Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda

Research Application Summary

Ethno-botanical and morphological characterisation of cocoyams (*Colocasia esculenta* L. Schott and *Xanthosoma sagittifolum* L. Schott) germplasm in Malawi

Mwenye, O.[1], Labschagne, M.T.[2], Herselman, L.[2], Benesi, I.R.M.[3] & Chipungu, F.P.[1]
[1]Bvumbwe Research Station, P. O. Box 5748, Limbe, Malawi
[2]Department of Plant Sciences, University of the Free State, P. O. Box 339, Bloemfontein, Republic of South Africa
[3]Chitedze Research Station, P. O. Box 158, Lilongwe, Malawi
Corresponding author: omwenye@yahoo.co.uk

Abstract

Cocoyam accessions of Malawi were characterised using ethno-botany and morphological characters. Thirty above ground qualitative characters were evaluated. The cultivars were identified mainly based on the predominant leaf base and petiole attachment. The study revealed farmers' preferences of cocoyam varieties of interest to them. These included uses of plant parts for food, livestock feed, medicine, ornamental and adaptation to different agro-ecologies**.** The study further revealed significant amount of cocoyam diversity in Malawi. Farmers maintaining this diversity also hold rich ethno-botanical and ecological knowledge of the cocoyam cultivars that they are conserving. A thorough collection country wide and a complete agro-morphological evaluation study are recommended.

Key words: Cocoyam, genetic diversity, Malawi

Résumé

Des accessions de cocoyam du Malawi ont été caractérisées en utilisant l'ethno-botanique et les caractères morphologiques. Trente caractères qualitatifs sur la surface du sol ont été évalués. Les cultivars ont été identifiés, étant principalement basés sur l'attachement prédominant de base et de pétiole de la feuille. L'étude a indiqué les préférences des fermiers sur les variétés d'intérêt de cocoyam pour eux. Celles-ci comprennent les utilisations des parties de la plante pour se nourrir, nourir le bétail, se soigner, orner et aussi s'adapter aux différentes agro-écologies. En plus, l'étude a indiqué une quantité significative de la diversité de cocoyam au Malawi. Les fermiers, maintenant cette diversité, tiennent également la connaissance ethno-botanique et écologique riche des cultivars de cocoyam qu'ils conservent. Une collecte minutieuse des données dans tout le

pays et une étude d'évaluation agro-morphologique complète sont recommandées.

Mots clés: Cocoyam, diversité génétique, Malawi

Background

Plant genetic resources are an important component in breeding. Prerequisite to a sustainable plant genetic resource conservation and improvement programme is the knowledge of genetic variation present within the cultivars and/or closely related species. Limited or no information exists on the levels and pattern of genetic diversity as well as utilisation of cocoyam in Malawi. Therefore, the study aimed at characterizing cocoyam accessions collected from local farmers collected in northern and southern regions of Malawi. Characterisation was based on ethno-botany and morphological characters using the International Plant Genetic Resources Institute (IPGRI) descriptors.

Literature Summary

Cocoyam is one of the major root and tuber crops of the tropics (O'Hair, 1990). It is widely grown as a staple food and the potential of the crop is high in the humid and sub-humid tropics (Onwueme, 1978; Okonkwo, 1993). It is a member of the Araceae family and the two most important species of the edible aroids are *C. esculenta* and *X. sagittifolium* (Purseglove, 1972). *Colocasia esculenta* is commonly known as *taro* or old cocoyam and *X. sagittifolium* as *tannia* or new cocoyam. They are generically called cocoyam in most parts of the tropics and both produce edible starchy corms and cormels (Purseglove, 1972; Janseens, 2001).

In Malawi, like in most developing countries, root and tuber crops such as cassava, sweet potato, yam and cocoyam act as principal sources of food, nutrition and cash income especially to most food insecure households. These crops, cocoyam included, have a greater ability to produce more edible energy per hectare per day compared to other commodities and produce satisfactory under adverse conditions where other crops may fail (Onwueme, 1978; Malawi Government Report, 1996; Moyo *et al.*, 1999; Sandifolo, 2003).

