# ANTINUTRITIONAL FACTORS INTAKE IN LAYING HENS FED COCOYAM (*Xanthosoma sagittifolium*) BASED DIET

**A. A. Hassan[1], G. T. Iyeghe-Erakpotobor[2], M. Abdulrashid[3], M. M. Getso[4], A. Musa[3], I. Abdullahi[2], U. A. Umar[2], A. A. Isa[3], and O. M. Daudu[2]**

Corresponding author: abdulmuminal99@gmail.com, +2348105819540
[1]Department of Animal Science, Federal University, Dutse
[2]National Animal Production Research Institute, Zaria
[3]Department of Animal Science, Ahmadu Bello University, Zaria
[4]Department of Animal Science, Kaduna State University

**Abstract**
The study was conducted to evaluate the effect of cocoyam-based diets processed by either boiling or sun drying on anti-nutrient intake of laying hens. A total of 160 day old commercial chicks (Shika Brown) were allotted to seven dietary treatments (n=20 birds per treatment) in a 2×3+1; 2 factorial arrangement: 2 factors (raw and boiled cocoyam), 3 levels (25, 50 and 75%) and 1 control (0%; n=40) in a completely randomized design, with 80 chicks for raw sun dried (RS) cocoyam and 80 chicks for boiled sun dried (BS) cocoyam. The cocoyam inclusion rates comprised 4 diets from RS and 4 from BS cocoyam, each replacing maize at 0, 25, 50, and 75%. During the 12-months experimental period, the birds were given feed based on their nutritional requirements and water *ad libitum*, routine vaccinations and medications were administered appropriately. Data collected on anti nutritional factors (oxalate, phytate, tannin, saponin, cyanide and hydrogen cyanide) were subjected to analysis of variance and significant differences among treatment means were compared using pair wise difference method (P diff test) at 5% level of significance. The results indicated a significant ($P<0.05$) reduction in intake of the antinutritional components in the BS diets compared to the RS diets. The inclusion levels showed significant ($P < 0.05$) differences across all parameters. It was concluded that processing cocoyam by boiling resulted in lower antinutritional factor intake, with the 50% inclusion level having the lowest values and thus recommended.

**Keywords:** Cocoyam, Anti-nutritional factors, Shika Brown, Raw sundried, boiled sundried

## Description of the problem

Cocoyam products are recognized as better carbohydrate sources than grains or other tuber crops [1]. Tannia cocoyam (*Xanthosoma sagittifolium*) is a non-conventional feedstuff that provides readily available energy through easily digestible carbohydrate [1]. The nutritional quality of cocoyam compares favourably with that of cassava, potatoes and yams [2]. The substitution of grains with roots and tubers is an economical option, and roots have a great potential in many areas of the world as a major energy supplier for animals [3]. Although root and tuber meals are low in protein, their energy content is remarkably high and heir prices are low relative to maize, hence the cost of production will be low. However, cocoyam contains antinutritional factors, which could limit its use [4], but these limiting factors can be reduced by boiling or sun-drying [5]. Therefore, the objective of this study was to evaluate the best processing method for reducing the content of anti nutritional factors present in cocoyam-based diet.

## Materials and Methods

***Study area***: The study was carried out at the Poultry Research Program Section of the National Animal Production Research Institute, Shika, Zaria Nigeria.

***Experimental animal and management***: A total of one hundred and sixty (160) day-old layer chicks (Shika Brown) were used in this study. The animals were procured from hatchery section at artificial insemination unit of National Animal Production Research Institute, Shika (NAPRI), Zaria. The birds were raised on litter (wood shavings) with good absorbent quality. The birds were brooded for two weeks at a mean temperature of 35ºC.

***Procurement and processing of cocoyam (Xanthosoma sagittifolium)***: Cocoyam (*Xanthosoma sagittifolium*) was purchased at Dal market, Sumaila Local Government, Kano State. The cocoyam was clean of sand and external fibres manually using hands, followed by chopping using a knife. The chopped cocoyam was subjected to two different processing methods to improve its nutritive value i.e raw & sundried (RS) and boiled & sundried (BS). The method of [6] was used to prepare the sundried cocoyam meal. The cleaned cocoyam were sliced and spread on an even surface to sundry. Sun drying was done for five consecutive days until crisp texture was achieved. The chopped cocoyam was immersed in boiling water (75 liter) at 100ºC and allowed to boil continuously for thirty minutes, then cooled, drained and dehydrated. This method was previously described by [7].

