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Comparative Proximate Composition Study of Nine Varieties of Cocoyam (Araceae) grown in Port Harcourt, Rivers State

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Abstract

Cocoyam [*Colocasia esculenta* (L.) Schott] which belongs to the Araceae plant family is an important food crop especially in the tropics and subtropics. Its corms and leaves are eaten after cooking in the rural areas in Nigeria due to its numerous culinary applications and exceptional dietary value. However, the nutritional proximate composition of cocoyam grown in Port Harcourt, is not well known due to lack of scientific information concerning productions. This study is aimed at investigating the nutritional compositions of the nine varieties of cocoyam researched.In this study the Nine varieties (NXs001, NXs002, NXs003, NCe004, NCe005, NCe006, NCe007, NCe008, NCe009) of cocoyam corms were gotten from National Root Crops Research Institute (NRCRI) Jos, Nigeria and sown into polyethene bags field with 18kg loam soil at the rate of two corms per bag and allowed to grow for 6 months at the Research plot, Department of Plant Science and Biotechnology, Rivers State University, Rivers State. Watering and cultural practices were done at intervals when necessary. Proximate analysis of harvested corms for carbohydrate, moisture, ash, lipid, protein and crude fibre contents was carried out using standard laboratory techniques as described by Association of Analytical chemists (AOAC). The results revealed the presence of all constituents analysed for all nine varieties with protein content recording highest values (3.37±0.23) in NCe005 compared to other varieties with NCe004 recording the least value (1.69±0.41). Moisture content was highest (18.78±0.11) in NXs001, while lowest contents (12.49±0.06) was revealed in NXs008 when compared to other varieties. Highest (2.72±0.04) and lowest (1.11±0.06) values of ash content were recorded in NXs003 and NCe007 respectively. Crude fibre content was highest (4.47±0.17) in NCY008 and lowest (1.88±0.07) in NXs002 compared to other varieties. Fat content across all varieties revealed that NCe008 and NXs001 had highest (4.51±0.17) and lowest (1.86±0.02) values respectively. NCe007 and NCe006 revealed to have the highest (77.37±0.04) and lowest (70.72±0.00) values of carbohydrate content for all varieties studied. The high carbohydrate content and other proximate observed in this study indicates that cocoyam corms are a good source of nutritional energy and its consumption helps the body to utilize the necessary nutrients to combat malnutrition and promote food security in rural areas as increased productivity and therefore, should be included in diets to supplement our daily allowance needed by the body.

Keywords: Araceae, Cocoyam, Corms, Proximate analysis, Malnutrition

Introduction

Cocoyam [Colocasia esculenta (L.) Schott] is an important tropical root cropgrown purposely for its starchy corms or underground stem (Si *et al.*, 2018). It is an herbaceous perennial plant that constitute one of the six most important roots and tuber crops world-wide. It is regarded as oneof the most important staple crops in the Pacific Islands, Asia and Africa (Onyeka 2014). It is oneof the oldest world's food crops believed to have been first domesticated in SoutheastAsia before its eventual spread to other parts of the world (Ubalua *et al.*, 2016).

The two most commonlycultivated species of cocoyam (*Colocasia esculenta* and *Xanthosoma sagittifolium*) belong to the Araceae family and are extensively cultivated in Africa. About 1.4 million ha worldwide have been recorded to be cultivated with aroids yielding 8.3 million tonnes per year (FAO, 2008). China, Ghana, Nigeria, Burundi, Cóte d'Ivoire, Japan, Madagascar, Papua New Guinea, Philippines and Thailand are cocoyam producers in the world (FAOSTAT, 2021). Like many plants of the Araceae family, cocoyam grows from the fleshy corm (tuber) that can be boiled, baked or mashed into a meal and used as staple food or snack.

The corms supply easily digestible starch and are known to contain substantial amounts of protein, vitamin C, thiamine, riboflavin, niacin and significant amounts of dietary fiber (Niba, 2003). Leaves of cocoyam (*Colocasia*) are cooked and eaten as vegetable. They are reported to contain β-carotene, iron and folic acid, which protects against anaemia (FAO, 1990; Sukamoto, 2003), and are important source of proteins and vitamins. The main nutrient supplied by cocoyam, as with other roots and tubers, is dietary energy provided by the carbohydrates (Jirarat *et al.*, 2006).