This suggests that the potential of such crops like cocoyam, for food security, income generation and nutritional enhancement in the households are grossly underutilised. Cocoyam, despite possessing such rare attributes such as yielding 30-60 ton/ha, being rich in minerals and vitamins and possessing small starch

grains, remains an indispensable, yet neglected, food crop especially for predominantly malnourished rural households (Ekwe *et al*., 2009). Detailed conservation and characterisation of cocoyam would not only help in conserving the national heritage in minor root and tuber crops but also generate information on their worthiness in terms of nutritional and potential industrial utilisation and on the genetic diversity that exists (Malawi Government Report, 1996).

Study Description

Cocoyam germplasm were collected from several districts in the northern and the southern regions of Malawi. In the north it was done along the lake shore districts of Nkhatabay, Rumphi, Karonga and Chitipa. In the south collection was done in the Shire highlands and the Shire valley districts of Mangochi, Machinga, Zomba, Mulanje, Thyolo and Chikwawa. Detailed passport data for each accession was recorded and this also included farmers' knowledge of their cultivars, i.e., taste, maturity period, target use, period that cultivar has been with the farmer and preferred characteristics of the cultivar. The location of collection in terms of latitude, longitude and altitude was captured. For morphological characterization, pre-sprouted corms were planted at Chitedze Research Station in a randomised complete block design (RCBD), with three replicates of five plants each. The planting distance was 0.9 m between rows and 0.9 m between plants.

The morphological (above ground) parameters were evaluated between 3-6 months after planting. Data for 30 above ground qualitative characters were collected according to the International Plant Genetic Resources Institute (IPGRI) Taro descriptor (IPGRI, 1999. Morphological data for the 28 accessions were converted into a binary matrix using the procedure of Benesi (2005). Thus traits with two categories were scored in a normal binary matrix and traits with multiple categories of description, i.e., colour and shape, were coded considering the range of diversity of the trait and scored against that particular class. Similarity coefficients for morphological data were calculated using the Dice coefficient (Dice, 1945) and the NTSYSpc version 2.2c computer package (Rohlf, 2000). Dendrograms were constructed using the unweighted pair group method of arithmetic averages (UPGMA) in SAHN programme parameters (Rohlf, 2000). The goodness of fit of clustering matrices was calculated using COPH and MXCOMP programmes in NTSYSpc.

Research Application

Farmers from the two regions prefer cocoyam with high dry matter (HDM) content. Other traits that farmers preferred included taste, high yield in terms of tuber size, mealyness, resilience to bad weather, early maturity and good cooking properties (Table 1). In both regions people opted for tubers with HDM content (41%), followed by taste (17%), high yield (17%) and good cooking properties like boiling (17%), mealyness (8%) and suitability for making pulp (*msima*) (8%) (Table 1).

Table 1. Frequencies of desired cocoyam traits in Malawi as reported by farmers at collection points.

Preferred characteristics	North		South		General	
	No	%	No	%	No	%
High dry matter	2	6	12	35	14	41
Taste	3	8	3	8	6	17
High yield (tuber size)	5	14	1	3	6	17
Good for breakfast (boiled tubers)	3	8	3	8	6	17
Mealyness	3	8	0	0	3	8
Good for *msima* (pulp)	3	8	0	0	3	8
Easy to cook (cooks fast)	1	3	0	0	1	3
Resilience to bad weather (adaptability)	2	6	0	0	2	6
Early maturing	0	0	1	3	1	3
Tuber flesh colour	1	3	0	0	1	3
Good flowers (ornamental)	1	3	0	0	1	3
Total number of respondents	-	34	-	34	-	34

About 88% of the respondents use cocoyam as food in the form of boiled tubers, 12% as *msima* (pulp) and 38% use the leaves as a vegetable. The study showed that most people from the northern region use cocoyam for making pulp. Both the northern and the southern region used cocoyam leaves as vegetable although more people from the south (29% versus 9%) used the leaves as vegetable. Eating cocoyam as boiled snacks is common in both regions and seems to be the main way of consuming cocoyam. Cocoyam is used as a source of income to many (21%) growers in the northern region (Table 2). Mature tubers are usually sold along the main roads. It is also used as a livestock feed in the southern region (6%). The leaves are fed to pigs and used as fish feed in fish ponds. Cocoyam is also used as a medicinal and ornamental plant. People from the south use the leaf sap as an ointment to treat ringworms, i.e., a fungal skin infection (Table 2).

