

Review Article

Health values of cassava compared to wheat and yam in relation to diabetes and dyslipidaemia management

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Received: 15 November 2019

Revised: 03 January 2020

Accepted: 04 January 2020

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ABSTRACT

The objective of the study was to evaluate how diabetes and dyslipidaemia can be managed by increasing the consumption of root and tuber crops such as cassava and yam. Journal literatures based on research reports as well as institutional publications and databases on nutritional values of various foods were reviewed. Critical reviews were also performed to synthesize a comparison between the various foods, especially in terms of their fibre values. The critical review shows that guidelines devoted six pages to protein-energy malnutrition and another seven pages on micronutrients. However, there is no mention of the dietary fibre values of the staple root and tuber food crops. From the narrative review, previous report showed that carbohydrate or fibre and fat or fibre ratios are negligible in the raw products, but highest in wheat flour and higher in yam relative to cassava flour. A further comparative review in terms of proximate analysis of the foods elaborates that unprocessed wheat is high in crude protein, carbohydrate and fibre. Thus, the extent or nature of processing is a key factor. Whether wheat has better health value over root and tuber crops has neither being expatiated, nor cassava and yam acknowledged as having any medical value relative to wheat. Since fat is pro-obesity and pro-diabetic while fibre is anti-dyslipidaemic; the foods based on processed wheat flour may possess the least pharmacological values relative to the indigenous carbohydrate food crops. This report provides indication of medical nutrition therapy potentials of indigenous carbohydrate food crops in Delta state of Nigeria.

Keywords: Dietary fibre, Root and tuber crops, Medicinal plants, Medical nutrition therapy

INTRODUCTION

Plants are major group of life forms, they include trees, herbs, bushes, grasses, vines, ferns, mosses and green algae. The benefits of plants to humans are essentially infinite. Humans have been utilizing plant materials for years in form of food additives, food preservatives and medicine which could be used to treat health disorders or to prevent and manage diseases.¹ Majority of the drugs manufactured by pharmaceutical companies are from materials naturally gotten from plants hence, plants origin remain the most important sources of new drugs.² There are twenty thousand known secondary plant metabolites

which play a significant role as organic compounds that are often used for medicinal purposes to fight infections and diseases.³ Plant extract as well as their primary and secondary metabolites play significant therapeutic role in many human disease. Secondary plant metabolites are compounds which are not essential for plants growth and reproduction but rather through interaction with their environment, enhance plant prospect of survival. People have been appreciating materials obtained from plants for years now for the treatment and management of different types of diseases in all continents especially in Africa.³ Medicinal plants have been tested and have been found to be safe in the management of many diseases, but the

extent of their preparation and prescription within conventional medicine varies greatly between nations.^{4,5} Although they have been remarkable breakthroughs recorded by the use of synthetic drugs, majority of prescribed drugs in industrialized countries are derived entirely or partly from plant materials due to their numerous biological activities, safety and cheaper.⁶

In developing countries, plant play a prominent role in health care systems especially in Africa where modern health care is very expensive and unaffordable for the poor.⁷ The acceptability of medicinal plants for treatment of many diseases has been on the increase, creating a platform for the production of many drugs of plant origin. Among the numerous successes recorded in using medicinal plants to treat diseases can be seen in the discovery of quinine and quinidine.⁸ The acceptability of medicine with plant origin has created a new expanding market as ‘herbal components of health foods and preventive medicine’ under “nutraceuticals” or “nutriceuticals”.⁹ The term nutraceutical was coined by Stephen De Felice in 1998 meaning ‘food, or parts of food which provide medicinal or health benefits, as well as the prevention and treatment of disease’. Africa is highly endowed with numerous medicinal plants, having not less than 30,000 medicinal plants with various medicinal values.¹⁰