Cocoyam flour can be used for the preparation of soups, biscuits, bread, beverages, and puddings. However, in spite of its importance as a staple food in many countries, cocoyam has received very little research attention to enhance itsproduction and utilization potentials (Watanabe, 2002; Ndabikunze *et al.*, 2011). Research and development of root and tuber crops in general, and cocoyam in particular, have been neglected because only 10% of the world populations, mainly leaving in the developing tropical countries, use root and tuber crops as staple foods.

Despite their nutritional composition, the potential for the development of value-added cocoyam products have not been investigated (Palapala *et al.*, 2005). Opportunities to promote and support the use of cocoyam can make a major contribution to the food security of countries in the cocoyam growing regions. It is for this reason the current study was aimed at investigating the proximate composition of Nine cocoyam varieties (NXs001, NXs002, NXs003, NCe004, NCe005, NCe006, NCe007, NCe008, NCe009) grown in Port Harcourt, Rivers State, Nigeria to explore the possibility of promoting their utilization withinthe partner countries.

Materials and Methods

Experimental Site

This study was conducted at the Research Plot, Department of Plant Science and Biotechnology, Rivers State University, Port Harcourt, Rivers State, Nigeria, which experiences tropical monsoon climate with a latitude and longitude of (4.804^{o}N and 6.980^{o}E) and an annual temperature range of 25^{o}C-27^{o}C, annual rainfall of 200.45mm and relative humidity of 78%-89%.

Soil Collection

Loam soil for the study was obtained from the Department of Plant Science and Biotechnology, Botanical Garden, Rivers State University, Port Harcourt, Rivers State, Nigeria. Twenty (20) kg of soil was sacked into a polythene bags.

Source of Plant Sample

Nine varieties of cocoyam corms were obtained from National Root Crops Research Institute (NRCRI), Jos, Plateau State, Nigeria.

Sowing of Corms

The corms were sown into polythene bags (55 x 49 x 49 cm) containing 20kg of loam soil at the rate of two corms per bag. Corms of equal sizes were selected for planting for uniformity and bases for comparative study.

Experimental Design

The corms planted in the polythene bags had nine varieties which was replicated six times and arranged in a Completely Randomized Design in the open field giving a sample size of 54 experimental units.

Cultural Practices

Watering of the plant was done at 2-days interval by applying one litre of water per experimental unit respectively; weeding and earthing of the plants were carried out when necessary.

Methods

Proximate Analysis

Carbohydrate Determination by ClegAnthrone Method

Plant sample of 0.1g was weighed into a 25mls volumetric flask, 1ml distilled water and 1.3mls of 62% perchloric acid was added and shaken for a period of 20mins to homogenize completely. The flask was made up to 25mls mark with distilled water and stopper. The solution formed was filtered through a filter paper or allowed to sediment and decanted. 1ml of the filtrate was collected and transferred into a 10ml test tube. This was diluted to volume with distilled water. 1ml of working solution was pipette into a clean test tube and 5mls Anthrone reagent was added. 1ml distilled water and 5mls Anthrone reagent was mixed. Similarly, and the whole mixture were read at 630nm wave length using the 1ml distilled water and 5mls Anthrone reagent prepared as blank. Glucose solution of 0.1ml was also prepared and was treated as the sample with Anthrone reagent. Absorbance of the standard glucose was read and the value of carbohydrate as glucose was calculated using the formula below.

Calculation

$$\% \text{ CHO as Glucose} = \frac{25 \quad x \quad \text{Absorbance of Sample}}{\text{Absorbance of Standard Glucose x 1 1}} \times \frac{100}{}$$

Moisture Determination by Air Oven Method

Plant sample of 1g was weighed into a clean dried porcelain evaporating dish. This was placed in an oven to maintain a temperature of 105^{o}C for six hours. The evaporating dish was cooled in desiccators to room temperature then it was re-weighed and recorded.

Calculation

$$\% \text{ Moisture} = \frac{\text{Weight of fresh sample – weight of dried sample x 100}}{\text{Weight of sample used}}$$

Ash Determination by Furnace Method

Dried plant sample of 1g was weighed into a porcelain crucible which was previously preheated and weighed. The crucible was inserted into a muffle furnace and regulated to a temperature of 630^{o}C for 3 hours and allowed to cool to room temperature and re-weighed.

