Asian Journal of Agriculture and Rural Development
Volume 7, Issue 3(2017): 48-55

http://aessweb.com/journal-detail.php?id=5005

Nutritional composition of cocoyam *(Colocasia Esculenta)*, grown in manicaland province in Zimbabwe

Matikiti A.[a*], Allemann J.[a], Kujeke G.[b] , Gasura E.[b], Masekesa T.,[b] Chabata I.[b]

[a*, a] Department of Soil, Crop and Climate Sciences, University of the Free State, South Africa. *amatikiti@agric.uz.ac.zw* (Corresponding author)
[b] Department of Crop Science, University of Zimbabwe, Mt Pleasant, Harare, Zimbabwe.

Corresponding author

ARTICLE HISTORY:

Received: 09-Feb-2017
Accepted: 12-Jul-2017
Online available: 20-Jul-2017

Keywords:
Composition,
Cocoyam,
Manicaland

ABSTRACT

Cocoyam is one of the important root food crops especially in Eastern parts of Zimbabwe. However, the nutritional composition of the Zimbabwean cocoyam has not been ascertained. A field trial was conducted in Rusape, Makoni District, Manicaland Province, Thandi Area under Chief Makoni in Maramwidze Village, 10km from Rusape town in 2015/16 season. Treatments consists of the control, cowdung manure, inorganic fertilizer, and a combination of cowdung manure and inorganic fertilizer, and was laid out in a split-plot design with cocoyam types (Madhumbe, Magogoya and Ghana) assigned to the main plots and manure type as the sub-plots with three replications. The results showed that nutrient supply to the cocoyam crop influenced the quality of the crop in a non-synchronously form. Proximate nutrition composition of cocoyam were in the range of 65 – 78% (moisture), 2 – 5 % (ash), 0.2 – 1.10% (fat), 2 – 5% (fibre), 14 – 23% (carbohydrates), 390 – 460 mg/100g (potassium), 24 – 43 mg/100g (calcium), 79 – 91 k/cal (energy), 0.3 – 4.8% (protein) and 79 – 110 mg/100g (magnesium). The high carbohydrate content in the cocoyam shows that the crop is superior compared to other tubers like sweet potatoes and cassava. In conclusion, the utilization of cocoyam combined with other foods with high protein content like cowpea will be beneficial to the nutrition of vulnerable groups considering the resultant high nutritive values.

Contribution/ Originality
The current study ascertained the nutritional composition of the Zimbabwean cocoyam. The study also shows that cocoyam is superior as compared to other tubers like sweet potatoes and cassava.

DOI: 10.18488/journal.1005/2017.7.3/1005.3.48.55
ISSN (P): 2304-1455/ISSN (E):2224-4433

Citation: Matikiti, A., Allemann, J., Kujeke, G., Gasura, E., Masekesa, T., and Chabata I. (2017). Nutritional composition of cocoyam (colocasia esculenta), grown in manicaland province in Zimbabwe. Asian Journal of Agriculture and Rural Development, 7(3), 48-55.

1. INTRODUCTION

Cocoyams are tubers that are widely cultivated in both the tropical and sub-tropical regions of the world. It is a wetland herbaceous plant which grows to a height of 1 – 2m and it is perennial. Cocoyam can be distinguished into two main groups; the "eddoes" and the "dasheen" types (Onwueme, 1994). The eddoes type which is refered to *madhumbe* in Zimbabwe, have side tubers (cormels) that may be 5 – 20 in number and they become as big as the mother corm. In Manicaland Province where it is mainly grown, cocoyam ranks second in importance after sweet potato among the root and tuber crops cultivated and consumed in that area. The tubers are edible and they provide carbohydrates for human consumption. Usually they are used as a substitute for bread just like cassava and sweet potatoes (Kusena, 2002). In Nigeria, being the largest producer of cocoyam, and other West African countries it is an important staple food crop commonly grown by women (Eze and Okorji, 2003).