Market for medicinal plants- the health economics

A call was made in 1996 by World Health Organization (WHO) advising that developing countries should endeavor to develop and utilize local medications that are most appropriate to their local circumstances especially for primary health. The reason for the advice was due to huge cost associated with incessant drug importation. In 2002 WHO reported an increase in global utilization of medicinal plants for the treatment of many diseases. Many people are now accepting to be treated of their respective illnesses with herbs. There is a continuous increase in demand for medicinal plants throughout the globe. The world market for plant derived materials such as; pharmaceuticals, fragrances, flavours and colour ingredients recently exceeds several billion dollars per annum.⁴ The increase may be attributed to the population increase of humans and inadequate modern health facilities in the developing countries.¹¹

The marketed medicinal plants are in form of health foods, food supplements, herbal tea, and other forms related to health and personal care. In 1999 the global market for medicinal plant material was calculated to worth US\$ 19.4 billion; the distributions is shown in Figure 1.¹¹ A report from the Secretariat of the convention on Biological diversity stated that the global sales of herbal products amounted to an estimated sum of US\$60,000 million in 2000, an indication that there is a steady shift from the consumption of synthetic drugs to medicinal plants products.¹²

Billion US\$

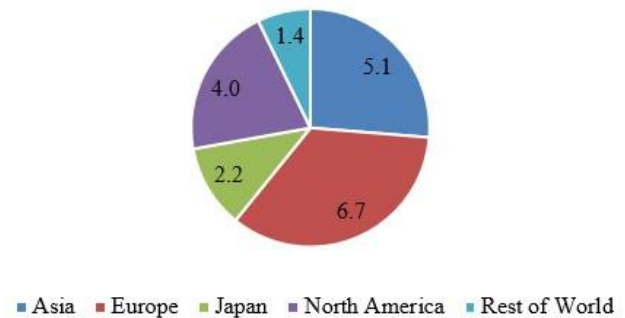


Figure 1: Distribution of retail sales of medicinal plants in the world.¹¹

METHODS

This review adopted both critical and narrative approaches. Firstly, the food based dietary guidelines for Nigeria; being the primary site of research was utilized. In addition, two databases including Australia’s AusNet and America’s USDA on nutritional values of various foods were reviewed. Critical reviews were performed to synthesize a comparison between the various foods, especially in terms of their fibre values.

RESULTS

Critical review of food based dietary guidelines for Nigeria

The guidelines have methodically separated different disease conditions, especially the metabolic syndrome components. Various age groups were excellently stratified for their age-specific nutritional requirements. Delineations between foods that should be eaten or discouraged were clear. However, some confusion could be seen in the recommendations (Table 1). In the context of this review, two points of confusion are worthy of note:

- Diabetes patients are discouraged from eating cassava and yam while still allowed for obesity patients. This is evidence that the benefits of dietary fibre in cassava and yam have yet to be appreciated
- Roots and tubers for obesity include cassava as separate from cassava flour. This is confusing, because the common processed product, garri, is a flour but different from the high quality cassava flour used for baking.¹³

Further, the guidelines devoted six pages to protein-energy malnutrition and another seven pages on micronutrients. It is acknowledged that root and tuber food crops are the main source of energy in majority of Nigerian diet. Yet, there is no mention of dietary fibre.¹⁴ It is known that increased dietary fibre intake is recommended for the elderly in national dietary

guidelines and food guide pyramid.¹⁵ While the absence of such recommendation of dietary fibre in the Nigerian guideline may be a reflection that 'dietary fibre malnutrition' is not a problem in Nigeria, the possibility of this healthy scenario being due to the staple root and tuber food crops needs to be speculated.

Table 1: Foods encouraged or discouraged for diabetes and cardiovascular disease patients in Nigerian diets.¹⁴

Conditions	Foods that are encouraged	Foods that are discouraged
Diabetes mellitus	Whole grain: e.g. maize, Roots/tubers: e.g. water yam	Cassava, yam, highly refined flour
Dyslipidaemia*	Cassava, yam, whole wheat	Refined foods: e.g. semovita, baking flour, spaghetti, etc.
Obesity	Roots/tubers: e.g. cassava, yam, etc.	Refined products: e.g. cassava, wheat and yam flours

*One of cardiovascular diseases.

