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Original Article

DETERMINATION OF STARCH, PROTEIN AND CALCIUM CONTENTS OF YAM AND PLANTAIN VARIETIES

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Abstract

Background

Yam and plantain of several varieties are staple foods in many parts of the world especially in west and central Africa, parts of Central America and the Caribbean, the Pacific Island and South East Asia[1] Nutrients such as carbohydrate (starch), protein, minerals and vitamins are derived from them.

Since these nutrients are needed for proper functioning of the body and maintenance of good health, yet, certain disease conditions like diabetes mellitus need certain dietary restrictions and modifications as a very essential aspect of their management, determination of the nutritional contents of the different varieties of these staple foods is undoubtedly necessary.

Objective

To determine the value of the different nutrients present in each of the different species of yam and plantain. This would aid nutritional planning dietary modification in health and diseases like diabetes mellitus.

Method

The edible portions of the respective five varieties of plantain and yam were carefully mashed and analysed using known analytical methods for each given nutrient. Various percentages were determined using SPSS version 11.0.

Results

The research focused on the determination of starch, protein and calcium contents of the various varieties of yam and plantain.

On a general note, yams had lower starch contents but higher protein and calcium contents than plantains. Dioscorea cayenensis (Yellow yam; ji-ayabe) had the least starch content (9.05%), good Protein (5.60%) and the highest Calcium content (18.04 mg/ 100g).

French horn plantain had the highest starch content (34.07%), good calcium (12.02mg/100g) but the lowest protein (3.50%) contents. Discorea dumentorum (Trifoliate yam; ana) had the highest protein content (11.5%), moderate starch (13.3%) and good calcium (14.03 mg/100g) contents.

CONCLUSION

Yams are generally more nutritious than Plantains. The observations are important for nutritional planning in health and disease. Increase in production of highly nutritive varieties will lead to improvement in the economic/commercial benefits of the crops.

Key Words: *Nutrient, Quality Variety, Human.*

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INTRODUCTION

Yam is the third most important root crop after cassava and sweet potato. This is especially true in West Africa, Parts of Central America and the Caribbean, the Pacific Islands and Southeast Asia[1]. Plantain, on the other hand, is an important staple food in the humid tropical zones of Africa, Asia, Central and South America. It is undoubtedly, one of the oldest cultivated fruits in West and Central Africa[2-4] Yam and Plantain are staple foods from which nutrients such as carbohydrate (starch), Proteins, Lipids, Minerals and Vitamins are derived[5,6].

Since these nutrients (starch, protein and calcium) are important in the proper functioning of the body and maintenance of good health, the determination of the starch, protein and calcium contents of the different varieties of yam and plantain is necessary. Again, many people with diabetes mellitus are often advised by quacks and other ill informed health workers to avoid or eat certain species of yams and or plantains believing such to have negligible or no carbohydrate at all.

The aims of this research work were to determine the starch, protein and calcium contents of the different varieties of yam and plantain respectively; to determine which of the various varieties of yam and plantain that possess the greatest nutritional value. It was also to find out the varieties of yam and plantain that have tolerable energy values as well as to ascertain the economic/commercial benefits of the various species of yam and plantain. Thus, these could guide dietary recommendation for diabetic patients and patients suffering from other diseases where dietary modification may be required.

MATERIALS

The test samples used in this study were obtained from the Horticulture and Yam programmes of the National Root Crops Research Institute, Umudike, Abia State. The respective coordinating officers of the different programmes authenticated their respective botanical identities.

Laboratory and other facilities were obtained from the Central Service Laboratory of National Root Crops Research Institute Umudike, Abia State.

Five varieties of yam were used and included:

A. Dioscorea dumentorum (Trifoliate yam) Ona (una).
B. Dioscorea alata (Water yam) ji-abana.
C. Dioscorea rotundata (White yam) ji-ocha.
D. Dioscorea bulbifera (Aerial yam) Adu.
E. Dioscorea cayenensis (yellow yam) ji-ayabe.

Five varieties of plantain were used and included:

A. Horn plantain. (Aka Nkita, Ohi bere odu)
B. Musa cadaba (cooking banana). (Unere-igbo or Unere-osukwu or unere oji).
C. French horn plantain.
D. French plantain (Ojoko-oyo).
E. Musa balbisiana (False horn plantain) (Obughunu).

METHODS

Processing of Samples

The test samples were in each case peeled using a kitchen knife to obtain the edible portion. This edible portion was then cut into slices and mixed very well to accommodate all parts (head portion, middles and bottom) of the sample.

50g of each test sample was weighed out and homogenized (macerated in a blender). It was sieved to get the starch and oven dried at a temperature below 60°C to avoid gelling of the starch.

The rest of each of the samples was equally oven dried and stored in carefully labelled sample bags. Some quantity of the dried samples were ground and stored in equally labelled sample bottles. These were used for the protein and mineral tests.

