Scientia Agriculturae
www.pscipub.com/SA
E-ISSN: 2310-953X / P-ISSN: 2311-0228
DOI: 10.15192/PSCP.SA.2015.9.2.113-119

Sci. Agri.
9 (2), 2015: 113-119
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Comparative analysis of phenotypic characterization of Kenya and Pacific Islands tarogen germplasm collections Colocasia esculenta L. (Schott)

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Paper Information

Received: 15 November, 2014

Accepted: 17 December, 2014

Published: 20 February, 2015

Citation

Akwee PE, Netondo G, Palapala VA. 2015. Comparative analysis of phenotypic characterization of Kenya and Pacific Islands tarogen germplasm collections Colocasia esculenta L. (Schott). Scientia Agriculturae, 9 (2), 113-119. Retrieved from www.pscipub.com (DOI: 10.15192/PSCP.SA.2015.9.2.113119)

A B S T R A C T

Fifty accessions of taro germplasm collections Colocasia esculenta L. (Schott) were collected from Kenya and Pacific Islands tarogen germplasm collections. Twenty five accessions of Kenyan taro germplasm were collected from Western, Nyanza and Rift valley province. The taro germplasm were planted at Masinde Muliro University of Science and Technology main campus farm field station at Kakamega county (00^{O} 17.30’ and 34^{o}45’East GPS receiver) in western province of Kenya. The phenotypic characterization was based on the International Plant Genetic Resources Institute's (IPGRI) descriptors for Colocasia esculenta. The data was collected from both qualitative and quantitative traits. The phenotypic characteristics were classified into leaf and petiole characteristics. From the research study, the phenotype characters such as plant height, presence or absence of stolons, number of sucker holds the highest criteria to be selected towards improving the taro crop. These phenotypic characters are vital diagnostic features for distinguishing taro genotypes and they may serve as genetic bench markers that could facilitate selection of suitable germplasm variety for crop improvement in the country. Comparative assessment on the phenotypic characterization of the germplasm is a key guide to search for desirable traits that are important in crop productivity and breeding. This could lead to an increased understanding of the adaptation potential of taro in various ecological zones to enhance development of efficient and sustainable taro cultivation practices.

Key words: *Crop productivity and breeding; crop improvement; Desirable traits; Genetic variability; phenotypic characters.*

Abbreviations

GPS-Geographical positioning system; FAO- Food and Agriculture Organisation; International Plant Genetic Resources Institute's (IPGRI) descriptors.

Introduction

Taro (Colocasia esculenta L. (Schott), commonly known as arrowroots, and locally known as “Nduma” is a well-balanced food highly nutritious and compares favorably with other foods rich in carbohydrates, proteins vitamins and minerals (Jirarat et al., 2006; Vishnu et al, 2012). Its corms, cormels, leaves, stalks and inflorescence are utilized for human consumption. Most Kenyan communities have traditionally continued to rely on staple foods like, potatoes, sorghum, millet, beans, maize and cassava, but have not realized the significance of growing cocoyams as as one of the solutions to food security. Taro yields in Kenya are unknown compared to West Africa countries. In West Africa, the yields are lower than those of the Pacific and Asian Countries (FA0, 1987). Comparatively in Pacific Island countries, Asia and the Caribbean Asia, taro is an important staple food crop for its fleshy corms and nutritious leaves (Dako, 1981; Dura and Uma, 2003). There is little recorded literature on the development of cocoyam cultivation and consumption in Eastern Africa in general (Chepchumba, 2007) and in Kenya in particular. Small scale growing of cocoyams is what has been reported in many areas. Cocoyams in these areas particularly in flood prone areas in Kenya are intercropped with bananas and other crops (Dennery, 1995).

Cocoyams have an established place in production systems and food cultures of countries with extensive agricultural economies such as China, India and Japan (FAO, 1998). A study done in Hawaii reported an increased contribution of Cocoyams in the Hawaiian economy and increased popularity of cocoyam products in the world market (Valenzuela et al. 1991).

Other studies indicate that the potential of cocoyams being processed into snack foods depends on economics and public acceptance (O'Hair, 1990). In the USA the importance of Cocoyams is indicated by its increased production value from US$ 6.5 million in 1983 to US$7.7 million in 1987 (O'Hair, 1990). The extent of phenotypic variability and genotype performance of various Kenya taro varieties remains unknown indicating a vast and largely untapped potential for research on such underutilized crop in the region compared to Pacific Islands countries. Paul et.al 2012 reported that research on taro crop rarely is high on the agenda of many countries and Kenya is not an exceptional.