Study had shown that consumption of West African naturally-occurring dietary fibre is associated with hypolipidaemic activities, reduction in plasma low-density lipoproteins, very low-density lipoproteins cholesterol and triglycerides levels as well as decrease in blood glucose and increase in high-density lipoproteins cholesterol.¹⁶ What this review highlights is that the fibre content of the staple root and tuber crops being cassava and yam have yet to be appreciated or integrated in national guidelines. Even the studies that compiled antidiabetic plants have yet to include root and tuber crops, except taro.^{17,18}

The narrative review

Investigations have revealed that medicinal plants have the potentials to play the key role towards WHO goal in ensuring a sustainable socioeconomic and productive life for all people by the year 2000 and beyond.⁴ Many people are becoming interested in promoting the potentials of indigenous plant foods in developing countries and utilizing them into modern health system, this shift is as a result of high cost of Medicare and side effect of therapeutic drugs.⁹ The utilization of plant food for therapeutic purposes can be seen as the biggest regard for natural flora which provides bio-active materials that have medicinal values.¹⁹

It is believed that Nigerian flora would continue to make great contributions towards the alleviation of health status and wellness of Nigerians.²⁰ Although many therapeutic synthetic drugs are mainly used as medicine in health care management but majority of them exhibits some side

effects, this prompted a search for an alternative in the plant kingdom for components that are of less severe or even no side effect.^{21,22} Research reports suggested that the collections of bioactive materials in the medicinal plants may act in relation to produce a glycemic control through interference with one or more processes involved in glucose metabolism and homeostasis.²² The survey carried out on many medicinal plants revealed that the polysaccharides, sterols, terpenoids, alkaloids, saponins, flavonoids, amino acids and their derivatives are the most encountered bioactive principles that exhibit glycemic control on experimental animals.²²

Ease of availability, least side effect and low cost make the herbal preparation the main key player of all available therapies especially in the rural areas.²³ Right from the beginning of civilization, alkaloids have been of great interest to humans because of their pronounced physiological and medicinal properties. Alkaloids are natural, organic substances that are predominantly found in plants. They are active components of numerous medicinal plants or plant-derived drugs as well as poisons; their structural diversity and different physiological activities are unmatched by any other group of natural products.²⁴ Alkaloid-containing plant extracts have been used in all cultures as potions, medicines, and poisons. They are predominantly found on plants particular organs such as barks, roots, leaves and fruits.²⁴ The primary benefits of using plant alkaloids as medicines are because they are relatively safer than synthetic alternatives, offering profound therapeutic benefits and are more affordable. Majority of the root and tuber crops consumed in Nigeria especially cassava and yam contain alkaloids and fibre.²⁵ The presence of alkaloids, flavonoids, tannins, cardiac glycosides, anthraquinone, phlobatinnins, saponins and anthrocyanosides in aqueous and ethanolic extracts of raw tubers and cassava has been confirmed.²⁶

Focus on cassava

Cassava (*Manihot esculenta* Crantz) is a woody shrub of the Euphorbiaceae (spurge) family was said to have originated from Latin America but was brought into Africa by the Portuguese in the sixteen century.²⁷ It is extensively cultivated as an annual crop in the tropical and subtropical regions for its edible starchy tuberous root.²⁸ Due to low input requirement for cassava production, the income generated from the crop after sales has placed the crop on the scale of priority more than any other staple crops cultivated in Nigeria.²⁸ Currently, Nigeria is the largest producer of cassava in the world with an annual output of over 34 million tons of tuberous roots, the output from cassava as well as other roots and tubers can be shown in Figure 1.^{29,30}