Laboratory Analysis

Each of the above samples was analysed for parameters which included starch content, protein content and mineral content (calcium) of the various species or varieties.

Starch content was determined by the gravimetric method as described by Balagopalan[7] The protein content was determined by the modified Kjeldhi method as described by James[8] and chang[9] For each sample, the mineral content was determined by the dry ash extraction method of James[8], while the calcium content was determined by the standard EDTA complexiometric titration method

In each case, the samples were analysed in duplicates and the appropriate SPSS version 11.0 applied as statistical software for the determination of the various percentages and other statistical analysis.

Table 1: Starch content of Yam and Plantain Varieties (Values in % dry matter)

Sample	W^1	W^2	$W^2 - W^1$	% starch	Remarks
D. dumentorum	17.861	24.515	6.654	13.30	GOOD STARCH CONTENT
D. alata	18.405	30.635	12.23	24.46	
D. rotundata	18.541	23.625	5.084	10.17	
D. bulbifera	18.207	26.255	8.048	16.10	
D. cayenensis	16.213	20.736	4.523	9.05	
					HIGH STARCH CONTENT
Horn plantain	17.977	31.633	13.656	27.31	
Cookingbanana	18.187	29.812	11.625	23.25	
French horn plantain	17.914	34.950	17.036	34.07	
French plantain	27.321	34.700	7.379	14.76	
False horn plantain	18.096	30.382	12.286	24.57	

$$\% \text{ starch} = \frac{w^2 - w^1}{50g} \times \frac{100\%}{1}$$

Where w^1 = weight of empty container; w^2 = weight of the container and starch.

From table 1, plantain had a higher starch content between the two crops and has the following pattern for the varieties; French horn plantain > horn plantain > false plantain > cooking banana > French plantain. Yam had a lower starch content than plantain and has the following pattern for the varieties, D. alata > D. bulbifera > D. dumentorum > D. rotundata > D. Cayenesis.

From the table, French horn plantain had the highest starch content (34.07%) while D. cayenensis (yellow yam) had the lowest starch content (9.05)

Table 2: Protein Content of Yam and Plantain Varieties (value expressed in mg/100g edible portion)

Sample	2nd (cm^3) Titre	1st (cm^3) Titre	(cm^3) Titre	T-Blk	$\%N_2$	% protein
Blank	1.20	1.00	0.20	-	-	-
Dioscorea dumentorum	18.50	15.00	3.50	3.30	1.848	11.55
D. alata	20.70	18.50	2.20	2.00	1.120	7.00
D. rotundata	22.20	20.70	1.50	1.30	0.728	4.55
D. bulbifera	24.70	22.20	2.50	2.30	1.288	8.05
D. cayenensis	26.70	24.70	1.80	1.60	0.896	5.60
Horn plantain	8.10	6.70	1.40	1.20	0.672	4.20
Cookingbanana	9.40	8.10	1.30	1.10	0.616	3.85
French horn plantain	10.60	9.40	1.10	1.00	0.860	3.50
French plantain	12.00	10.60	1.40	1.20	0.672	4.20
False horn plantain	13.40	12.00	1.40	1.20	0.672	4.20

$$\%\ N_2 \left(\frac{100}{0.5} \times \frac{14 \times 0.02}{1000} \times \frac{100}{10}\right) T - Bilk$$

$$= 0.56\ (T - Blk) \qquad \% \text{ protein} = \%\ N_2 \times 6.25$$

Table 2, shows that yam had a higher protein content than plantain. The protein content for yam varieties had the following pattern: D. dumentorum > D. bulbifera > D. alata > D. cayenensis > D. rotundata, while plantain which has lower protein content had this pattern: Horn plantain > French plantain > False horn plantain > Cooking banana > French horn plantain.

It was observed that D. dumentorum (Ona) had the highest protein content (11.55%) while French horn plantain had the lowest protein content (3.50%).

Table 3: Calcium content of yam and plantain varieties (Values Expressed in mg/100g Edible Portion)

Sample	2nd (cm^3) Titre	1st (cm^3) Titre	(cm^3) Titre	T-Blk	Ca mg/100g
Blank	2.20	2.00	0.20	-	-
Dioscorea dumentorum	8.20	7.65	0.55	0.35	14.03
D. alata	8.70	8.20	0.50	0.30	12.02
D. rotundata	9.30	8.70	0.60	0.40	16.03
D. bulbifera	9.85	9.30	0.55	0.35	14.03
D. cayenensis	10.50	9.85	0.65	0.45	18.04
Horn plantain	5.60	5.10	0.50	0.30	12.02
Cookingbanana	6.15	5.60	0.55	0.35	14.03
French horn plantain	6.65	6.15	0.50	0.30	12.02
French plantain	7.20	6.65	0.55	0.35	14.03
False horn plantain	7.65	7.20	0.45	0.25	10.02

$$\text{Ca mg/100g} = \left(\frac{100}{5} \times 20.04 \times 0.02 \times \frac{100}{20}\right) T - Blk$$

$$= 40.08\ (T - Blk)$$

Table 3 shows that aside D. cayenensis and D. rotundum species of yam which had the highest calcium contents (18.04mg/100g and 16.03 mg/100g respectively) and False horn plantain specie with the least calcium value (10.02 mg/100g), the other varieties of plantains and yams have relatively comparable values of calcium contents.

