__Original Research Article__

Proximate and Anti-nutrient compositions of cocoyam (*Colocasia esculenta*): the effect of cooking and dietary palm oil treatments.

ABSTRACT

The influence of cooking and dietary palm oil on the nutrient and anti-nutrient contents of cocoyam was investigated. Cocoyam is ranked third in importance, after has been found to be nutritionally superior to cassava and yam due to its easily digestible starch and high protein, vitamins and mineral contents. There are heath concerns over the anti-nutritional contents of cocoyam which could lead to several ailments. The addition of palm oil, which contains healthy components, and cooking known to also reduce and inactivate some of these antinutrients would be carried out in this study. Four portions of healthy cocoyam were given different treatments and labeled A, B, C and D for uncooked raw (control 1), cooked without dietary palm oil (control 2), cooked with little dietary palm oil at ratio 1:5, cooked with much dietary palm oil at ratio 1:10 respectively. These portions were mashed for nutrient and anti-nutrient content analysis. The moisture contents of portion B was the highest (80.48%) compared to moisture content values recorded for other cocoyam portions. The ash content of the C portion was the highest (3.38%) followed by cocoyam portion D. Raw cocoyam had the highest carbohydrate (86.58%) and protein content (8.61%) while portion D had highest protein content amongst boiled cocoyam portions. The highest caloric value was recorded for the cocoyam portion D (444.75%). The raw portion had higher content values for all the anti-nutrients. Values recorded for anti-nutrient contents of the other cooked and cooked with oil additions cocoyam (B, C and D) portions were significantly reduced.

Key words: Nutritional contents, proximate analysis, Anti-nutritional contents, cocoyam, dietary palm oil

INTRODUCTION

Most plants used as foods commonly synthesize a range of secondary metabolites, as part of their protection against attack by herbivorous, insects and pathogens or as means to survive in adverse growing conditions, termed anti-nutrients [1] which exerts effect contrary to optimum nutrition when consumed [2]. Cocoyam is one of the most widespread of the root and tuber crops cultivated almost everywhere throughout the tropics and in over 65 countries of the world [3]. Although they are ranked third in importance, after cassava and yam in many West and Central Africa countries according to Adisa and Okunede [4], cocoyams have been found to be nutritionally superior in the possession of higher protein, mineral and vitamin contents as well as easily digestible starch [5].

According to Giacometti and Leon [6] cocoyam plants are food crops of the tropical rain forest which in their natural habitat grow under the forest canopy, but when cultivated, they are usually sown with full exposure to sunlight. Cocoyam belong to either the genus *Colocasia* or *Xanthosoma* and are generally comprised of a large spherical corm (swollen underground storage stem), from which a few large leaves emerge [7]. About 30-40 species of cocoyam have been identified but only 5-6 species produce edible parts [8]. The corms and cormels of cocoyam, the major economic parts, are noted to be high with nutrients (15 to 39% carbohydrates, 2 to 3% protein and 70 to 77% water), the young leaves contain 2% protein and are also rich in vitamin C, thiamine, riboflavin, niacin, calcium, phosphorus and iron [9]. It has a nutritional value comparable to potato but easier to digest [10]. The presence of anti-nutrients in edible foods such as cocoyam, has become a major concern for human health [11]. Although most anti-nutritional factors are removed or partially inactivated by heat or cooking, their residual and bioaccumulated content have been reported to being the cause of many ill-health conditions [12; 13; 14]. This study evaluated the effect of cooking and palm oil treatments to the nutritional and anti-nutritional contents of cocoyam. Crude palm oil (CPO, known also as red palm oil, RPO) is known to contain both healthy beneficial compounds, such as triacylglycerol (TAGs), vitamin E, carotenoids, phytosterols, as well as impurities, such as phospholipids, free fatty acids (FFAs) gums and lipid oxidation products; the latter can be removed by means of refining processes according to Sambanthamurthi, Sundram and Tan [15].

MATERIALS AND METHODS

Sample Collection

Healthy cocoyam cormels (*Colocasia esculenta*) were bought from a local market in Akwa-Ibom State, Nigeria.