***Experimental diets and design***: A total of one hundred and sixty day-old layer chicks were sourced from incubation section at artificial insemination unit of National Animal Production Research Institute, Shika, Zaria and allocated into eight dietary treatments of twenty (20) birds per treatment in two replicates in a completely randomize design, 80 for raw cocoyam and 80 for boiled cocoyam. Eight experimental diets were formulated, comprising 4 diets from raw sundried and another 4 from boiled sundried form, each replaced maize 0%, 25%, 50%, and 75% as treatment 1 ($T_1$), treatment 2 ($T_2$), treatment 3 ($T_3$) and treatment 4 ($T_4$) respectively. The experiment last for the period of 12 months.

**Anti-nutritional Factors Analysis**

Two samples of the test materials, raw cocoyam (tannia) and boiled cocoyam (tannia) were analyzed in the Laboratory, Department of Animal Science, Ahmadu Bello University, Zaria for the determination of HCN [8], phytates [9], oxalates [10], tannins [11] and saponins [12] as shown in Table 1.

**Antinutritional Factors Intake Determination**

The content of anti-nutrient intake in laying bird at 9-18 weeks of age was quantified by the total amount of feed consumed using the formula below;

$$ANF\ Intake\ (mg/day) = Feed\ Intake\ (kg/day) \times Inclusion\ Level\ of\ Ingredient\ in\ Diet\ (\%) \times Concentration\ of\ ANF\ in\ Ingrdient\ (mg/kg)$$ [13].

## Result and Discussion

Significant differences in the intake of antinutritional factors, phytate, oxalate, tannin, saponin, cyanide, and HCN, were observed between raw and boiled cocoyam diets during the 9–18-week period, with boiled diets consistently resulting in lower intakes across all parameters ($P < 0.05$). Specifically, phytate intake decreased from 78.66 mg in raw diets to 70.15 mg in boiled diets, oxalate from 0.07 mg to 0.05 mg, tannin from 0.47 mg to 0.18 mg, saponin from 15.85 mg to 12.28, cyanide from 0.80 mg to 0.56 mg, and HCN from 0.15 mg to 0.09 mg. These reductions likely result from the heat treatment during boiling, which degrades or leaches antinutritional compounds, reducing their bioavailability [14]. Heat processing disrupts the chemical structure of phytates and tannins, while oxalates and cyanogenic glycosides (precursors to cyanide and HCN) may solubilize in water or break down under thermal stress [15]. The 50% inclusion level exhibited the lowest intake for all antinutritional factors (phytate: 63.08 mg; oxalate: 0.05 mg; tannin: 0.27 mg; saponin: 11.92 mg; cyanide: 0.58 mg; HCN: 0.10 mg), while the 75% level showed the highest (phytate: 86.65 mg; oxalate: 0.07 mg; tannin: 0.38 mg; saponin: 16.42 mg; cyanide: 0.80 mg; HCN: 0.14 mg). This pattern suggests an optimal balance at 50% inclusion, where the concentration of antinutritional factors is diluted compared to higher inclusion levels, possibly due to interactions with other dietary components [16]. The interaction effect further elucidated these trends, with boiled cocoyam at 50% inclusion yielding the lowest intake across all parameters (phytate: 59.87 mg; oxalate: 0.04 mg; tannin: 0.15 mg; saponin: 0.08 mg; cyanide: 0.48 mg; HCN: 10.48 mg), while raw-cocoyam at 75% showed the highest (phytate: 94.53 mg; oxalate: 0.08 mg; tannin: 0.57 mg; saponin: 19.05 mg; cyanide: 0.97 mg; HCN: 0.18 mg). The significant interaction ($P < 0.05$) indicates that processing and inclusion level jointly influence antinutritional factor intake. Boiling likely enhances the degradation of these compounds at moderate inclusion levels, whereas raw diets at higher inclusions concentrate these factors, exacerbating their intake [15]. These findings align with [14], who reported reduced phytate and tannin levels in heat-processed cocoyam diets for poultry, attributing the effect to thermal denaturation.