Cultivation of cassava is recorded throughout the tropics and is regarded as the most important root crop in relation to its cultivated area and total staple food production.²⁹ Cassava grows almost in all states and thrives in all agro-

ecological zones in Nigeria.³¹ The total harvest of the crop in 2012 was 3.85 million hectare with an average yield 14 ton per ha.³² Within the agricultural sector, cassava is regarded as the major food crop cultivated in Nigeria because it requires minimum inputs and labour.³³ The common processed cassava products in Nigeria includes; garri, akpu, tapioca, starch, chips, and flour. As a food crop, cassava fits well into the farming of smallholder farmers in Nigeria because it is available all year, thus providing household food security. Cassava provides food and income to over 30 million farmers and large number of processors and traders who are involved in different stages in its various activities.

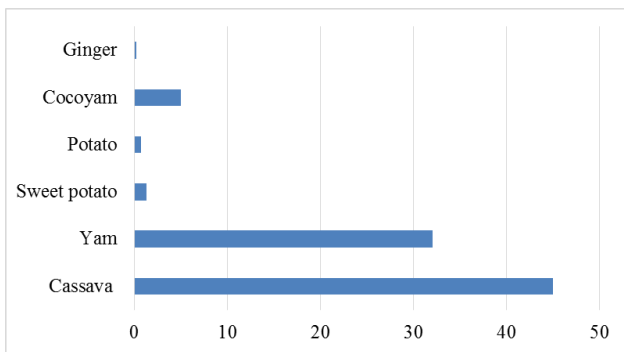


Figure 1: Nigeria's annual production of root and tuber crops (MMT).³⁰

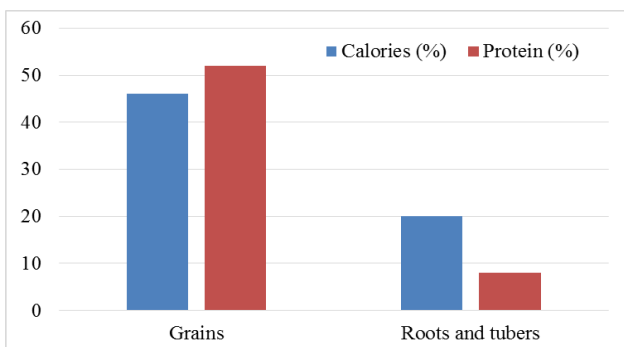


Figure 2: Major food crops consumed in Nigeria.³⁵

Cassava play a vital role in food security, poverty alleviation and source of raw materials for agro-allied industries in Nigeria with huge foreign exchange earned from its export, these attributes of cassava made it to be highly valued.³⁴ There have been recorded increase in the past 20 years in the area cultivated and yield per hectare, this is due to the continuous transformation on cassava from famine community staple crop to a cash crop in Nigeria.²⁸ Cassava is Nigeria's second most important food staple in terms of per capita calories consumed providing carbohydrate for majority of Nigerians, more than 200 million people in the tropics and for over 800 million people in the world. Published data obtained from the literature review,³⁵ shows the major food crops consumed in Nigeria with grains maintaining the lead in the area of calories and protein production due to the

neglect of indigenous crops which are mainly root and tuber crops in favour of grains (Figure 2).³⁵

The consumption of cassava products touches all parts of the country, it is a major source of calorie for roughly two out of every five Nigerians, in some household cassava is consumed daily and sometimes more than once a day.³⁶ Studies have shown that cassava has the potentials to industrialize Nigeria more than any other crop if its potentials are properly harnessed, about US\$5 billion per annum can be realized from cassava and its by-products hence, increasing foreign exchange earnings and employment opportunities.³⁴ The general acceptance of cassava products to all classes of Nigerians draw close attention to the various actors who play major role in making cassava value added products available to the consumers.²⁸