Sample Preparation

Cocoyam tubers (2kg) were washed thoroughly, to remove soil particles and other debris, then hand-peeled. The peeled tubers were washed again with clean water, sliced into smaller pieces of 2.0 mm thickness using sterile kitchen knife and divided into four portions. Three portions (B, C and D), were boiled at 80^{o}C for 15mins while a portion (A) was blended and left raw. The boiled portion B were mashed and left without dietary palm oil addition. These two portions served as control. One cooked cocoyam portion (C) was mixed with little palm oil (1:5) while another cooked portion (D) was mashed and mixed with a larger quantity of dietary palm oil (1:10). Each portion was arranged randomly on drying tray in single layers and left to dry at 65^{o}C in an air draught oven (Gallenkamp, BS Model 250 size 2 UK), until they were dried enough to be broken sharply between the hands [16].

Proximate Composition Analysis

The proximate composition (nutrient and anti-nutrient) of the cocoyam portions (A, B, C and D) was determined using a Micro-Kjedhal method [16] which involves wet digestion, distillation, and titration, while the anti-nutritional content was determined using the methods of AOAC[16] Ukpabi *et al.*[17] and Nkama and Gbenyi [18].

Statistical analysis of the average results was carried out to evaluate the significance or not of the treatments to the nutrient and anti-nutrient values of the cocoyam portions.

RESULTS AND DISCUSSIONS

Table 1 and 2 show results for the Proximate/Nutritional and Anti-nutritional contents of the four sample portions respectively.

Table 1: Proximate composition for cocoyam analysis

s/n	Sample	Moisture (%)	Ash (%)	Fibre (%)	Protein (%)	Lipid (%)	CHO (%)	Caloric Val (Kcal)
1	A	80.48±0.045	2.25±0.025	1.71±0.021	8.61±0.128	0.56±0.001	86.58±0.113	385.88±0.112
2	B	82.53±0.038	3.28±0.01	2.20±0.015	5.95±0.000	1.36±0.02	87.15±0.040	384.00±0.106
3	C	9.47±0.006	3.90±0.02	1.69±0.010	6.24±0.098	6.87±0.025	81.07±0.048	411.17±0.465
4	D	8.84±0.021	3.38±0.020	2.23±0.025	7.02±0.o40	13.44±0.020	73.92±0.076	444.75±0.031

Values are means ± SD triplicate determinations. A= raw (control I), B= cooked without dietary palm oil (control II), C= cooked with 1:5 dietary palm oil, D = cooked with 1:10 dietary palm oil

Table 2: Anti-nutrient determination in cocoyam

S/N	Sample	HCN(%)	Tanin (%)	Oxalate (%)	Phytate (%)
1	A	10.21±0.030	22.20±0.015	30.28±0.080	1.78±0.021
2	B	7.38±0.032	16.13±0.010	22.34±0.481	0.47±0.015
3	C	7.11±0.020	9.85±0.021	10.61±0.120	ND
4	D	6.77±0.015	6.34±0.554	7.39±0.066	ND

Results: mg/100g. *Values are means ± SD triplicate determinations, ND= Not detected, A= raw (control I), B= cooked without dietary palm oil (control II), C= cooked with 1:5 dietary palm oil, D = cooked with 1:10 dietary palm oil*

Proximate Analysis of Cocoyam Samples

Table 1 contains results for proximate analysis of the different cocoyam portions.

Moisture content

The average results recorded for moisture content of the raw cocoyam portion was 80.48% this is slightly higher than the values reported for raw cocoyam samples [19; 9]. Ndon *et al.* [9] had reported moisture contents of between 70 to 77% as average for raw cocoyam, therefore cocoyam is a water holding tuber. These moisture values were observed to be very high compared to those obtained for raw cocoyam tubers grown in Ethiopia [20]. The boiled portion had average moisture content of 82.53%. While this value is higher than that of the raw, obviously due to the water used for the boiling process, it was way higher than the 10.19% value reported by Adane *et al.* [20] for cocoyam grown in Ethiopia. Cocoyam portions (C and D) boiled with oil amendment had lower values than the portions without oil treatments (9.47 and 8.84% respectively). This moisture value reduction could be due to the addition of oil as oil and water do not mix well.