Food is one of the people's basic necessities of life, therefore cocoyam represents important vital economic food value in most rural households, farmers produce their crop mainly for consumption and family upkeep, and they also sell and preserve for replanting in the subsequent cropping season. Nutritionally, cocoyam is superior to cassava and yam because of its high protein content, minerals and vitamins in addition to more digestible starch (Onyenweaku and Okoye, 2007). The main nutrient provided by cocoyam, as with many other root and tuber crops, is the dietary energy supplied by carbohydrates (O'Hair, 1990). The protein fraction content of corms and cormels is low (1-3%) and like other tuber crops proteins, sulphur containing amino acids are limiting (Mwenye *et al.*, 2011). The mature corms are mostly boiled in Zimbabwe, while in West African countries they can be roasted, baked and fried. They can be eaten alone or with stew and they are served in some five star hotels (personal observation). The boiled corms are sometimes mashed like Irish potatoes and used as a weaning diet for babies. In West Africa, the mature corms are also processed into flour, which is used to prepare "fufu" that is commonly eaten with stews. The leaves of cocoyam are also nutritionally rich, containing about 23% protein on a dry-weight basis (Onwueme, 1994). Young cocoyam leaves are mixed with coconut cream to prepare a dish, which is then eaten with the boiled or roasted cocoyam, breadfruit or plantain. The leaves and sometimes stems are eaten as spinach and provide a supplement to maize (Coetze and Allenmann, 1996). Cocoyam can be used as an industrial raw material in the manufacture of alcohol and drugs (Okwuowulu *et al.*, 2000).

Recent studies in other crops have revealed that use of intergrated use of organic and inorganic fertilizer influences yield and nutritional composition of the crops (Hota *et al.*, 2016). However, there is need to apply both inorganic and organic fertilizers to increase the performance and chemical properties of soil such as pH, total nutrient content and nutrient availability (Usman *et al.*, 2015). Hence there is need to ascertain the nutritional composition of cocoyam in this study.

2. MATERIALS AND METHOD

The experiment was carried out in Rusape, Makoni District, Manicaland Province, in Thandi Area under Chief Makoni in Maramwidze Village, 10km from Rusape town in 2015/16 season, on three farmer fields. Makoni District is in Natural Region II and receives about 1250 – 1800mm rainfall per annum falling between November and March with dry spells in mid-January. Most soils in the area are loamy with high land-use potential. The cropping season starts around November and lasts until the end of April. Cropping, gardening, livestock rearing, fruit production and forestry are integrated on these communal farms. Mechanisation is very low and family labour is the main labour sources.

2.1. Description of varieties used in the experiment

2.1.1. Madhumbe (Eddoes)

The eddoes type which is refered to *madhumbe* in Zimbabwe, have side tubers (cormels) that may be 5 – 20 in number and they become as big as the mother corm. The corm is small, globoid, and surrounded by several cormels (stem tubers) and daughter corms. The cormels and the daughter corms together constitute a significant proportion of the edible harvest. Corms, cormels and daughter corms are quite similar in their internal structure.

2.1.2. Magogoya (Dasheen)

The dasheen type is known as *magogoya* in Zimbabwe, the cormels are usually absent and it is the mother corm which is the main storage organ (Tumuhimbise *et al*., 2009). In the dasheen types of taro, the corm is cylindrical and large. It is up to 30cm long and 15cm in diameter, and constitutes the main edible part of the plant. The crop can grow up to 1.5m in height than the eddoes. The crystal oxalates in the dasheen type is less than in the eddoes (Onwueme, 1994).

2.1.3. Ghana variety (Mankani brobe)

Mankani brobe is an indigenous variety to West Africa (KariKari, 1976). It is a stout herbaceous plant, tuberous rhizomes, erect, semi-erect or horizontal, up to 3 m high, leaf-blade up to 35 cm broad, 30-50 cm long, bottom nerves nearly marginal at petiole. The leaves arise from a broad corm; offshoots appear on short rhizomes extending from the corm. The corms have mixed colours of white and pink.

2.1.4. Soil analysis

At the experimental site soil samples were taken on-farm station in Rusape sites for physical and chemicals analysis at the Chemistry and Soils Research Institute of Zimbabwe.