This comparative assessment on the phenotypic characterization of the germplasm would be a key guide to search for desirable traits that are important in crop productivity. This research interest in neglected taro food crop stems from a variety of factors of developing a comparative assessment of phenotypic characterization of Pacific Island countries where taro production systems are well developed and known compared to Kenyan taro germplasm. Phenotypic characterization on Kenya taro germplasm diversity has not been done which is very fundamental in understanding its diversity towards improving the crop. The objective of this research was to determine the phenotypic characteristics of taro germplasm using agro-morphological descriptors to identify and document its phenotypic diversity. This could lead to an increased understanding of the adaptation potential of taro in various ecological zones to enhance development of efficient and sustainable taro cultivation practices in Kenya.

Materials And Methods

Taro vegetative samples were collected from the regions that grow taro arrow roots from Pacific community islands and Kenya taro germplasm. Twenty five accessions of the Pacific community islands germplasm were imported following the Plant Phytosanitary and Quarantine requirement. Then twenty accessions of the Kenyan taro germplasm were collected from Western, Nyanza and Rift valley province parts of Kenya. The taro germplasm were planted at Masinde Muliro University of Science and Technology main campus farm field station at Kakamega county (00^{O} 17.30' and 34^{o}45'East GPS receiver) in western province of Kenya. Random complete block design was employed as the experimental designs. The land was tilled and harrowed before planting. The soils were made into raised beds. Each bed was 4-5 m wide, with 1 m space between beds. The furrows between the beds served for drainage. Planting was done in holes that were dug to 60cm depth and each sucker firmly placed using hands. The spacing was 0.5 m between plants and 1.0 m between rows (Ivamu et al., 2009). Leaf and petiole characters were studied based on key IPGRl descriptors for Colocasia esculenta (IPGR, 1999).The phenotypic characters included: Plant span; Plant height; Stolon formation; Number of stolons; Number of suckers (direct shoots); Predominant position (shape) of leaf lamina; Predominant shape of lamina; Leaf lamina margin, Leaf blade colour; Leaf lamina variegation; Vein junction colour; Petiole basic colour; Petiole attachment; Petiole junction colour; Petiole junction colour of the top third; Petiole Junction pattern.

Results And Discussions

The phenotypic characterization results show that there exist a wide genetic variability among taro collections with regard to phenotypic variations. The phenotypic characters showed variations in their percentage of frequencies performance. In terms of plant span and height, Most Kenya taro germplasm collections showed medium plant span and height (64% medium and 44%) respectively and compared to Pacific Islands tarogen collections which showed a wide medium plant span and height of 84 %. Law et. al., 1978 reported that selection for height was found to be more effective at improving yields than direct selection for yield on wheat varieties. A positive correlation was observed between height and yields amongst a set of inter-varietal chromosome substitution lines in wheat varieties. The heights of most of the Pacific Islands tarogen collections were much taller than Kenyan taro accessions. A total of 80 % of taro genotypes from Pacific-Asian lacked the stolons while 88 % Kenyan variety also lacked stolons a clear indicator of good taro production in terms of corm yields. A few of taro genotypes from both had stolon present (12% for Kenyan and 20% of Pacific islands tarogen collections) as shown in table 1 and 2. Absence of stolon formation is a clear indication of desirable heritable traits amongst taro accessions like corm yields and corm shape. The presence of stolons is often found to be co-related with undesirable traits amongst taro accessions.

In terms of suckers' formation among taro accessions, Pacific Asian taro collections 72% of them produced 5 to 10 suckers, 24% produced 1 to 5suckers while 6 % produced 10 to 20 suckers. The Kenyan taro genotypes performances in terms of suckers' production, 64 % of them produced a range of 1 to 5 suckers, 20 % produced 5 to 10 suckers and 16 % from 10 to 20 suckers (Table 1 and 2). This corroborated by similar study by Sivan 1977 and 1980 who found out that the number of suckers produced is influenced to a large extent by the production system and cultural practices given that suckering ability is highly inheritable. Higher sucker production contributes to corm yield under flooded conditions but reduces corm yields when grown in upland conditions. This means low yields are determined by the type of taro cultivars or plant materials. Therefore, the phenotypic suckering ability character is a key selection factors for taro germplasm accessions to improve its yields. Furthermore, there is need of determining whether whether poor yields amongst taro are determined by its suckering ability.