Calculation

$$\% \text{ Ash} = \frac{\text{Weight of crucible + Ash sample – Weight of crucible x 100}}{\text{Weight of sample}}$$

Lipid Determination by Soxhlet Extraction Method

Plant sample of 2g was inserted into a filter paper and was placed into a soxhlet extractor. The extractor was placed into a pre-weighed dried distillation flask. Then the solvent (acetone) was introduced into the distillation flask via the condenser end attached to the soxhlet extractor. The set-up was held in place with a retort stand clamp. Cold water jet was allowed to flow into the condenser and the heated solvent was refluxed as a result, the lipid in the solvent chamber was extracted in the process of continuous refluxing. When the lipid was observably extracted completely from the sample under test, the condenser and the extractor was disconnected and the solvent was evaporated to concentrate the lipid. The flask was then dried in the air oven to constant weight and reweighed to obtain the weight of lipid.

Calculation

$$\% \text{ Lipid} = \frac{\text{Weight of flask and extract – Weight empty flask x 100}}{\text{Weight of sample extracted}}$$

Protein Determination by Kjeldahl Method

Stage 1: Digestion

Plant sample of 0.1g was weighed into a clean conical flask 250ml capacity and 3g of digestion catalyst was also added and heated to digest. The content changed from black to sky-blue coloration. The digest was cooled to room temperature and was diluted to 100ml with distilled water.

Stage 2: Distillation

Diluted digest of 20ml was measured into a distillation flask and the flask was held in a place on an electro-thermal heater or hot plate. The distillation flask was attached a Liebig condenser connected to a receiver containing 10mls of 2% boric acid indicator. 40ml of 40% Sodium hydroxide was injected into the digest via a syringe attached to the mono-arm steelhead until the digest became strongly alkaline. The mixture was heated to boil and the distilled ammonia gas via the condenser into the receiver beaker. The color of the boric acid changed from purple to greenish as ammonia distillate was introduced into the boric acid.

Stage 3: Titration

The distillate was titrated with standard 0.1N Hydrochloric acid solution back to purple from greenish. The volume of hydrochloric acid added to effect this change was recorded as titer value.

Calculation

$$\% \text{ Organic Nitrogen} = \frac{\text{titer value x 1.4 x 100 x 100}}{\text{1000 x 20 x 0.1}}$$

Where;

Titer value = the Volume of HCL used in titrating the ammonium distillate.

1.4 = Nitrogen equivalent to the normality of HCL used in titration 0.1N.

100 = Total volume digestion dilution.

100 = Percentage factor
1000 = Conversion factor from gram to milligram.
20 = Integral volume of digits analyzed or distilled.
0.1 = Weight of sample in gram digested.

Crude Fibre Determination

Crude fibre represents the insoluble and combustible organic residue which remains after a sample has been treated with light petroleum ether, dilute acid and alkali. It theoretically includes materials that are indigestible in human and animal system. 2gram of samples was extracted with petroleum ether and weighed as W1. The sample was boiled under reflux for 30mins with 200ml of dilute hydrochloric acid and filtered. The residue was properly washed with water until it became acid free. The residue was then transferred into a beaker and boiled for another 30mins with 200ml of dilute sodium hydroxide solution, filtered and transferred into ignited crucible. The residue was then washed 3 times with 20ml n ethanol and 2 times with 10mls ether. The residue was dried in an oven and cooled and cooled before weighing as W2. The dried residue was transferred into a furnace, ignited, cooled and weighed as W3

Calculation

$$\% \text{ Crude Fibre} = \frac{W2 - W3 \times 100}{W1}$$

Results

The results for proximate composition as shown in Table 1, revealed that all cocoyam varieties constitute varying values of protein, moisture, ash, crude fibre, fat and carbohydrate.For protein content, highest values (3.37±0.23 and 3.22±012) were recorded in NCY005 and NCY006 compared to other varieties with NCY004 recording the least value (1.69±0.41). Moisture content was highest (18.78±0.11 and 18.44±0.10) in NCY001 and NCY006 respectively, while lowest contents (12.49±0.06) was revealed in NCY008 when compared to other varieties. Highest (2.72±0.04) and lowest (1.11±0.06) values of ash content were recorded in NCY003 and NCY007 respectively. Crude fibre content was highest (4.47±0.17) in NCY008 and lowest (1.88±0.07) in NCY002 compared to other varieties. Fat content across all varieties revealed that NCY008 and NCY001 had highest (4.51±0.17) and lowest (1.86±0.02) values respectively. NCY007 and NCY006 revealed to have the highest (77.37±0.04) and lowest (70.72±0.00) values of carbohydrate content for all varieties studied. In general, NCY008 had highest proximate contents while lowest proximate content was recorded for NCY001 and NCY007.