Table 1: Summary of the soil analysis results for the experimental site in the 2015 -2016 rainy season

Parameter	Karumbidza	Maramwidze	Makuvaza
pH ($CaCl_2$)	5.65	5.63	6.10
Nitrogen (mg/Kg)	18	15	20
Phosphorus (mg/Kg)	29	23	32
Calcium (me%)	18.78	17.22	21.45
Magnesium (me%)	5.89	6.03	6.34
Potassium (me%)	0.67	0.84	0.51
Sodium (me%)	0.35	0.28	0.43
Clay %	27	31	22
Silt %	10	13	8
Sand %	63	66	70
Soil Texture	SCS	SCS	SCS
Soil Colour	Black	Black	Black

2.2. Experimental design and treatments

The trial was laid out as a split-plot design consisting of control, cowdung manure and inorganic fertilizers and the other with inorganic fertilizer only. Cocoyam varieties were assigned to the sub-plots with three replications and 12 plants in each sub-plot.

2.3. Establishment and maintenance of experimental plots

The experiment was set up in a swampy area. The field was manually cleared on the land which a crop of maize had been grown previously. The land preparation was done using ox-drawn mould board ploughs and harrowed to a fine tilth. Main plots measuring 6m x 6m were laid out with 1m border between plots. Holes were made with a hoe with a circumference of about 45cm and depth of 15-20cm. Each replication contained four main plots accommodating the cowdung

manure,inorganic fertilizer, cowdung manure and inorganic fertilizer and the control. Three varieties namely*: Madhumbe, Magogoya* and Ghana V1 were the sub-plots. The plant spacing was 1m x 1m (10,000 plants ha^{-1}) and contained 36 plants. The crop was planted on 05 August 2015. The experiments were kept weed-free throughout the experiment by hand-hoeing. While weeding the plants were heaped with soil so that they have room for tuber growth. This was done three times. At 90 days (DAP) amoerilites were added to the plants as top dressing.

2.4. Harvesting and measurements

Plant growth was evaluated at 60, 90, 120 days after planting (DAP). Data collected included plant height, number of shoots, number of corms, corm fresh weight. Corms were harvested on maturity on the 15 May 2016. The fresh corms were thoroughly washed with tap water and sent to Food Science Department for nutritional analysis.

2.5. Determination of nutritional composition

The nutritional analysis was conducted in the Department of Food Science, Faculty of Science at the University of Zimbabwe. The nutritional composition (protein, ash, fibre, carbohydrate and moisture) were determined by the methods of Association of Official Analytical Chemists (2005). The minerals composition (calcium and magnesium) were determined using Atomic Absoption Spectrophotometer as outlined (AOAC, 2005). Pottasium was determined using flame photometer. Atwater factors were used to calculate the energy value of the samples. Samples were analysed in triplicates.

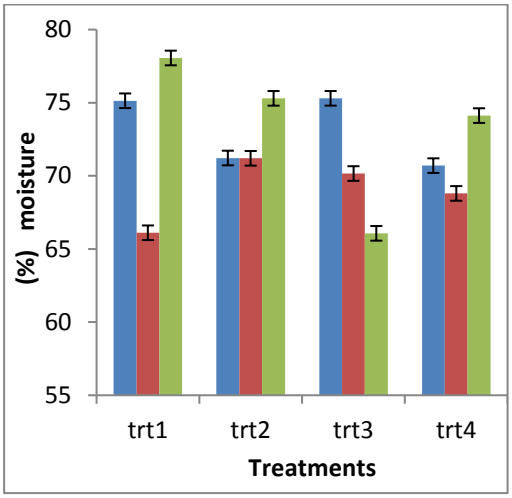
2.6. Data anaysis

Data obtained was subjected to analysis of variance (ANOVA). Significance difference was accepted at 5% probability level.

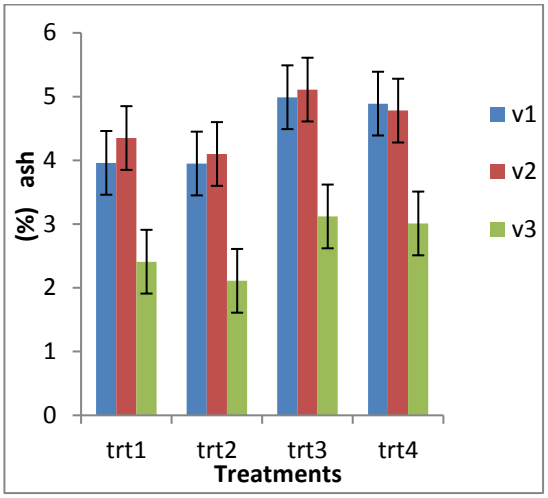
3. RESULTS

3.1. Effects of organic and inorganic manure on nutritional composition of cocoyam (colocasia esulenta) in rusape district on three varieties