Table 1. Phenotypic characterization of the taro collections based on IPGRI descriptors of 25 cocoyam accessions from Kenya Varieties

Acc. No	PS	PH	SF	SL	NOS	PPLLS	PSL	LLM	LLC
KCT/GTH/31	Medium	medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Entire	Green
KCT/KGI/32	Wide	tall	Absent	None	1 to 5	Semi-horizontal	Cup shaped	Entire	Dark green
KCT/NGC/33	Wide	medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Entire	Dark green
KWK/LKW/13	Medium	medium	Absent	None	1to 5	Horizontal	Flat	Undulate	Green
KWK/ISW/14	Medium	Medium	Absent	None	1to 5	Horizontal	Flat	Entire	Green
KWK/SHT/12	Wide	tall	Absent	None	1to 5	Horizontal	Cup shaped	Undulate	Green
KWK/KAK/15	Medium	medium	Absent	None	1to 5	Erect apex down	Cup shaped	undulate	Green
KWK/KAK/16	Medium	medium	Absent	None	1to 5	Erect apex down	Cup shaped	undulate	Green
KWK/KAK/17	Medium	Medium	Absent	None	1to 5	Erect apex down	Cup shaped	Entire	Green
KM/AMAK/72	Wide	tall	Absent	None	10 to 20	Horizontal	Flat	Undulate	Yellow green
KMM/ELU/73	Wide	medium	Absent	None	10 to 20	Erect apex up	Cup shaped	Entire	Yellow Green
KMM/ENG/75	Wide	tall	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Yellow green
KMM/END/74	Wide	tall	Present	Long	1to 5	Semi-horizontal	Cup shaped	Entire	Green
KMM/MMU/78	Wide	tall	Absent	None	1to 5	Erect apex down	Cup shaped	Undulate	Yellow green
KMM/MMU/79	Wide	tall	Absent	None	5 to 10	Semi horizontal	Horizontal	Undulate	Yellow green
KRT/KTL/61	Wide	tall	Absent	None	10 to 20	Erect apex down	Cup shaped	Undulate	Purple
KNY/SYA/51	Medium	medium	Absent	None	1to 5	Erect apex down	Cup shaped	Undulate	Green
KNY/KIS/81	Wide	tall	Absent	None	1to 5	Erect apex down	Drooping edge	Entire	Dark green
KNY/KIS/82	Medium	medium	Absent	None	1to 5	Erect apex down	Cup shaped	undulate	Green
KNY/NYA/52	Wide	tall	Absent	None	1to 5	Erect apex down	Cup shaped	Undulate	Yellow green
KNY/LVT/21	Wide	tall	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Purple
KNY/LVT/22	Medium	medium	Present	Short	1 to 5	Erect apex down	Cup shaped	Undulate	Purple
KWK/BSA/41	Wide	tall	Absent	None	10 to 20	Erect apex down	Cup shaped	Undulate	Purple
KWK/KAK/12	Wide	tall	Present	Long	1to 5	Semi-horizontal	Cup shaped	Entire	Yellow green
KWK/LVT/23	Wide	tall	Absent	None	1to 5	Erect apex down	Cup shaped	Entire	Green
TOTAL	MD: 64	MD :44	AB: 88	NN: 88	1to 5: 64	EAD: 64	CP: 80	UN: 60	YG: 28
Frequency	WD: 36	TL: 56	PR: 12	SH: 4	5 to 10: 20	EAU: 4	DP: 4	EE: 40	GRN: 44
(%)				LG: 8	10 to 20: 16	SMHL: 32	FT: 12		DGRN: 12
							HL: 4		PP: 16

KEY: PS: Plant span, PH-Plant height, SF: Stolon formation, NS; Number of stolons, SL-Stolon length, NOS-number of suckers (direct shoots), PPLLS-Predominant position (shape) of leaf lamina surface, PSL-Predominant shape of lamina, LLM-Leaf lamina margin, LBC-leaf blade colour, LLV-leaf lamina variegation, Vein junction colour, PBC- Petiole Basic colour, PA- Petiole Attachment, PJC- Petiole junction colour, PJCTP-Petiole junction colour of the top third, PJP-Petiole Junction pattern.