Focus on yam

Yam belongs to the genus *Dioscorea* in the family Dioscoreaceae. Yams family is recognized to be among the earliest angiosperms and probably originated from Southeast Asia. Generally, yams have up to 600 species but only few have economic importance, they include: white yam (*Dioscorea rotundata*), yellow yam (*D. cayenensis*), water yam (*D. alata*), trifoliolate yam (*D. dumetorum*) and Chinese yam (*D. esculenta*).³⁷

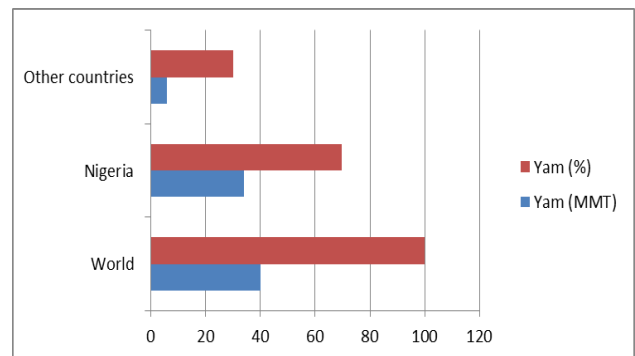


Figure 3: Global production in MMT of yam.

The yam species that have their origin in Africa are *D. rotundata* and *D. cayenensis* but the leading specie in terms of total area of production globally is *D. rotundata*.³⁷ Yam is a valuable source of carbohydrate for people mainly of the tropical and sub-tropical Africa, central and southern America, parts of Asia, the Caribbean and the pacific island. In Africa yam is the second most important root crop after cassava, sub-Saharan Africa accounts for 95% (2.8 million ha) of the entire global area under yam cultivation with a mean gross yield of 10t/ha.³⁸ The total world production of yam had been estimated as 40 million tons per year while Nigeria as the highest producer account for 34 million tons estimated as 69.8% of the entire global production as shown in Figure 3.³⁹

In Nigeria yam is a very important crop which plays a major role in ensuring food security and poverty reduction. The average consumption rate of yam in Nigeria is estimated in the range of 0.5 to 1 kg per person per day.⁴⁰ The main nutritional value of yam is carbohydrate, providing energy in the amount ranging between 80 to 120 kcal per 100 g. Depending on the yam variety, the moisture content of fresh tuber ranges between 58 to 80%, ash between 0.5 to 1.2%, carbohydrate between 17.5 to 28%, crude protein between 1.5 to 6%, fat between 0.1 to 0.2% and fibre between 0.6 to 1.5% respectively.⁴⁰ Like cassava yam contains toxic molecule discorene but can be made harmless through processing. The common processed products from yam in Nigeria are flour, chips, pellets and starch.

Comparison of wheat with cassava and yam

In a previously published critical analysis, it was reported that carbohydrate or fibre and fat or fibre ratios are negligible in the raw products, but highest in wheat flour and higher in yam relative to cassava flour.⁴¹ That is, evidence has been presented that, all things being equal, cassava flour may contribute the least fat and most fibres while yam flour follows. It was concluded that since fat is pro-obesity and pro-diabetic, while fibre is anti-dyslipidaemic; wheat may possess the least pharmacological values relative to the indigenous carbohydrate food crops of Delta State Nigeria.⁴²

Additional comparative review in terms of proximate analysis of the foods in Figure 4 elaborates that, unprocessed wheat is high in crude protein, carbohydrate and fibre. Studies have confirmed that most of the essential elements such as; fibre, vitamins and minerals are lost in refined products hence, refining decreases the content of almost all the elements in wheat flour.⁴³ In the case of root and tuber crops such as cassava and yams, processing is very essential to reduce the moisture contents in them and hence increase their shelf life.