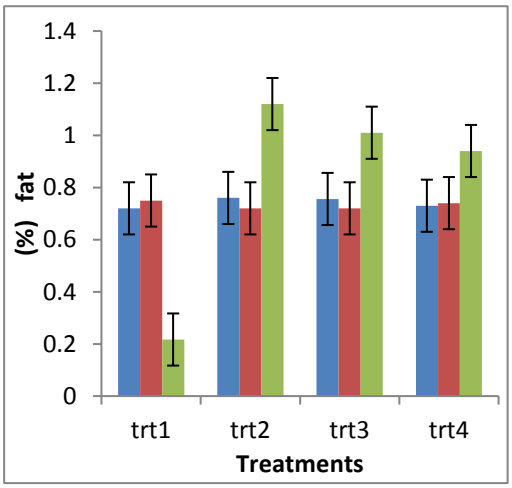
There was a highly significant ($P<.001$) interaction between variety and fertilization with respect to all the nutritional composition measured (Figure 1). The nutritional composition responded according to the type of fertilization that was applied. For moisture content, treatment 1 with cowdung manure produced the highest moisture content on Ghana variety and also Magogoya produced the lowest moisture content on that same treatment. As for ash content, the Ghana variety produced the lowest and as for Magogoya and Madhumbe it was almost the same. Ghana variety produced the highest fat content on treatment 2, 3, 4 and there were small differences on the two varieties. However, on treatment 1 the Madhumbe and Magogoya varieties produced the highest.