Ash content

The average ash content for the cocoyam portion was 2.25%. This study value was slightly lower than those reported by Adane *et al.* [20] and Ndabikunze *et al.* [19] who also evaluated raw cocoyam. For the boiled cocoyam portion, result was also lower when compared with ash content value from works of Adane *et al.* [20] but higher than the value reported by Kolawole and Obueh [21] for boiled cocoyam samples. The ash content values for cocoyam samples boiled and amended with oil were observed to be higher than sample portions without oil amendments. This could be resultant from the oil amendment.

Fibre content

The average fibre content for the raw cocoyam portion was 1.71% and in the fibre value range (1.96%) obtained by Ndabikunze *et al.* [19] for raw cocoyam samples. These values were seen to be low when compared to result by Adane *et al.* [20] who had 2.63% raw cocoyam samples. Fibre content value for boiled cocoyam portion for this study was lower than values obtained by Adane *et al.* [20] and Kolawale and Obueh [21] for boiled cocoyam samples. Adane *et al.* [20] also reported higher fibre content for fermented cocoyam. The boiled cocoyam portion with 1:10 oil amendment had the highest fibre content of 2.23%.

Protein content

The average protein content recorded for raw cocoyam sample in this study was found to be higher than values obtained by Adane *et al.* [20] and Ndabikunze *et al.* [21]. Protein content value (5.95%) for boiled cocoyam was in same value range with study report by Adane *et al.* [20] but higher than average value (0.93%) reported by Kolawale and Obueh [21] for cocoyam grown in Ethiopia. With oil amendment, protein contents for boiled cocoyam portions C and D were higher.

Lipid content

The lipid/fat content (0.56%) of cocoyam obtained for this study is in the range of average value obtained by Adane *et al.* [20]. Lipid content of boiled portion of cocoyam obtained in this study was higher than those reported by Adane *et al.* [20] and Kolawale and Obueh [21] for boiled cocoyam samples. Oil additions would normally increase the lipid content as obvious in this result.

Carbohydrate content

The average carbohydrate content (86.58%) was in same value range with that reported by Adane *et al.* [20] but higher than values reported by Ndabikunze *et al.* [19] for raw cocoyam samples. Boiled cocoyam samples for this work also have same value (87.15%) range result as the work of Adane *et al.*

[20] for carbohydrate. Boiled cocoyam portions (C and D), with oil amendment, recorded reductions in their carbohydrate content values.

Caloric content

Same trend observed with the carbohydrate content is observable with the caloric content for raw and boiled cocoyam portions of this study. The oil amended portions also recorded lower caloric values [20].

Anti-nutritional Compositions of Cocoyam Samples

Evaluation of the anti-nutritional contents of cocoyam portions are as contained in Table 2.

Phytate content

Result from this study indicates that the average phytate content for raw cocoyam portion was 1.78%. This value falls within range value gotten from studies conducted by Abdulrashid and Agwunobi [22]. With boiling the value is seen to lower (0.47%) than that obtained from the raw portions and is totally not detectable in cocoyam portions with oil amendment [12; 13; 14]. High content of phytate in foods is of nutritional significance because phytate phosphorous is unavailable to human, but its presence lowers the availability of many other dietary minerals such as iron and zinc [23].

Oxalate content

The average oxalate content was recorded as 30.28% for raw cocoyam portion. Boiling treatment reduced the oxalate value to 22.34% while boiled and oil amended cocoyam portions (C and D) had even lower oxalate values [12; 13; 14]. This reduction accounted for about 76% of the initial Oxalate content. This values support the findings of Abdulrashid and Agwunobi [22] who had recorded a value of 33.32% and 21.70% for raw and boiled cocoyam samples. FAO [24] reports that oxalates are major anti-nutritional factors also present in cocoyam. Studies by Noonan and Savage [25] has it that oxalate has a deleterious effect on human nutrition and health particularly by decreasing calcium absorption and aiding the formation of kidney stones.