Sample	Protein	Moisture	Ash	Crude fibre	Fat	Carbohydrate
NXe001	1.80±0.05^{d}	18.78±0.11^{a}	2.49±0.06^{b}	3.19±0.05bc	1.86±0.02^{h}	72.19±0.04^{g}
NXe002	2.86±0.01^{b}	16.26±0.11^{d}	2.27±0.04^{cd}	1.88±0.07e	2.47±0.01^{f}	74.43±0.03^{c}
NXe003	2.64±0.26^{bc}	15.69±0.16^{e}	2.72±0.23^{a}	2.620.35d	3.07±0.01^{d}	74.06±0.00^{d}
NCe004	1.69±0.41^{d}	16.77±0.04^{c}	1.90±0.02^{e}	2.58±0.28d	2.74±0.00^{e}	74.44±0.00^{bc}
NCe005	3.37±0.23^{a}	14.53±0.11^{g}	2.59±0.01^{ab}	3.40±0.03b	4.16±0.00^{b}	72.29±0.00^{f}
NCe006	3.22±0.12^{a}	18.44±0.10^{b}	1.59±0.08^{f}	3.28±0.01bc	3.04±0.00^{d}	70.72±0.00^{h}
NCe007	2.29±0.14^{c}	14.86±0.06^{f}	1.11±0.06^{g}	2.55±0.01d	2.13±0.05^{g}	77.37±0.04^{a}
NCe008	2.57±0.11^{bc}	12.49±0.06^{i}	2.28±0.03^{c}	4.47±0.17a	4.51±0.02^{a}	73.99±0.01^{e}
NCe009	2.33±0.07^{c}	14.34±0.10^{h}	2.11±0.10^{d}	3.06±0.07c	4.03±0.00^{c}	74.49±0.05^{b}
P value	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Significant Difference	Yes	Yes	Yes	Yes	Yes	Yes

Discussion

Root crops including cocoyam are very good sources of energy, fiber, calcium and vitamins. Root plants provide up to 24% of the energy required and 100% of vitamin C (Otekunrin *et al.,* 2021). Cocoyam is also a functional food and possesses bioactive chemicals which help maintain good health. Cocoyam corms are characterized by low protein and fat content, but high carbohydrate and mineral contents which corresponds with the results from this study. The ash content in cocoyam has been reported to range from o.6 to 2.6% (Otekunrin *et al.,* 2021) which agrees with the results of this study.

The nutritional composition of cocoyam tubers varies significantly depending on the genotype, environment and the relationship between these two factors as observed in this current study (Lebot 2009; Sharma *et al.,* 2020). This current study is similar to the reports of Englberger *et al.,* (2003) who reported that the ranges of proximate values correspond to the values recorded in this research. Cocoyam is reported to have a low dry matter content and thus high moisture content, accounting for two-third of the total fresh root weight (FAO 2004; FAO 2006).

The diversity of the dry matter of varieties correlates to the results of (Lebot *et al.,* 2004). However, the differences across the varieties were not much and may have been caused by differences in the size of the corms. Several authors have attributed the high moisture content of cocoyam to be the cause of early spoilage of the corms (Huang *et al.,* 2007; Ndabikunze *et al.,* 2011; Acheampong *et al.,* 2015). Ahmed and Khan (2013) reported that cocoyam corms have about 70-80% carbohydrate/starch which corresponds to the results gotten from this study. Oladebeye *et al.,* (2008) reported that starch contents vary on the variety hence the observable differences in the results of this current research.

Cocoyam starch is considered to be easily digestible and is therefore widely used in infants' foods and in diets of gluten-allergic and lactose-sensitive children (Ahmed and Khan, 2013). Cocoyam starch is an easily digestible starch because fine and starch grains have hypoallergenic properties (low susceptibility to allergy) and gluten free. Consumption of the corms have also been reported to be good for patients with peptic ulcer, pancreatic diseases, chronic liver problem, inflammatory bowel diseases and gallbladder (Lebot *et al.,* 2011).