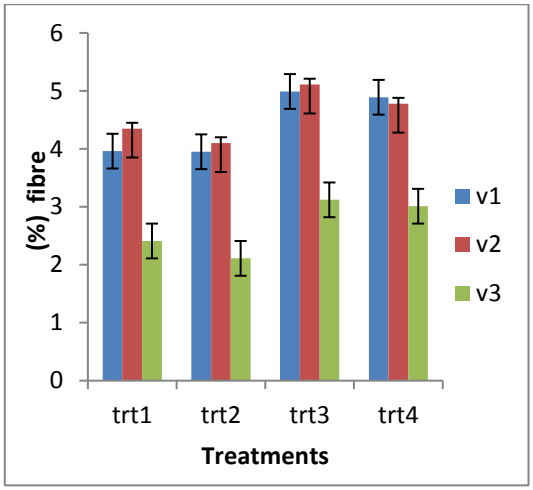
MOISTURE



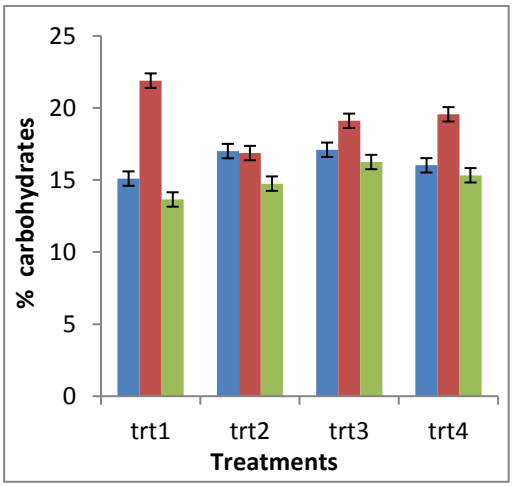
ASH



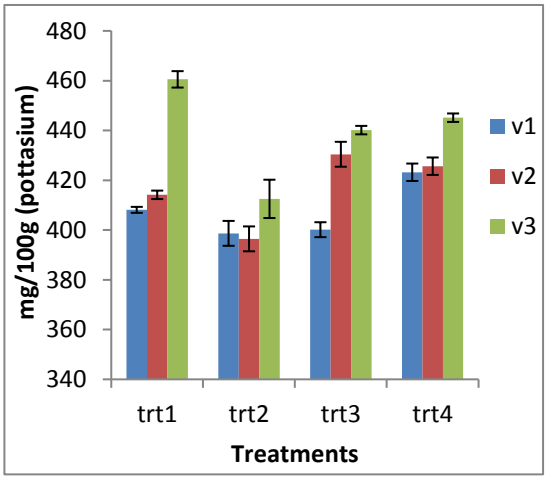
FAT



FIBRE



CARBOHYDRATES



POTTASIUM

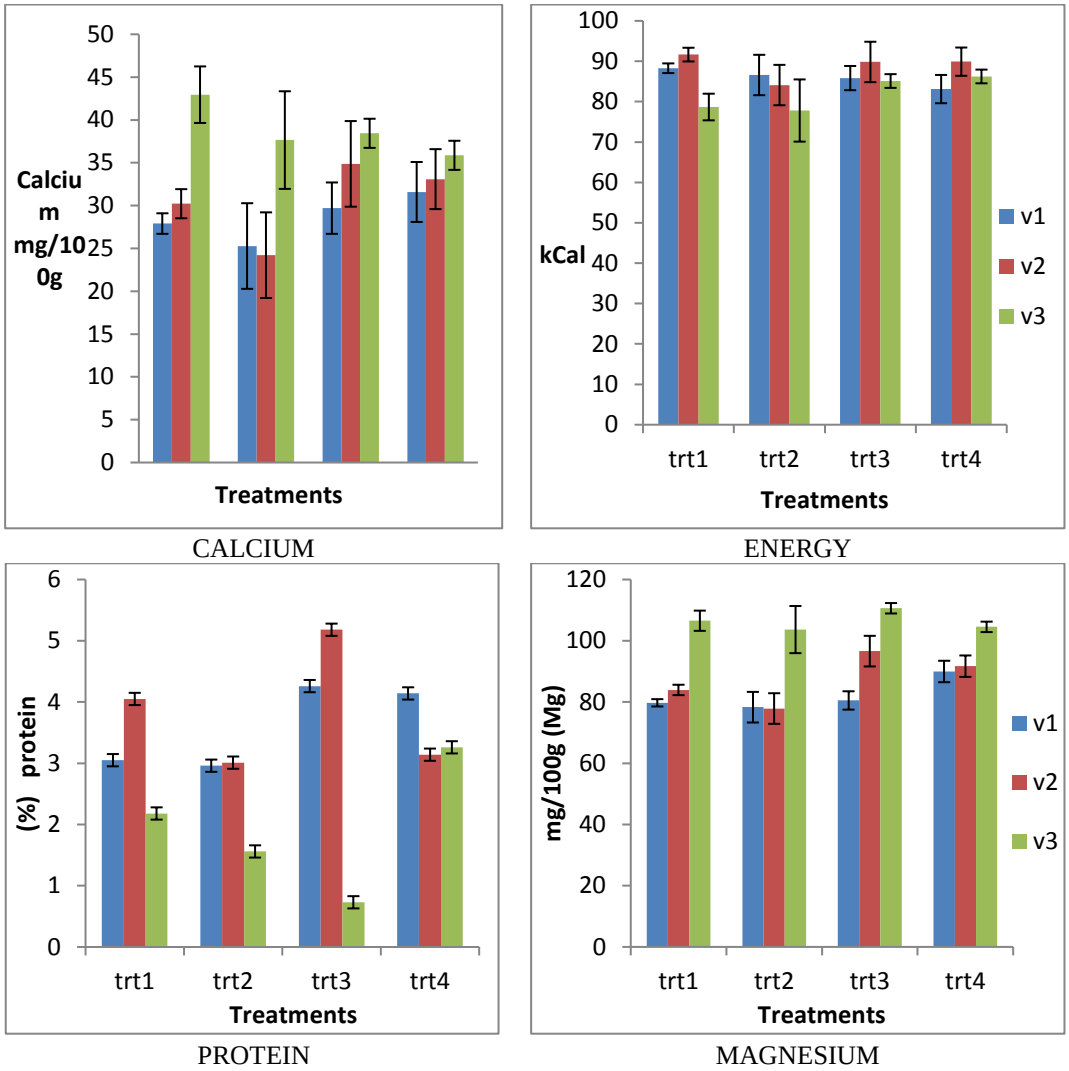


Figure 1: Variety and treatment interaction on nutritional composition of cocoyam. Variety V1, V2, V3 represents *Madhumbe, Magogoya* and Ghana respectively. Treatment 1, 2, 3 and 4 represents cowdung manure, inorganic fertilizer, cowdung and inorganic fertilizer and control respectively. Bars indicate SED values