Table 1: Levels of Anti-nutritional Factors in Raw Sundried Tannia and Boiled Sundried Tannia Cocoyam Meals

| Parameters (*mg/100g*) | Raw Cocoyam Meal | Boiled Cocoyam Meal |
|---|---|---|
| Phytate | 0.09 | 0.07 |
| Oxalate | 0.19 | 0.13 |
| Tannin | 3.08 | 2.25 |
| Saponin | 20.15 | 17.50 |
| Cyanide | 0.60 | 0.25 |
| HCN | 1.02 | 0.80 |

*HCN: hydrocyanide*

Table 2: Antinutritional factors intake in laying bird fed cocoyam (*Xanthosoma sagittifolium*) based diet at 9-18 weeks of age

| | Processing | | | | Level of cocoyam (%) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Parameters | Raw | Boiled | SEM | P-value | 25 | 50 | 75 | SEM | P-value |
| Phytate | 78.66[a] | 70.15[b] | 0.5225 | 0.0001 | 78.17[b] | 63.08[c] | 86.65[a] | 0.4686 | 0.0001 |
| Oxalate | 0.07[a] | 0.05[b] | 0.0004 | 0.0001 | 0.07[a] | 0.05[b] | 0.07[a] | 0.0005 | 0.0001 |
| Tannin | 0.47[a] | 0.18[b] | 0.0025 | 0.0001 | 0.34[b] | 0.27[b] | 0.38[a] | 0.0044 | 0.0001 |
| Saponin | 15.85[a] | 12.28[b] | 0.0981 | 0.0001 | 14.74[b] | 11.92[c] | 16.42[a] | 0.0966 | 0.0001 |
| Cyanide | 0.80[a] | 0.56[b] | 0.0048 | 0.0001 | 0.72[b] | 0.58[c] | 0.80[a] | 0.0052 | 0.0001 |
| HCN | 0.15[a] | 0.09[b] | 0.0009 | 0.0001 | 0.12[b] | 0.10[c] | 0.14[a] | 0.0011 | 0.0001 |

[a,b,c]*Means within the rows with different superscripts are significantly different (p<0.05)*

Table 3: Interaction effect of antinutritional factors intake in laying bird fed cocoyam (*Xanthosomasagittifolium*) based diet at 9-18 weeks of age

| | Raw cocoyam | | | Boiled cocoyam | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameters | 25 | 50 | 75 | 25 | 50 | 75 | SEM | p-value |
| Phytate | 80.27[b] | 66.28[e] | 94.53[a] | 76.06[d] | 59.87[f] | 78.76[c] | 0.4525 | 0.0001 |
| Oxalate | 0.07[b] | 0.06[c] | 0.08[a] | 0.06[c] | 0.04[d] | 0.06[c] | 0.0004 | 0.0001 |
| Tannin | 0.48[b] | 0.40[c] | 0.57[a] | 0.19[d] | 0.15[e] | 0.19[d] | 0.0021 | 0.0001 |
| Saponin | 16.17[b] | 13.36[c] | 19.05[a] | 13.31[c] | 10.48[d] | 13.78[c] | 0.0843 | 0.0001 |
| Cyanide | 0.82[b] | 0.68[d] | 0.97[a] | 0.61[e] | 0.48[f] | 0.63[c] | 0.0007 | 0.0001 |
| HCN | 0.15[b] | 0.13[c] | 0.18[a] | 0.10[e] | 0.08[f] | 0.11[d] | 0.0041 | 0.0001 |

[a,b,c,d,e,f]*Means within the rows with different superscripts are significantly different (p<0.05)*

However, [16] found that raw cocoyam at high inclusions increased cyanide intake, consistent with the current results, though they noted less pronounced effects at lower inclusions, possibly due to differences in cocoyam varieties. The lower intake in boiled diets implies improved nutrient availability and reduced interference with mineral absorption, which could enhance growth and reproductive performance in laying birds [14]. Conversely, higher intakes in raw diets, particularly at 75%, may impair performance by binding essential nutrients or causing toxicity, as cyanogenic compounds are linked to metabolic stress [15].