The dendrogram constructed using the morphological characters separated the accessions according to species basing on leaf base shapes (petiole attachment), i.e., peltate leaf base

Table 2. Frequencies of common uses of cocoyam in Malawi as reported by farmers at collection points.

Most common uses	North		South		General	
	No	%	No	%	No	%
Food - boiling tubers	15	44	15	44	30	88
Food - *Msima* (pulp)	4	12	0	0	4	12
- Leaves as vegetables	3	9	10	29	13	38
Source of income (sale of fresh tubers)	7	21	0	0	7	21
Livestock feed - fish	0	0	1	3	1	3
- pigs	0	0	1	3	1	3
Medicine - for ring worms	0	0	1	3	1	3
Ornamental flowers	1	3	0	0	1	3
Total number of respondents	-	34	-	34	-	34

accessions (*Colocasia*) and sagittate (*Xanthosoma*). Accession coy5 and coy28 were the most dissimilar among the *Xanthosoma* species (sagittate group). Accession coy16 was most dissimilar among the *Colocasia* species (peltate). The accessions further differentiated based on region of collection within the main clusters. Accession from the northern region clustered separate from the ones from the southern region. High levels of variation were identified between the two cocoyam species (45% similar). Variation within the species was moderate; however it was high in *Colocasia* species (peltate) compared to *Xanthosoma* (sagittate). Accessions of cluster I (sagittate) were 45% similar to accessions of cluster II (peltate). Accessions within cluster I were more closely related compared to those in cluster II. However, accessions Coy5 and Coy28 which clustered outside the main cluster I, contributed much to the variation in this cluster. Accessions in Cluster II showed high levels of variation. The matrix correlation based on the goodness of fit of clustering to data matrixes was calculated using COPH and MXCOMP programmes. The r value, gives a measure of goodness of fit for a cluster analysis (0.87220) which suggested a good fit (Fig. 1).

Recommendation

It is recommended that farmers' ethno-botanical knowledge be preserved and incorporated into future improvement programmes of the crop. Incorporating farmers' preferences into a breeding programme not only shapes its strategy but also enhance the adoption of newly developed cultivars. A thorough collection country wide and a complete agro-morphological evaluation study are recommended.