Culture and its impact on diet

Culture influences the type of food consumed by a particular set of people and the processes the food pass through before it is finally consumed. Traditional food can be said to mean all foods from a culture, which is available from local sources and is culturally accepted as appropriate and desirable foods.⁴⁴ These traditional foods are often used in sciences as basis for ensuring and optimizing the utilization of indigenous foods and their health benefits by individuals, households and communities.⁹ Recently, some traditional foods such as root/tuber crops have been discovered to be of great importance in the management of diabetes globally and have been used empirically in anti-diabetic and anti-hyperlipidaemic remedies.⁴⁵ These food crops have been confirmed to contain glycosides, alkaloids, terpenoids, flavonoids, carotenoids, etc. which are acknowledged as having anti-diabetic properties.⁴⁵ The Food and Nutritional Research Institute has performed a short-term investigation on the glycemic index and cholesterol-lowering effect of root crops and discovered that all root crops are low in glycemic index ($GI \leq 55$) meaning that they are potentially hypocholesterolemic foods.⁴⁶ Root and tuber crops have potential health benefits in the prevention for the risk of chronic diseases such as cardiovascular diseases and diabetes mellitus. The anti-hyperglycemic activity of these materials in root crops are seen in their ability to restore the function of pancreatic tissues by causing an increase in insulin output or inhibit the intestinal absorption of glucose or to the facilitation of metabolites in insulin dependent processes.⁴⁵

Focus on diabetes mellitus

Diabetes mellitus is a metabolic disorder that affects the way the body handles basic food components like carbohydrates, protein and fats. This is mostly due to lack or abnormality in action or effect of the hormone insulin. Globally, there are different prevalent levels varying from country to country, race and ethnic groups. The International Diabetes Federation (IDF) in its recent publication came up with prevalence and incidence values around different regions and countries of the World. They reported that about 415 million people have diabetes in the world while 1.56 million cases of diabetes are reported in Nigeria.⁴⁷ The progressive increase in the prevalence rates of diabetes is associated with lifestyle

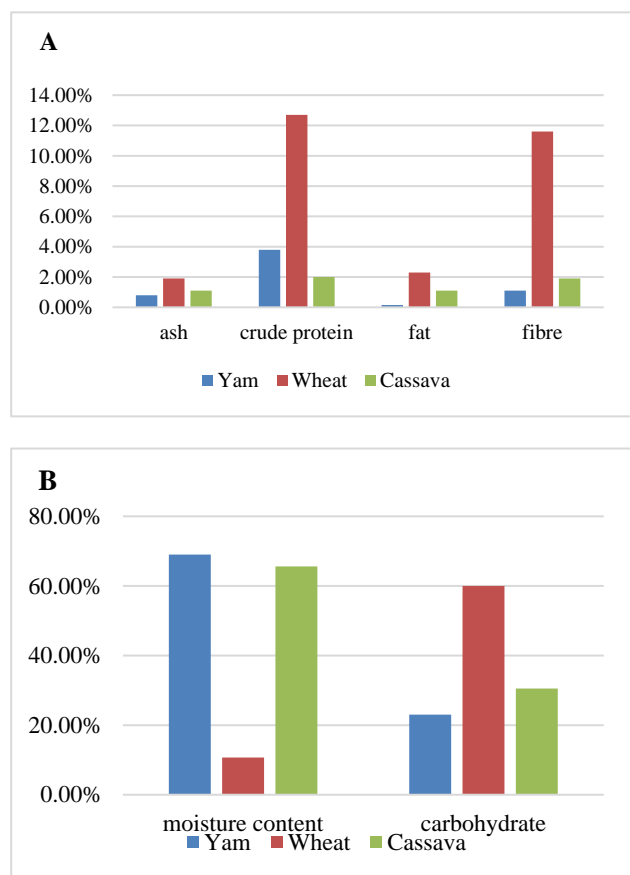


Figure 4 (A and B): Proximate analysis.^{35,40}

changes; overweight and obesity, physical inactivity, alcohol consumption, dietary changes and cigarette smoking.⁴⁸ Much attention is being given even recently to Communicable diseases like HIV, Tuberculosis and Malaria at the detriment of the emerging epidemic of Non-Communicable disease like Diabetes, hypertension and heart disease.⁴⁹ Importantly, majority of Nigerian diabetic population cannot afford meaningful treatment; and over 80% of the healthy populations are ignorant about diabetes due to lack of adequate information.⁹ Scarcity of health resources, prohibitive cost of drugs and their non-availability, sale of counterfeit drugs are the major factors that militate against the effective management of diabetes in Nigeria.⁴⁹