DISCUSSION AND CONCLUSION

The result obtained showed that the starch content of the crops had the following pattern; plantain > yam while the protein content showed a reverse trend; yam > plantain. The calcium contents of the different species of the two crops appear to be fairly maintained. Table 1 showed that yam species or varieties are lower in starch content compared with plantain varieties with the yellow (ji-ayabe) variety of yam being the lowest in starch content (9.05%). The same cannot be said of the report by Oyenuga[5] in which the starch content was not determined rather the calories per 100g of the various varieties were determined. The starch content of plantain was higher than that of yam with the French horn plantain being the highest in starch content (34.07%). This relatively high starch content found in plantain in this study is, however, lower than the value found in a study by Ketiku[6] in which plantain starch content was shown to be 83.25% and 66.4% for unripe and ripe plantains respectively. This significantly high starch content of plantain shows it to be a very good energy source.

From table 2, the protein contents of yam varieties were higher than that of plantain varieties with the variety D. dumentoum (Ona) being the highest in protein content (11.55%). This is in keeping with the report by Oyenuga[5] that showed the same

variety to possess the highest protein content (11.73%) among the species he studied.

Also, from the result (see table 2), the protein content of plantain varieties appeared to be low. French horn plantain had the lowest protein content (3.50%). This is in line with the finding by Ketiku[6] who showed that plantain was low in protein content; 3.0% and 3.5% for unripe and ripe plantains respectively.

The calcium content of yam species as shown in table 3 was higher than that of plantain species, with yellow yam (ji~ayabe) being the highest in calcium content (18.04%). The calcium content of all the species of plantain studied appeared not to differ significantly. This is in line with the report by Ketiku[6] in which calcium content in plantain varieties appear to be fairly maintained.

Yellow yam (ji~ayabe) with the least starch content, good protein content and the highest calcium content is thus, regarded as the most nutritious. Yams, irrespective of the specie, had better protein and calcium contents than plantain. On the other hand, French horn plantain with the highest starch content appears to be the richest source of energy.

The findings of this study is quite informative because it has revealed that contrary to the wide belief, particularly in the South Eastern part of Nigeria, that D. alata (water yam) had the least starch content compared with other yams, it has actually been shown to possess the highest starch content. It was also generally believed that yams had higher starch content than plantain but the opposite is the finding in this study. Therefore, the advice often given to diabetic patients to eat water yam instead of other species and to eat plantain rather than yam on the assumption that they respectively had lower carbohydrate content than the others has been shown to be a very erroneous advice.

Cooking banana (Unere oji in Ibo land) which most diabetic patients eat or are often advised to eat in preference to any other species of yam or plantain had second to the least starch content among all the plantain species studied. However, its starch content (23.25%) is comparable to the starch content of the yam; D. alata, which had the highest starch content (24.46%). Therefore, D. Cayensis iji ayebe) and D. Rotunda iji ocha) with the least starch contents (9.05% and 10.17%) as well as reasonable protein (5.6% and 4.55%), and calcium (18.04mg/Kg and16.03mg/Kg) contents would be preferred for diabetic patients with; as usual, emphasis of moderation of quantity.

CONCLUSION

Yam is a good energy source, richer in protein and calcium than plantain and, thus, is more nutritious than plantain. Contrary to public view, plantain is, generally, higher in starch content than yam. On the other hand, plantain is a very good source of energy, but is low in protein and calcium compared with yam.

These observations are therefore, important for nutritional planning in health and disease conditions; for example, in diabetes mellitus, where dietary modification may be required.

The commercial consequences of these findings are also worthy of further exploration. An increase in the production of highly nutritive yellow yam and energy rich French horn plantain will lead to provision of raw materials for industries and improved economic/commercial gains of the crops.

RECOMMENDATIONS

From the findings of this research, the following recommendations could be made:

The public should be informed and encouraged to consume varieties of yam and plantain that are of good nutritional value in other to improve their dietary habits.

Patients on dietary modification, e.g. diabetic patients and others suffering from diseases that may require intake of low carbohydrate diets, should take more of yellow yam (ji-ayabe) and for those that require intake of high energy diet, French horn plantain is a good source.

Governments, agriculturists and farmers should be encouraged to increase the production of the Yellow yam and French horn plantain varieties as well as the other varieties of yam and plantain because of their nutritional and economic values.

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