†MD: Medium; WD: Wide; AB: Absent PR: Present; NN: None; SH: Short; LG: Long; EAD: Erect Apex down; SMHL: semi horizontal/Horizontal; CP: Cup shaped DP: Drooping edge; FT: Flat; UN: undulate; EE: Erect apex up GRN: Green; DGRN: Dark Green; YG: Yellow green

In terms of predominant position of leaf lamina surface, the Kenyan taro genotypes displayed erect apex down position with 64 % whiles a few showed semi-horizontal positions of 32%. Majority of the Pacific Islands taro collections showed erect apex down predominant position (shape) of leaf lamina (80%) and only a few with semi-horizontal position (20%). In terms of the predominant shape of leaf lamina, 80 % of Kenyan taro genotypes showed cup-shaped which was comparatively the same as Pacific Asian taro collections (72%) while a few showed drooping edge shape (4 % for all) and flat shapes were 24% for Pacific Islands taro collections and 12 % for Kenyan genotypes. The taro phenotype character for leaf lamina margin was almost the same (Undulate 60% for Kenyan and 52% for Pacific Islands communities) for both (Table 1 and 2). Taro genotypes from Kenya displayed greater phenotypic diversity in terms of leaf lamina color. The color range diversity was ranging from yellow green (28%), normal green (48%), dark green (12%) and purple (16%). Majority of the Pacific Islands taro collections reflected three dimensions of leaf lamina color; the normal green (72%), Dark green (6%) and yellow green (24%).

Kenya taro germplasm collections also reflected greater phenotypic variation on leaf blade coloration; (green 40%), yellow green (16%), purple green (32%) and yellow (12%) which was distinctly different from Pacific Islands tarogen collections. Majority displayed normal green leaf blade coloration (90%) and a few were yellow green (6%) and purplish leaf blade coloration (4%). 76 % of Pacific Islands tarogen collections showed 76% leaf lamina variegation compared to 36% of the Kenyan taro genotypes. Vein junction colour was phenotypically varied for Kenyan taro genotypes ranging from green (48%), purple (32%) and yellow green (20%) while Pacific Islands showed a discontinuous variation of green vein junction color (48%) and purplish vein junction coloration (36%) as indicated on Table 3 and 4.

In the same vein, the petiole characters displayed by taro genotypes collections showed greater diversity. Most of the taro genotypes petiole attachments were phenotypically similar. They showed peltate attachment (84% Kenya taro and 96%

Pacific Islands taro). A few of the variety displayed sub peltate attachment. Taro genotypes from Kenya displayed greater phenotypic diversity in terms of petiole basic color. The petiole basic color range diversity was ranging from normal green (56%), red purple (8%), dark purple (24%) and yellow (12%) for Kenya taro genotypes. Majority of the Pacific Islands taro collections reflected three dimensions of petiole basic color; the normal green (64%), White (4%) and purple (32%). Higher phenotypic variation was highly evident on petiole junction colour amongst Kenya and Pacific Island taro genotypes. The local Kenyan taro varieties displayed the following; normal green (56%), red purple (8%), dark purple (24%) and yellow (12%) while Pacific Islands showed a color variation of green petiole junction color (36 %), red purple (48%), and dark purple (4%) and yellow (8%). The colour of the top third for petiole was majorly green for Kenyan taro genotypes 64 %. Majority of Pacific Islands taro collections showed both white and green (36% each) and 28% were purple.

Table 2. Phenotypic characterization of the taro collections based on IPGRI descriptors of 25 cocoyam accessions from Pacific-Islands