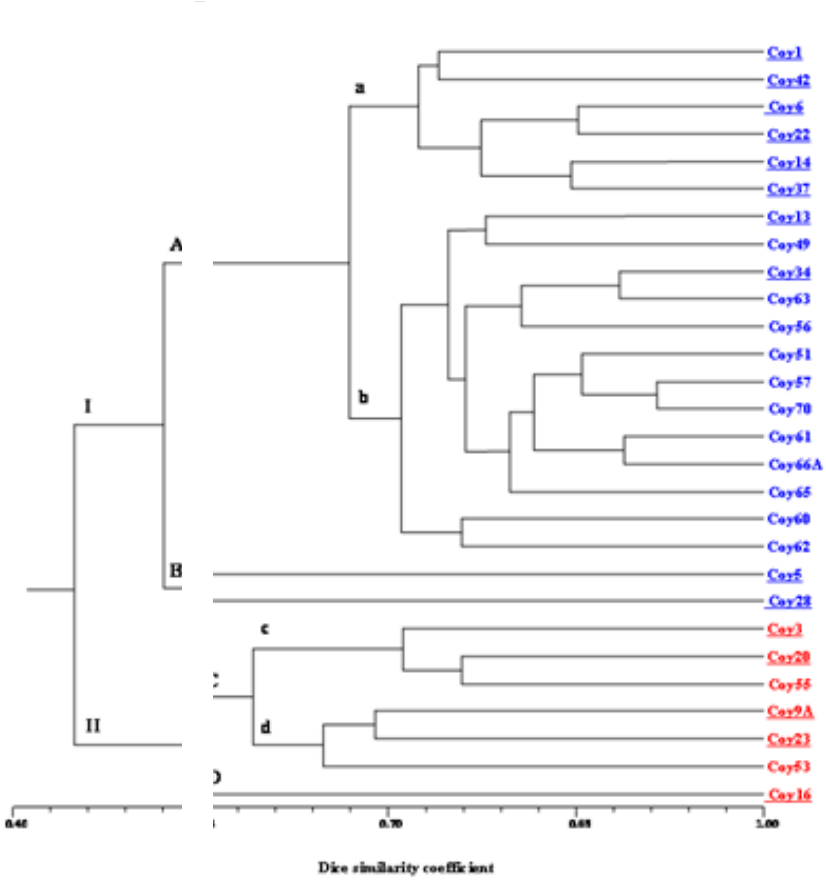

Figure 1. Clustering of 28 cocoyam accessions from Malawi based on 30 morphological characters and UPGMA clustering using the Dice similarity coefficient. Red represents accessions with peltate leaf base shapes, blue, accessions with sagittate leaf base shapes, while accessions collected from the south are underlined and the rest are from the north (r=0.87220).

References

Benesi, I. 2005. Characterisation of Malawian cassava germplasm for diversity, starch extraction and its native and modified properties. PhD Thesis, University of the Free state, South Africa. 199pp.

Ekwe, K., Nwosu, K., Ekwe, C. and Nwachukwu, I. 2009. Examining the underexploited values of cocoyams (*Colocasia* and *Xanthosoma* species) for enhanced household food security, nutrition and economy in Nigeria. In: Jaenicke, H., Ganry, J., Zeledon-Hoeschle, I. and Kahane, R. (Eds.). Proceedings of the International Symposium on underutilized plants for food security, income and sustainable development. *Acta Horticulturae* 806:71-78.

Janseens, M. 2001. Crop production in tropical Africa. Bonn, Germany: Institut fur obst-und germusebau, abt. Tropicscher pflanzenbau, Rheinische Friedrich-Wilhelms-Universitat

Bonn, auf dem Hugel 6, D-53121 Bonn, Germany. Directorate general for international co-operation, Karmelietenstraat 15, B-1000 Brussels, Belgium. pp. 221-228.

Malawi Government Report. 1996. Country report to the FAO international technical conference on plant genetic resources. Leipzig: FAO. pp. 9-28.

Moyo, C.C., Mahungu, M., Soko, R. and Sandifolo, V. 1999. Progress in developing cassava varieties in Malawi. In: Akaroda, M. and Teri, J. (Eds.). Food security and crop diversification in SADC countries: The role of cassava and sweet potato. Proceedings of the scientific workshop of the Southern Africa Root Rrops Research Network (SARRNET). pp. 143-150.

Onwueme, I. 1978. Tropical tuber crops*:* Yams, cassava, sweet potato and cocoyams. John Wiley and Sons. pp. 199-225.

Purseglove, J. (1972). Tropical crops: Monocotyledons 1. London: Longman. pp. 66-74.

Rohlf, F. 2000. NTSYS-pc: Numerical taxonomy and multivariate analysis system. Applied Biostatistics. New York: Exerter Publishing Ltd.

Sandifolo, V. 2003. Estimation of crop losses due to different causes in root and tuber crops: The case of Malawi. Proceedings of the Expert Consultation on Root Crop Statistics-Volume II: Invited Papers. Harare, Zimbabwe: Food and Agriculture Organisation of The United Nations, Statistics division, Regional Office for Africa. FAO, Rome, Italy. pp. 41-47.