4. DISCUSSION

Nutritional composition of crops is a highly challenging trait due to both the different properties which determine crop quality and the various factors the affects them (Wiesler *et al.*, 2002). The determination of proximate and mineral compositions of cocoyam will go a long way in providing substantive information on the crop for effective guide on dietics in Zimbabwe. In this study, nutrient supply to the cocoyam crop influenced the quality of the crop in a non-synchronously form. Obervations made in this study revealed that, the difference in mineral composition of the cocoyam grown could be probably due to the differences in the potential of each variety to obtain nutrients from the soil. The moisture content obtained is consistent with earlier research conducted in South Africa and Nigeria (Mwenye *et al.*, 2011 and Aregheore and Perera, 2003). Both authors obtained moisture contents that was between 65% - 80%, the variation may be attributed to the cocoyam variety used, environmental factors and agronomic practices. The low moisture content for Treatment 1 on Magogoya variety and Treatment 3 on Ghana Variety is important as it enables

long storage by minimizing fungal contamination and spoilage on cocoyam and also during transportation to the markets. The percentage ash content fall within the range reported in the literature, (Lewu *et al.*, 2010) which is between 1 – 5%. The ash content of Ghana variety was however lower than the other two local varieties. The ash content helps to determine the amount and type of minerals in cocoyam (reference), whereby minerals are essential for growth and metabolism in humans and helps in preventing mineral deficiency disease like anemia, goiter, cretinism and mycardiopathy and reducing the risk of contracting other chronic dieases like cancer and cardiovascular (Wiesler *et al.*, 2010). The local varieties had the highest fibre content than the Ghana variety confirming that they are good source of fiber compared to other root and tubers especially potato (Bradbury and Holloway, 1988). The high fiber content found in the local varieties is good for the Zimbabwe population as this highlights protection against some health problems. Conversely, low fibre is undesirable as it can cause constipation resulting in diseases of the colon like piles, appenditics and cancer (Olaleye *et al.*, 2013). The high carbohydrate content in the cocoyam shows that the crop is superior compared to other tubers with low carbohydrates (reference). Generally, cocoyam is a carbohydrate/energy source with very low protein content (Aregheore and Perera, 2003); this agrees with the fact that tuber and other root crops in rich in carbohydrates hence their high caloric values. The makes the crop to be of high value both nutritionally and economically hence it is food of major importance in the Eastern parts in Zimbabwe. The low protein in the first three treatments by the Ghana variety could be due to low intake of nitrogen by the plant. The mineral composition of cocoyam showed high percentage of potassium, calcium and magnesium on the Ghana variety and the other varieties had almost similar percentages. This indicates that the Ghana variety had the capacity to take more of these minerals from the soil than the other two.

5. CONCLUSION AND RECOMMENDATION

It is evident from this study that cocoyam can be consumed with other staple foods with higher protein to make up for the deficiency. Cocoyam production and consumption should be encouraged and popularized nationally as an additional tuber crop next to sweet potato, cassava and Irish potato to help curb malnutrition and lower incidence of other diet related diseases. This will extend the utilization options for this underutilized tuber beyond its current use in Zimbabwe hence increased source of income for farmers and market stall vendors. The results of this study will help nutritionists, hospitals, government and non-governmental organizations with data in their planning. The study also revealed that conjuctive use of soil amendments, balanced fertilizers and organic manure improves the physio-chemical and biological properties hence obtaining a sustainable crop with good nutritional values for good health.

Funding: This study received no specific financial support.
Competing Interests: The authors declared that they have no conflict of interests.
Contributors/Acknowledgement: The author is grateful to the South African Government for sponsoring this study through the University of the Free State. The late Dr David Ichisihayo is acknowledged for his critical statistical advice. We are also thankful to the University of Zimbabwe, Departments of Food Science and Crop Science for providing laboratory facility in the research work and the farmers in Rusape for their land use.