The results for proximate contents are in consonance with the reports of similar studies by Sefe-Dedeh and Agyir-Sackey (2002) and Ukom and Okerue (2018). Our findings also align with those reported by Olaleye *et al.,* (2013). The ash content and moisture reported by Alinnor and Akalezi (2010) in *Colocasia esculenta* is similar to the current findings. The results of this study also conform with the results of Acheampong *et al.,* (2015). The reports of Soudy *et al.,* (2016); Rashmi *et al.,* (2018); Boakye *et al.,* (2018); Palapala and Nandi (2011) also agrees with the results of the current study though with little variations in the values of parameters studied.

Cocoyam has been reported to contain approximately 11% protein in its corms. This is more than the protein content of yam, cassava and sweet potato (Otekunrin *et al.,* 2021). The reports revealed that protein content in this study is in correlation to the studies of Lucy *et al.,* (2004); Njintang *et al.,* (2008); Temesgen and Ratta (2021) as they reported similar corresponding values in their work respectively. The protein fraction of cocoyam corms is reported to be rich in essential amino acids such as threonine, leucine, arginine, valine and phenylalanine (Otekunrin *et al.,* 2021). FAO (2018) attributed that the abundance of protein

in cocoyam as against other root crop is due to the presence of symbiotic soil bacteria in its roots and rhizome parts (Setyanwan *et al.*, 2021).

Lipid (Fat) content is very low as compared to the reports of Otekunrin *et al.*, (2021), but in correspondence to the reports of FAO (2018) as the values corresponds to those reported although with variability amongst varieties. Crude fibre of the current study is in line with the results of Rashmi *et al.*, (2018), similar reports by Agbelemoge (2013) corresponds to the findings of this study as they also stated that cocoyam contains dietary fibre making it a tuber crop with desirable functional properties, which includes facilitating nutrition, helping in micro-supply of components and glucose metabolism, slowing down the process of absorption of undesirable dietary components such as cholesterol (Njintang *et al.*, 2008), they also shorten intestinal transit time, reduce postprandial glucose levels and insulin in the blood, acts as a buffer and reduces excessive acid secretion in the stomach, prevents constipation (Biziuk and Kuczyaka, 2006), increases water absorption of food, increases food stability by modifying the structure and density of food, giving it texture and ability to thicken food (Ferdaus *et al.*, 2023).

Conclusion

The results from current study reveals that cocoyam is nutritionally rich in carbohydrates and other proximate parameters observed.However, its composition varies according to the variety and country of origin. The results indicates that cocoyam corms are a good source of nutritional energy and its consumption helps the body to utilize the necessary nutrients to combat malnutrition and have potential to offer tangible contribution towards food shortage alleviation by promoting the production and consumption of cocoyam in rural areas.

References

Acheampong, P., Osei-Adu, J., Amengo, E., & Sagoe, R. (2015). Cocoyam value chain and benchmark study in Ghana. CSIR.

Agbelemoge, A. (2013). Utilization of cocoyam in rural households in South Western Nigeria. *African Journal of Food, Agriculture, Nutrition and Development*, 13(4), 7944–7956.

Ahmed, A., & Khan, F. (2013). Extraction of starch from taro (*Colocasia esculenta*) and evaluating it and further using taro starch as disintegrating agent in tablet formulation with over all evaluation. *Inventi Rapid: Novel Excipients*, 2, 1–5.

Alinnor, I. J., &Akalezi, C. O. (2010). Proximate and mineral compositions of *Dioscorea rotundata* (white yam) and *Colocasia esculenta* (white cocoyam). *Pakistan Journal of Nutrition*, 9(10), 998–1001.

Biziuk, M., & Kuczynska, J. (2006). Mineral components in food—Analytical implication. In Mineral compoo;/nents in foods (Chemical and Functional Properties of Food Components Series, pp. 1–31). CRC Press.

Boakye, A. A., Wireko-Manu, F. D., Oduro, I., Ellis, W. O., Gudjónsdóttir, M., & Chronakis, I. O. (2018). Utilizing cocoyam (*Xanthosoma sagittifolium*) for food and nutrition security: A review. *Food Science & Nutrition*, 6(4), 703–713. https://doi.org/10.1002/fsn3.602

Englberger, L., Aalbersberg, W., Ravi, P., Bonnin, E., Marks, G. C., Fitzgerald, M. H., &Elymore, J. (2003). Further analyses on Micronesian banana, taro, breadfruit and other foods for provitamin A carotenoids and minerals. *Journal of Food Composition and Analysis*, 16(2), 219–236.

Food and Agriculture Organization of the United Nations. (1990). Roots, tubers, plantains and bananas in human nutrition: Effect of processing on nutritive values. FAO.