Tannin content

Average values of Tannin for raw (22.20%) and boiled (16.13%) cocoyam portions was observed to be very high compared to the value recorded for raw and boiled cocoyam samples by Abdulrashid and Agwunobi [22]. Compared to others, cocoyam portions boiled and amended with oil showed significant reductions (71% of its initial content) in Tannin values [12; 13; 14]. Foods rich in tannins are considered to be of low nutritional value because they precipitate proteins, inhibiting digestive enzymes and iron absorption and affect the utilization of vitamins and minerals from meals, according to reports by Tinko and Uyano [26].

Cyanide content

Average Cyanide values obtained in this study for raw and boiled cocoyam portions (10.21 and 7.38%) were higher than values (1.02 and 1.01%) recorded for raw and boiled cocoyam samples by Abdulrashid and Agwunobi [22]. Although boiling and oil amendment reduced the values further up to 34% of its initial content, they were still higher than those reported by Abdulrashid and Agwunobi [22].

Statistical Analysis

Data analyzed using ANOVA table showed that the cooking and addition of oil to the cocoyam portions was significant at (p=0.05).

CONCLUSION

The influence of the dietary palm oil on the proximate composition and anti-nutritional content of cocoyam (*Colocasia esculenta*) can be concluded thus: the use of dietary palm oil has shown significant improvement in the proximate composition; the boiled and dietary oil amended cocoyam samples had higher protein, fat, crude fibre and carbohydrate values than those cocoyam portions that received only cooking treatment. From the result, cocoyam is a good source of dietary energy and essential minerals, provided the traditional processing techniques are improved on. The quantity of energy obtainable from cocoyam makes it one of the most carbohydrate-rich foods this part of Africa and can be considered as a crop which can contribute to the efforts of the Nigerian government to alleviate food and nutrition security. Many works abound in the use of cocoyam for poultry and other livestock supplements.

It is therefore recommended that treatments (eg heating/boiling and addition of dietary palm oil) should be adopted as these help in no small way to reduce the anti-nutrient content of cocoyam.

REFERENCES

1. Bora P. Anti-Nutritional Factors in Foods and their Effects. *Journal of Academia and Industrial Research*. 2014: 3(6): 285-290.
2. Soetan K, Oyewole O. The need for adequate processing to reduce the anti-nutritional factors in plants used as human foods and animal feeds: A review. *African Journal of Food Science* 2009: 3 (9): 223-232.
3. Pollock NJ. Cambridge World History of Food. Editor: Kenneth F Kiple & Kriemhild Conee Ornelas. volume 1. Cambridge, UK: Cambridge university press, 2000.
4. Adisa BO, Okunede EO. Women in Agriculture and Rural Development. In Madukwe, M.C. (edition), *Agricultural Extension in Nigeria* (2nd edition), AESON Publication ARMTI, Ilorin, Nigeria, 2011: pp 90-100.
5. Agueguia A. Non-destructive Estimation of Leaf Area in Cocoyam (*Xanthosoma sagktifolium* [l.] Schott). *Journal of Agronomy and Crop Science*, 1993: 171, 138-141.
6. Giacometti DC, León J. Tannia. Yautia (*Xanthosoma sagittifolium*). In: *Neglected Crops: 1492 from a different perspective*. Plant Production and Protection Series No. 26. Rome, Italy: FAO. (Eds. J.E Hernaldo & J. León), Rome, Italy, pp. 1994: 253-258.
7. Mbong GA, Fokunang CN, Fontem LA, Bambot MB, Tembe EA. An Overview of *Phytophthora colocasiae* of Cocoyams*:* A potential economic disease of food security in Cameroon. *Discourse Journal of Agriculture and Food Sciences*, 2013: 1(9): 140-145.
8. Nwanekezi EC, Owuamanam CI, Ihediohanma NC, Iwouno JO. Functional, Particle Size and Sorption Isotherm of Cocoyam Comel Flours. *Journal of Nutrition*, 2010: 9, 973-979.
9. Ndon BA, Ndulaka N, Ndaego NU. Stabilization of Yield Parameters and some Nutrient Components in Cocoyam Cultivars with time in Uyo, *S.E Nig. Glob. J. Agric. Sci.* 2003: 2(2):74-78.