Acc. No	PS	PH	SF	SL	NOS	PPLLS	PSL	LLM	LLC
BL/HW/08	Medium	Medium	Absent	None	1 to 5	Erect apex down	Cup shaped	Undulate	Yellow Green
BL/HW/26	Medium	Medium	Absent	None	10 to 20	Erect apex down	Drooping	Entire	Yellow green
BL/HW/37	Medium	Tall	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Green
BL/SM/043	Medium	Medium	Present	Short	5 to 10	Erect apex down	Cup shaped	Undulate	Green
BL/SM/80	Wide	Tall	Absent	None	5 to 10	Erect apex down	Flat	Undulate	Green
BL/SM/92	Wide	Medium	Absent	None	1to 5	Erect apex down	Cup shaped	Entire	Green
BL/SM/111	Medium	Medium	Absent	None	5 to 10	Erect apex down	Flat	Entire	Yellow green
BL/SM/116	Medium	Medium	Present	Short	5 to 10	Erect apex down	Cup shaped	Entire	Dark green
BL/SM/120	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Green
BL/SM/128	Medium	Medium	Present	Long	1to 5	Erect apex down	Cup shaped	Undulate	Green
BL/SM/132	Medium	Medium	Absent	None	1 to 5	Semi-horizontal	Flat	Entire	Yellow green
BL/SM/143	Medium	Medium	Present	Short	5 to 10	Erect apex down	Cup shaped	Entire	Green
BL/SM/149	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Yellow Green
BL/SM/151	Medium	Medium	Absent	None	5 to 10	Erect apex down	Flat	Entire	Green
BL/SM/152	Medium	Tall	Absent	None	5 to 10	Semi-horizontal	Flat	Undulate	Green
BL/SM/158	Wide	Tall	Absent	None	1to 5	Erect apex down	Cup shaped	Entire	Green
CA/JP/03	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Green
CE/IND/01	Medium	Medium	Present	Long	5 to 10	Semi-horizontal	Cup-shaped	Entire	Green
CE/IND/06	Medium	Medium	Absent	None	1to 5	Erect apex down	Cup shaped	Entire	Green
CE/MAL/14	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Green
CE/MAL/12	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Undulate	Green
CE/THA/07	Medium	Medium	Absent	None	5 to 10	Semi-horizontal	Flat	Entire	Green
CE/THA/09	Medium	Medium	Absent	None	5 to 10	Semi-horizontal	Cup shaped	Entire	Yellow green
CE/THA/24	Medium	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Entire	Green
BL/PNG/10	Wide	Medium	Absent	None	5 to 10	Erect apex down	Cup shaped	Entire	Green
TOTAL	MD: 84	MD :84	AB: 80	NN: 80	1to 5: 24	EAD: 80	CP: 72	UN: 52	YG: 24
Frequency %	WD: 16	TL: 16	PR: 20	SH: 12	5 to 10: 72	SMHL: 20	DP: 4	EE: 48	GRN: 72
†				LG: 8	10 to 20: 6		FT: 24		DGRN 6

KEY: PS: Plant span, PH-Plant height, SF: Stolon formation, NS; Number of stolons, SL-Stolon length, NOS-number of suckers (direct shoots), PPLLS-Predominant position (shape) of leaf lamina surface, PSL-Predominant shape of lamina, LLM-Leaf lamina margin, LBC-leaf blade colour, LLV-leaf lamina variegation, Vein junction colour, PBC- Petiole Basic colour, PA- Petiole Attachment, PJC- Petiole junction colour, PJCTP-Petiole junction colour of the top third, PJP-Petiole Junction pattern.

†MD: Medium; WD: Wide; AB: Absent PR: Present; NN: None; SH: Short; LG: Long; EAD: Erect Apex down; SMHL: semi horizontal/Horizontal; CP: Cup shaped DP: Drooping edge; FT: Flat; UN: undulate; EE: Erect apex up GRN: Green; DGRN: Dark Green; YG: Yellow green

Table 3. Phenotypic characterization of the taro collections based on IPGRI descriptors of 25 cocoyam accessions from Kenya Varieties