Food and Agriculture Organization of the United Nations. (2004). Protein sources for the animal feed industry (Animal Production and Health). Expert Consultation and Workshop, Bangkok, Thailand.

Food and Agriculture Organization of the United Nations. (2008). Importance of taro. http://www.fao.org/docrep/005/AC450e

Food and Agriculture Organization of the United Nations. (2021). FAOSTAT statistical database. http://www.fao.org/statistics/en/

Ferdaus, M. J., Chukwu-Munsen, E., Foguel, A., & da Silva, R. C. (2023). Taro roots: An underexploited root crop. Nutrients, 15(15), 3337.

Huang, C.-C., Chen, W.-C., & Wang, C.-C. (2007). Comparison of Taiwan paddy- and upland-cultivated taro (*Colocasia esculenta* L.) cultivars for nutritive values. *Food Chemistry*, 102(1), 250–256. https://doi.org/10.1016/j.foodchem.2006.04.044

Jirarat, T., Sukruedee, A., &Pasawadee, P. (2006). Chemical and physical properties of flour extracted from taro *Colocasia esculenta* (L.) Schott grown in different regions of Thailand. *ScienceAsia*, 32, 279–284.

Lebot, V. (2009). Tropical root and tuber crops: Cassava, sweet potato, yams and aroids. CABI.

Lebot, V., & Lawac, F. (2017). Quantitative comparison of individual sugars in cultivars and hybrids of taro [*Colocasia esculenta* (L.) Schott]: Implications for breeding programs. *Euphytica*, 213, 147.

Lebot, V., & Legendre, L. (2015). HPTLC screening of taro hybrids (*Colocasia esculenta* (L.) Schott) with high flavonoids and antioxidants contents. *Plant Breeding*, 134(1), 129–134.

Lebot, V., Malapa, R., & Bourrieau, M. (2011). Rapid estimation of taro (*Colocasia esculenta*) quality by near-infrared reflectance spectroscopy. *Journal of Agricultural and Food Chemistry*, 59(17), 9327–9334.

Lebot, V., Prana, M. S., Kreike, N., van Eck, H. J., Pardales, J., Okpul, T., Gunua, T., Thongjiem, T. M., Hue, H., Viet, N., et al. (2004). Characterization of the genetic resources of taro (*Colocasia esculenta* (L.) Schott) in Southeast Asia and Oceania. *Genetic Resources and Crop Evolution*, 51(4), 381–392.

Lucy, M., Reed, E., & Glick, B. R. (2004). Use of free growth in living plants-promoting rhizobacteria. *Antonie van Leeuwenhoek*, 86(1), 1–25.

Ndabikunze, B. K., Talwana, H. A. L., Mongi, R. J., Issa-Zacharia, A., Serem, A. K., Palapala, V., & Nandi, J. O. M. (2011). Proximate and mineral composition of cocoyam (*Colocasia esculenta* L. and *Xanthosoma sagittifolium* L.) grown along the Lake Victoria Basin in Tanzania and Uganda. *African Journal of Food Science*, 5(4), 248–254.

Niba, L. L. (2003). Processing effects on susceptibility of starch to digestion in some dietary starch sources. *International Journal of Food Sciences and Nutrition*, 54(2), 97–109.

Njintang, Y., Mbofung, F., Balaam, F., Kitissou, P., & Scher, J. (2008). Effect of taro (*Colocasia esculenta* (L.) Schott) addition on functional flour and alveographic properties of flour and wheat dough. *Journal of the Science of Food and Agriculture*, 88(2), 273–279.

Oladebeye, A. O., Oshodi, A. A., & Oladebeye, A. A. (2008). Proceedings of the International Conference of the Chemical Society of Nigeria.

Olaleye, L. D., Owolabi, B. J., Adesina, A. O., & Isiaka, A. A. (2013). Composition of red and white cocoyam (*Colocasia esculenta*) leaves. *International Journal of Science and Research*, 2(11), 121–126.

Onyeka, J. (2014). Status of cocoyam (*Colocasia esculenta* and *Xanthosoma spp*) in West and Central Africa: Production, household importance and the threat from leaf blight. CGIAR Research Program on Roots, Tubers and Bananas (RTB). www.rtb.cgiar.org

Otekunrin, O. A., Fasina, F. O., Omotayo, O. A., Otekunrin, O. A., & Akram, M. (2021). COVID-19 in Nigeria: Why continuous spike in cases?*Asian Pacific Journal of Tropical Medicine*, 14(1), 1–4.

