *Bowen J. Agric.* 1 (1): 61-69.

**Google Earth, 2015.** Owerri google earth 3D map, 2015. www. Maplandia.com/Nigeria/imo/Owerri -google-earth.html

**Iwu, M. M. 1993.** Handbook of Africa Medicinal Plants. *CRC press Inc.* Florida (1993) Pp 1.

**Kwari, I.D., Igwebuike, J.U., Mohammed, I.D. and Diarra, S.S. 2011.** Growth, Haematology and serum chemistry of broiler chickens fed raw or processed Sorrel (*Hibiscus Sabdariffa*) seed meal in a semi-arid environment. *Int. J. Sci. and Nature.* 2(1): 22-27.

**Maxwell, M.H., Robertson, W.J., Spanser, S and Maclorquodale, C.C. 1990.** Comparison of haematological parameter in restricted and ad libitum fed domestic fowls *Br. Poult. Sci.* 1990; 31: 407-413.

**Medugu, C.I., Kwari, I.D., Gwebuike, J., Nkama, I. Mohammed, I.D., Hamaker, B. 2010.** Carcass and blood components of broiler chickens fed sorghum or millet as replacement for maize in the semi- arid zone of Nigeria. *Agric & Bio. J. North America* 1 (3):326-330.

**Merck Veterinary Manual. 2005.** Merck 2005. The Merck veterinary manual. Duluth (GA): Merial.

**Okoli, I. C., Ebere, C. S., Uchegbu, M. C., Udah, C. A. and Ibeawuchi, I. I. 2002.** A Survey of the Diversity of Plant Utilized for small Ruminant Feeding in South-Eastern Nigeria. *Agric. Ecosystem and Environment* 96:147-154.

**SAS, Inc. 1999.** Statistical Analysis System/Stat: Guide for Personal Computer Version of Statistical Analysis System Institute Inc. Cary NC., USA. (1999).

**Uchegbu, M.C., Onwuka, K.C., Okoli, I.C., Obikaonu, H.O., and Ahiwe, E.U. 2015.** Performance of starter broilers fed raw and cooked *Napoleona imperialis* seed diet. *Int. J. Agric and Rural Dev.* 18(1):2097 – 2102.

**Udedibie, A. B. I. , Opara, C. C. 1998.** Response of growing broilers and laying hens to the dietary inclusion of leaf meal from *Alchornea cordifolia. Anim. Fd. Sci. Tech.* 71 (C2): 157-164.

**Udedibie, A.B.I. and Carlini, C.R. 1998.** Crack and Cook (CAC): A simple and quick process for elimination of *concanavalin* A (Con A) from *Canavalia* seeds. *Anim. Fd. Sci. Tech.* 71:179 – 184.

**WHO. 2006.** Guideline on standard operating procedures for Clinical chemistry. (2006), 53:176-181.

**Wikipedia, 2015.** Imo state. https://en.wikipedia.org/wiki/Imo_%28state%29.

*Received: 11th June, 2015*
*Accepted: 20th October, 2015*