Acc. No	LBC	LLV	VJC	PA	PBC	PJC	PJCTP	PJP
KCT/GTH/31	Green	Absent	Green	Peltate	Green	Green	Green	Large
KCT/KGI/32	Green	Absent	Green	Peltate	Green	Green	Green	Medium
KCT/NGC/33	Yellow green	Present	Yellow	Sub-peltate	Light green	Yellow	Light green	Large
KWK/LKW/13	Green	Absent	Green	Peltate	Green	Green	Green	Small
KWK/ISW/14	Purple	Absent	Purple	Peltate	Purple	Green	Green	Small
KWK/SHT/12	Purple	Present	Purple	Peltate	Purple	Purple	Purple	Large
KWK/KAK/15	Yellow	Absent	Yellow	Peltate	Light green	Green	Light green	Small
KWK/KAK/16	Purple	Absent	Purple	Peltate	Purple green	Green	Green	Small
KWK/KAK/17	Green	Present	Green	Peltate	Purple	Purple	Purple	Small
KM/AMAK/72	Yellow	Absent	Yellow	Peltate	Yellow	Green	Green	Large
KMM/ELU/73	Green	Absent	Green	Peltate	Green	Green	Green	Large
KMM/ENG/75	Yellow green	Absent	Green	Peltate	Light green	Green	Green	Small
KMM/END/74	Green	Absent	Dark Green	Sub-peltate	Dark purple	Green	Light green	Large
KMM/MMU/78	Purple green	Absent	purple	Peltate	Dark purple	Red purple	Purple	Large
KMM/MMU/79	Yellow Green	Absent	Yellow Green	Peltate	Green	Green	Green	Small
KRT/KTL/61	Purple	Absent	Green	Peltate	Purple	Purple	Purple	Large
KNY/SYA/51	Purple	Absent	Purple	Sub Peltate	Purple	Purple	Purple	Medium
KNY/KIS/81	Dark green	Present	Dark green	Sub-peltate	Dark purple	Green	Green	Medium
KNY/KIS/82	Green	Present	Green	Peltate	Dark green	Green	Green	Large
KNY/NYA/52	Yellow green	Absent	Green	Peltate	Light green	Yellow	Yellow	Medium
KNY/LVT/21	Purple	Absent	Purple	Peltate	Purple	Purple	Purple	Medium
KNY/LVT/22	Purple	Absent	purple	Peltate	Dark purple	Red purple	Purple	Large
KWK/BSA/41	Green	Absent	Purple	Peltate	Purple	Purple	Purple	Large
KWK/KAK/12	Yellow	Present	Yellow	Peltate	Light green	Yellow	Green	Small
KWK/LVT/23	Green	Present	Green	Peltate	Light green	Green	Light green	Small
TOTAL	GRN: 40	AB: 54	GRN: 48	PT: 84	GRN: 48	GRN: 56	PP: 32	
Frequency	YGRN: 16	PR: 36	PP: 32	SPT: 16	Y: 4	RPP: 8	Y: 4	
(%)	Y: 12		YGRN: 20		PPG: 48	DPP: 24	GRN: 64	
	PPG: 32					Y: 12		

KEY: LBC-Leaf blade colour; LLV-Leaf lamina variegation; VJC-Vein junction colour; PBC- Petiole Basic colour; PA-Petiole Attachment; PJC- Petiole junction colour; PJCTP-Petiole junction colour of the top third; PJP: Petiole Junction pattern;
†GRN: Green; YGRN: Yellow green; Y: Yellow; PP: Purple; PPG: Purple green; AB: Absent; PR: Present; PT: Peltate; SPT: Sub peltate ; DPP: Dark purple.

Germplasm characterization and evaluation address the existing genetic variability that act as supporting backbone for providing basic information towards improving the crop plant (Paul et.al 2012). Dudly and Moll 1969 also found out that any breeding program for improving the genetic pattern of crop depends on the nature and magnitude of variability and the extent to which the desirable characters are heritable. Many developing countries in the tropics depend on taro as a source of carbohydrates; the importance of these genera's adaptability, acceptance and commercial food value has received very little attention (Goenaga et. al., 1991). Taro crop has demonstrated a great commercial potential especially upland taro yields can reach 34000 and 20000 kgha-1 (Goenaga and Chardon 1993, 1995). Greece and Pederson 1996 reported that the similarity of common names and lack of obvious phenotypic variations among many accessions has led authors to suspect a high degree of genetic relatedness. They further asserted that the best way towards crop improving management efficiency is the determination of the genetic diversity within the collection and elimination of duplicate accessions.

For genetic improvement of any crops breeder requires information on nature and magnitude of variation in the existing population. The high potentiality of the genetic variability as experienced by a character is the main concern of breeders and their magnitude can be measured from the study of genetic coefficient of variability (Paul and Bari, 2012). According to Offori and Bernett-larteg (1995) morphological characters are important diagnostic features for distinguishing among genotypes. They may serve as genetic markers which facilitate and speed up selection in crop improvement programmes. Paul and Bari, 2012 also found out that the phenotype characters such as plant height, petiole length and number of suckers has a direct effect on yield per plant at the genotypic level. These characters hold the highest criteria to be selected in the crop breeding programme towards improving the taro crop.