References

AOAC. (2005). *Association of official analytical chemists.* 18th Edition. Washington D.C. USA. view at publisher

Aregheore, E. M., & Perera, D. (2003). Dry matter, nutrient composition and palatability/acridity of eight exotic cultivars of cocoyams – taro (colocasia esculenta) in Samoa. *Plant Foods*

for Human Nutrition (Kluwer Academic Publishers), 58, 1 – 8. *view at Google scholar* / view at publisher

Bradbury, H., & Holloway, W. D. (1988). *Chemistry of Tropical Root Crops: Significance for Nutrition and Agriculture in the Pacific.* ACIAR Project, http://aciar.gov.au/search?terms=publications%20mn006.

Coetze, A. F., & Allenmann, J. (1996). *Amadhumbi: agricurtural research council.* Vegetable and Ornamental Plant Institute. Pretoria, South Africa.

Eze, C. C., & Okorji, E. C. (2003). Cocoyam production by women farmers under improved and local technologies in Imo state, Nigeria. *Journal of Science, 5*(1), 113-116. *view at Google scholar*

Hota, R., Jena, A. K., & Naranyana, K. L. (2016). Effects of inorganic and organic amendments on yield of cocoyam (Colocasia Esculenta), and on soil properties. *World Journal of Agricultural Research, 2*(2), 70 – 81. *view at Google scholar* / view at publisher

Karikari, S. K. (1976). *Preliminary evaluation of 14 Puerto Rican and six Ghanaian varieties of Cocoyam (Colocasia and Xanthosoma Spp) Under Ghanaian Conditions*. 5th International Symposium of Tropical Root and Tuber Crops, pp 615 – 621.

Kusena, K. (2002). *Case Study. Conservation and Sustainable use of Taro (Colocasia esculenta and Xanthosoma spp) in Makoni District*. Zimbabwe. *view at Google scholar*

Lewu, M. N, Adebola, P. O., & Afolayan. (2010). Comparative assessment of the nutritional value of commericially available cocoyam and potato tubers in South Africa. *Journal of Food Quality, 33*(4), 461 – 476. *view at Google scholar* / view at publisher

Mwenye, O. J., Labuschagne, M. T., Herselman, L., & Benesi, I. R. M. (2011). Mineral composition of Malawian cocoyam (Colocasia esculenta and Xanthosoma sagittifolium) genotypes. *Journal of Biological Sciences, 11*, 331–335. *view at Google scholar* / view at publisher

O'Hair, S. K. (1990). *Tropical root and tuber crops*. In: Janick J and Simon JE (eds.), Advances in new crops. Timber Press, Portland, pp.424-428. *view at Google scholar*

Okwuowulu, P. A., Asiegbu, J. E., & Nnado, W. F. (2002). Effect of row intercropping of cocoyam minisett on tuber/GARI yield and productivity in south eastern Nigeria. *Journal of Sustainable Agricultural and Environment, 2*, 214-225. *view at Google scholar*

Olaleye, L. D., Owolabi, B. J., Adesina, A. O., & Isiaka, A. A. (2013). Chemical composition of red and white cocoyam (*Colocosia esculenta*) Leaves. *International Journal of Science and Research, 2*(11), 121 – 126. *view at Google scholar*

Onwueme, I. C. (1994). *Tropical root and tuber crops – Production, perspective and future prospects*. FAO Plant Production and Protection Paper 126, FAO, Rome, Italy pp 228. *view at Google scholar*

Onyenweaku, C. E., & Okoye, B. C. (2007). Technical efficiency of smallholder cocoyam farmers in Anambara state, Nigeria: a translog stochastic production function approach. *International Journal of Agricultural and Rural Development, 9*(1), 535 - 541. *view at Google scholar*

Tumuhimbise, R., Talwana. H. L., Osiru, D. S. O., Serem, A. K., Ndabikunze, B. K., Nandi, J. O. M., & Palapala, V. (2009). Growth and development of wetland-grown taro under different plant populations and seedbed types in Uganda. *African Crop Science Journal, 17*(1), 49 – 60. *view at Google scholar* / view at publisher

Usman, M., Madu, V. U., & Alkali, G. (2015). The combined use of organic and inorganic fertilizers for improving maize crop productivity in Nigeria. *International Journal of Scienctific and Research Publications, 5*(10), 1 - 7. *view at Google scholar*

Wiesler, F., Gerendas, J., & Sattelmacher, B. (2002). Influence of mineral fertilizers on nutritional quality of staple foods crops. *Encyclopedia of Life Support Systems (EOLSS), 1*, 201 - 211. *view at Google scholar*