Otekunrin, O. A., &Otekunrin, O. A. (2021). Healthy and sustainable diets: Implications for achieving SDG2. In Zero hunger. Encyclopedia of the UN Sustainable Development Goals (pp. 1–17). *Springer.* https://doi.org/10.1007/978-3-319-69626-3_123-1

Otekunrin, O. A., Otekunrin, O. A., Momoh, S., & Ayinde, I. A. (2019). How far has Africa gone in achieving the Zero Hunger Target? Evidence from Nigeria. *Global Food Security*, 22, 1–12.

Otekunrin, O. A., Otekunrin, O. A., Sawicka, B., & Ayinde, I. A. (2020). Three decades of fighting against hunger in Africa: Progress, challenges and opportunities. *World Nutrition*, 11(3), 86–111.

Otekunrin, O. A., & Sawicka, B. (2019). Cassava, a 21st century staple crop: How can Nigeria harness its enormous trade potentials. *Acta Scientific Agriculture*, 3(8), 194–202.

Palapala, V., Talwana, H., Nandi, J. O. M., Sereme, A. K., & Ndabikunze, B. K. (2005). Evaluation of prospects and constraints to sustainable cocoyam (*Colocasia esculenta*) production in Lake Victoria crescent [Project report].

Rashmi, D. R., Raghu, N., Gopenath, T. S., Pradeep, P., Bakthavatchalam, P., Karthikeyan, M., Gnanasekaran, A., Ranjith, M. S., Chandrashekrappa, G. K., & Basalingappa, K. B. (n.d.). Taro (*Colocasia esculenta*): An overview. *Journal of Medicinal Plants*.

Sefa-Dedeh, S., & Sackey, E. K. (2002). Starch structure and some properties of cocoyam (*Xanthosoma sagittifolium* and *Colocasia esculenta*). *Food Chemistry*, 79(4), 435–444.

Setyawan, H. B., Yulianto, R., Zelin, O., & Purnamasari, L. (2021). Potential of three taro (Colocasia esculenta L.) cultivars as animal feed. *ASEAN Journal on Science and Technology for Development*, 38(3), 97–102. https://doi.org/10.29037/ajstd.716

Sharma, S., Jan, R., Kaur, R., & Riar, C. S. (2020). Taro (*Colocasia esculenta*). In G. A. Nayik& A. Gull (Eds.), Antioxidants in vegetables and nuts—Properties and health benefits. Springer.

Si, H., Zhang, N., Tang, X., Yang, J., Wen, Y., Wang, L., & Zhou, X. (2018). Transgenic research in tuber and root crops. *In Genetic engineering of horticultural crops* (pp. 225–248).

Soudy, I. D., Delatour, P., & Grancher, D. (2016). Effects of traditional soaking on the nutritional profile of taro flour (*Colocasia esculenta* L. Schott) produced in Chad. *Revue de Médecine Vétérinaire*, 161(1), 37–42.

Sukamoto, L. A. (2003). Development of early maturing and leaf blight resistant cocoyam (*Colocasia esculenta* (L.) Schott) with improved taste. In Proceedings of a final research coordination meeting organized by the joint FAO/IAEA division of nuclear techniques in food and agriculture (pp. 19–23). Pretoria, South Africa.

Temesgen, M., & Ratta, M. (n.d.). Nutritional potential, health and food security benefits of taro Colocasia esculenta (L.): A review. https://www.researchgate.net/publication/318562639_Nutritional_potential_Health_and_Food_Security_Benefits_of_Taro_Colocasia_esculenta_L_A_Review

Ubalua, A. O., Ewa, F., & Okeagu, O. D. (2016). Potentials and challenges of sustainable taro (*Colocasia esculenta*) production in Nigeria. *Journal of Applied Biology & Biotechnology*, 4(4), 053–059.

Ukom, A. N., & Okerue, C. F. L. (2018). Determination of the nutrients, anti-nutrients and functional properties of processed cocoyam (*Xanthosoma sagittifolium*) cultivars grown in Southeast, Nigeria. *Sustainable Food Production*, 1, 11–21.

Watanabe, K. Z. (2002). Challenges in biotechnology for abiotic stress tolerance on root and tubers. *JIRCAS Working Reports*, 75–83.