Table 4. Phenotypic characterization of the taro collections based on IPGRI descriptors of 25 cocoyam accessions from Pacific-Islands

Acc. No	LBC	LLV	VJC	PA	PBC	PJC	PJCTP	PJP/SNS
BL/HW/08	Green	Present	Dark purple	Peltate	Purple	Green	Purple	Small/Wide
BL/HW/26	Yellow green	Present	Light Green	Peltate	Whitish	Green	Green	Small/ Broad
BL/HW/37	Green	present	Yellow	Sub-peltate	Light green	Yellow	Light green	Large
BL/SM/043	Green	Present	Light purple	Peltate	Light green	Red purple	Whitish	Small/Wide
BL/SM/80	Green	Present	Dark purple	Peltate	Dark purple	Red purple	Whitish	Medium/Wide
BL/SM/92	Green	present	Dark Green	Peltate	Light green	Absent	Green	Large
BL/SM/111	Green	Present	Green	Peltate	Green	Red purple	Green	Small/Wide
BL/SM/116	Green	Present	Purple	Peltate	Dark Purple	Red purple	Purple	Small/Wide
BL/SM/120	Purple	present	Dark purple	Peltate	Green	Dark purple	Purple	Small/wide
BL/SM/128	Green	Absent	Green	Peltate	Light green	Green	Purple	Large
BL/SM/132	Green	Present	Purple	Peltate	Dark purple	Red purple	Whitish	Small/Wide
BL/SM/143	Green	Present	Yellow	Peltate	Dark green	Green	Whitish	Small/Wide
BL/SM/149	Green	Present	Purplish green	Peltate	Light green	Red purple	Whitish	Large/Wide
BL/SM/151	Dark Green	Present	Purple	Peltate	Dark purple	Red purple	Whitish	Large/wide
BL/SM/152	Green	Present	Light green	Peltate	Dark Green	Yellow	Whitish	Small/wide
BL/SM/158	Green	Absent	Green	Peltate	Light green	Green	Green	Large
CA/JP/03	Green	Absent	Purple	Peltate	Light green	Red purple	Whitish	Small/Wide
CE/IND/01	Green	Present	Yellow	Peltate	Dark purple	Red purple	Purple	Small/wide
CE/IND/06	Green	Absent	Dark purple	Peltate	Light green	Red purple	Purple	Small/Wide
CE/MAL/14	Green	Absent	Purple	Peltate	Light green	Green	Green	Small/wide
CE/MAL/12	Green	Present	Light purple	Peltate	Dark purple	Red purple	Purple	Small/ wide
CE/THA/07	Green	Absent	Light green	Peltate	Dark purple	Green	Green	Small /wide
CE/THA/09	Yellow	Present	Green	Peltate	Light green	Green	Green	Small/ wide
CE/THA/24	Green	present	Light green	Peltate	Light green	Yellow	Green	Small/wide
BL/PNG/10	Green	present	Light purple	Peltate	Light green	Green	Whitish	Small/Wide
TOTAL	GRN: 90	AB: 24	GRN: 48	PT: 96	GRN: 64	GRN: 36	PP: 28	
Frequency%	YGRN: 6	PR: 76	PP: 36	SBT: 4	WT: 4	RPP: 48	WT: 36	
	PP: 4		Y: 16		PP: 32	DPP: 4	GRN: 36	
						Y: 8		

KEY: LBC-Leaf blade colour; LLV-Leaf lamina variegation; VJC-Vein junction colour; PBC- Petiole Basic colour; PA-Petiole Attachment; PJC- Petiole junction colour; PJCTP-Petiole junction colour of the top third; PJP: Petiole Junction pattern;
†GRN: Green; YGRN: Yellow green; Y: Yellow; PP: Purple; PPG: Purple green; AB: Absent; PR: Present; PT: Peltate; SPT: Sub peltate ; DPP: Dark purple.

Conclusion

From the findings, it was evident that the phenotypic characters from taro genotypes both Kenya and Pacific Islands tarogen collections displayed a high range of phenotypic variations. The phenotypic characters exhibited pronounced level of genetic variability. Phenotypic variations are also contributed by the profound effect of environment on the genotypes especially for Pacific Island taro germplasm collections. Some of these phenotypic characters observed might have been influenced by environmental factors although greater influence on phenotypic characters is governed by genetic constitution of the genotypes. The existence of phenotypic variation amongst taro genotypes forms a solid foundation and basis for taro improvement in the country and its promotion amongst other cash crop. Such comparative analysis of phenotypic characters of taro genotypes is forms a benchmark towards improving food security in terms of taro production and productivity, and germplasm diversification. This would enhance food sufficiency in the country towards improving smallholders' farmers' livelihood and utilize this taro crop as a cash crop.

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