**Conclusion and Applications**

Boiling and sun-drying significantly reduced anti-nutritional factors in cocoyam-based diets compared to raw sun-drying. The 50% inclusion level of boiled cocoyam gave the lowest anti-nutrient intake, making it the most suitable substitution level. High inclusion of raw cocoyam increased anti-nutrient intake, which could impair nutrient utilization.

**References**

[1] Abdulrashid, M. and Agwunobi, L. N. (2012). Tannia (*Xanthosomasagittifolium*) Cocoyam as a dietary substitute for maize in broiler chicken.*Greener Journal of Agricultural Sciences*. 2(5), pp. 167-171. http://gjournals.org/GJAS.

[2] Apata, D. F. and Babalola, T. O. (2012). The use of cassava, sweet potato, cocoyam and their by-products by non-ruminants. *International Journal of Food Science and Nutrition Engineering*, 2(4): 54 – 62. DOI: 10.5923/j.food.20120204.02

[3] Gohl, B. O. (1975). Tropical feeds information summaries and nutritive value. Food and Agricultural Organization of United Nation. Rome 25, P. 31.

[4] Okon, B. I., Obi, M. B. and Ayuk, A. A. (2007). Performance of Quails (*Cotunixcotunix japonica)* fed graded levels of boiled sundried taro cocoyam *Colocasiaesculenta*as a replacement to maize *Medwell Outline Agricultural Journal*;2(6):654-657.

[5] Abdulrashid, M., Agwunobi, L. N., Akpa, G. N. and Aeyinka, F. D. (2006). The performance of broiler finisher on varying levels of taro cocoyam meal. *Proceedings of the 31st Annual Conference of the Nigerian Society for Animal Production*. 29:285-289. 12th- 15th March. Bayero University Kano, Nigeria.

[6] Uchegbu, M. C., Omede, A. A., Chiedozie, J. C., Nwaodu, C. H. and Ezeokeke, C. T. (2010). Performance of Finisher Broilers fed varying levels of raw and sun-dried Cocoyam (*Xanthosomasagittifolium*) corm meals. Report and Opinion. 2 (8): 22-25.

[7] Olajide, R., Akinsoyinu, A. O., Afolabi, K. D., Owosibo, A. O., Fakolade, P. O. and Akinleye, S. B. (2009).Digestibility of nutrients by hybro broilers as affected by contents of anti-nutritional factors in wild cocoyam corm-based diets. *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria*, Ogbomoso, Nigeria; 202-205.

[8] AOAC, (1975). Official Methods of Analysis Association of Official Analytical Chemist, 12th ed. Washington D.C.

[9] McCane, R. A. and Widdowson, E. M.(1953). Phytin in Human Nutrition Biochemistry, 29: 2694-2699.

[10] Oke, O. L. (1984). Nutrition Abstract Revised (series B), 54: 301-314.

[11] Burns, R. E. (1971). Method for estimation of tannin in the grain corn. *Acpron Journal* 163:511-9.

[12] Shukla, A. Y. and Thakur, R. (1986). Saponins and other constituents from Rhizomes of penax pseudo-ginseng, Phytochem, 25: 2201-2203.

[13] Makkar, H. P. S. (1993). Antinutritional factors in foods for livestock. Animal Production and Health Paper, Food and Agricultural Organization (FAO).

[14] Adeyeye, S. A., Agbede, J. O. and Aletor, V. A. (2020). Nutritional and antinutritional evaluation of processed cocoyam in poultry diets. *Journal of Animal Nutrition*, 6(3), 112–120.

[15] Ojo, M. O., Adebayo, I. A. and Ayoola, P. B. (2021). Antinutritional factors in tropical tuber crops and their mitigation through processing. *African Journal of Agricultural Research*, 17(4), 532–540.

[16] Ezeokeke, C. T., Onu, P. N. and Ani, A. O. (2022). Effects of cocoyam-based diets on growth and laying performance of poultry. *Poultry Science Journal*, 8(1), 45–53.