10. Sefa-Dedeh S, Agir-Sackey EK. Chemical Composition and the effect of Processing on Oxalate content of Cocoyam *Xanthosoma sagittifolium* and *Colocosia esculenta, Food Chemistry,* 2004: 85(4): 479-487.
11. McEwan R, Shangase FN, Djarova T, Opoku AR. Effect of three Processing Methods on some Nutrient and Anti-nutritional Factor Constituent of *Colocasis esculenta* (Amadumbe). *African Journal of Food Science,* 2014: 8(5):286-291.
12. FAO. *Roots, Tubers, Plantains and Bananas in Human Nutrition*. Rome: FAO corporate Documentary repository. 2013.
13. Akande KE. Doma UD. Agu HO, Adamu HU. Major Anti-nutrients found in Plants Proteins Sources: the Effect on Nutrition. *Pakistani Journal of Nutrition,* 2010: 9(8): 827-832.
14. Barde MI, Hassan LG, Faruq UZ, Maigandi SA, Umar KJ. Study of Bioavailability of Ca and Zn in flesh of yellow *Terminalia catappa* (Linn) Fruits. *Nigerian Journal of Basic and Applied Science,* 2012: 20 (3): 205-207.
15. Sambanthamurthi R, Sundram K, Tan Y. Biochemistry of Palm oil. *Prog. Lipid Resources,* 2000: 37, 507-558.
16. AOAC. *Official Methods of Analysis* 18th ed. Washington, DC: Association of Official Analytical Chemists, 2005.
17. Ukpabi UJ, Ejidoh JI. Effect of Deep oil frying on the Oxalate content and the Degree of itching of Cocoyams (*Xanthosoma* and *Colocasia* spp). Technical paper University of Technology, Owerri, Nigeria, 3-6 Sept. Vol 1 (1) Sept: 9-13, Publishers:Science Education Development Institute Nd edition) AESON Publication ARMTI, Ilorin, Nigeria 1989: Pp 90-100.
18. Nkama I, Gbenyi DI. The effects of Malting of Millet & Sorghum on the Residue Phytate and Poly-phenols in “Dakura”, a Nigerian Cereal/legume Snack Food. *Nig. Trop. J Agri*, 2001: 3, 270-271.
19. Ndabikunze BK, Taliwana HAL, Mongi RS, Issa-Zacharia A, Serem AK, Palapala V, Nandi JOM. Proximate and Mineral Composition of Cocoyam (*Colocasia esculenta,* L) grown along the lake Victoria Basin in Tanzania and Uganda. *African Journal of Food Science.* 2011: 5(4): 248-254.
20. Adane T, Shimelis A, Negussie R, Tilahun B, Haki GD. Effect of Processing Method on the Proximate Composition, Mineral Content And Antinutritional factors of Taro (*Colocasia esculenta*, L.) grown in Ethiopia. *African Journal of Food, Agriculture, Nutrition and Development*. 2013: 13(2): 7383-7398.
21. Kolawole SE, Obueh HO. Proximate and micronutrient compositions of some selected foods and diets in South–South Nigeria. *Scholarly Journals of Biotechnology*. 2012: 1(3):45-48.
22. Abdulrashid M, Agwunobi LN. Tannia (*Xanthosoma sagittifolium*) Cocoyam as Dietary Substitute for Maize in Broiler Chicken. *Greener Journal of Agricultural Sciences*. 2012: 2(5): 167-171.
23. Siddhuraju P, Becker K. Effect of various Domestic Processing Methods on Anti-nutrients, *in vitro*-Protein and Starch Digestibility of two Indigenous Varieties of Indian pulses, *Mucuna pruries* var utilis. *Journal of Agricultural and Food Chemistry*, 2001:49 (6): 3058–3067.
24. FAO. *Roots, Tubers, Plantains and Bananas in Human Nutrition*. Rome: Food and Agriculture Organization of the United Nations ISBN 92-5-102862. 1990.
25. Noonan S, Savage GP. Oxalate Content of Food and its effect on Humans. *Asia Pacific Journal of Clinical Nutrition* 1999: 8(1):64-74.
26. Tinko N, Uyano K. Spectrophotometric Determination of the Tannin Contents of various Turkish Black tea, Beer and Wine samples. *International Journal of Food Sciences and Nutrition*, 2001: 52, 289–294.