Among patients who can afford the drugs, poly-therapy with two or more hypoglycemic agents to achieve better glucose control is common practice in Nigeria and this is said to give rise to high incidence of diabetic complications and hyperglycemic emergencies.⁵⁰ Hence beside the high cost which is mainly borne by the patients themselves, the incidence of complications confound the chronic intake of large number of drugs with their attendant side effects constitute reasons for non-adherence to therapy amongst diabetic patients.⁵⁰ The economic burden of diabetes is enormous in terms of the direct cost in its management, monitoring and control which often involves medicinal therapy in combination with life style modification. Treatment of diabetes is more expensive compared to other chronic illnesses, in Untied States of America for instance, the per capita annual cost of health care for people living with diabetes rose from \$10,071 in 1997 to \$13,243 in 2002, an increase of more than 30%, the annual economic cost of diabetes in 2002 estimated to be \$132 billion.⁴⁹

The global concern for the diversification on the use of plant foods to improve normal and therapeutic nutrition for diabetes control has shifted scientists' interest to enhancing the potential sources of beneficial constituents in plant foods. Plant foods have generated increasing research interest because of their anti-diabetic potentials. There is need to integrate traditional plant foods within local research and innovative systems, in accordance with local needs, food habits and priorities. Currently, documentations on Nigerian indigenous plant foods with anti-diabetic properties are either scattered or lacking.⁹ This necessitated this research to carry out a comparative analysis on root and tuber crops in Nigeria in relationship to its contribution to health care. The utilization of root crops as a functional food will not only solve the problem of chronic diseases now prevailing in all countries especially in Nigeria but also encourage the industry and farmers to produce value-added or healthy products from root crops. This will increase production and income of producers of root crops and hence, have a positive impact on the health care.

CONCLUSION

The Global Burden of Disease study reported diet as the major contributing factor to the rise in hypertension, diabetes, obesity and other cardiovascular disease (CVD) components.⁵¹ Poor quality diets are high in refined grains, added sugars, salts and unhealthy fats. With increasing urbanization and modern food environment in many countries and Nigeria in particular, there is evidence showing that intake of refined carbohydrates such as polished white rice, cornstarch and white wheat flour is increasing while the consumption of less processed carbohydrate foods such as coarse grains, roots, tubers and legumes has decreased. The traditional diet of developing country such as Nigeria consists mainly of unprocessed foods, but with urbanization coupled with increase in economic development, people are now consuming more energy, more processed foods with reduced fibre. The clinical practice guidelines for diabetes management in Nigeria published by Diabetes Association of Nigeria reported that in Medical Nutrition Therapy (MNT) management of diabetes and dyslipidaemia, dieticians should use cultural specific foods for patient education, with reference to available local food for better accessibility and affordability.⁵² Traditional diets once rich in whole grains and dietary fibre now include highly refined carbohydrates, such as polished white rice and refined flours. Several reports on roots and tubers confirmed that they have medicinal values, but did not emphasize on their utilization in the management of diabetes and dyslipidaemia in Nigeria. Diabetes patients are being discouraged from consuming root and tuber crops products in favour of wheat which has resulted in poor diabetes management in Nigeria. There is need for proper investigation on the health benefits of root and tuber crops in relation to the management of diabetes and dyslipidaemia in Nigeria, and their proper integration into the indigenous diet of the people.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: Not required

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Cite this article as: Onodu B, Culas R, Nwose EU. Health values of cassava compared to wheat and yam in relation to diabetes and dyslipidaemia management. *Int J Community Med Public Health* 2020;7:791-8.