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Short Communication
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Review of Taro (*Colocasia esculenta*) Genetics and Breeding

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Abstract

Germplasm screening, characterization and genetic improvement activities play great role in production and productivity of crops. Crop genetic evaluation can be conducted by morphological or molecular techniques and the available result has wide application in agriculture. Beside, appropriate breeding methods help to develop desirable plant character for further utilization depending on the identified gaps. Better understanding of crop genetic characteristics and breeding methods are useful in germplasm collection, conservation and utilization particularly in case of root and tuber crops. Different scientific findings on taro genetic characterization and breeding achievements were reviewed in this paper for further understanding and information dissemination. It was characterized largely based on morphological characters and few on molecular techniques and in both presence of variability that can be used in improvement programs was reported. Classical and modern taro breeding approaches utilized resulted in high yielding variety, disease resistant variety and drought resistant cultivar.

Keywords: Germplasm; Taro; Breeding; Genetics; Crop

Introduction

There are numerous root and tuber crops are grown in the world. Taro is one of such crops grown for various purposes. It is an erect herbaceous perennial root crop widely cultivated in tropical and subtropical world belonging to genus *Colocasia* in the plant family called Araceae [1]. The origin of taro is uncertain and however reported as it was originated and first domesticated in Southeast Asia [2]. The crop has been largely produced in Africa even though the time of its spread to the region is unknown and nowadays cultivated in Cameroon, Nigeria, Ghana and Burkina Faso where it has gained high importance [3]. Ayogu et al. described world's largest taro production in Nigeria [4].

In Ethiopia taro is cultivated mostly in the high rainfall areas of South and Western parts of the country by smallholder farmers. There is limited information on how and when it was introduced. However, taro is mainly produced for food purpose in Ethiopia. Tewodros et al. suggested as the crop was cultivated to fill seasonal food gaps when other crops still in the fields because of its potential in giving reasonable yield under conditions where other crops may unable to give produce by various crop production constraints [5]. Yared et al. [6] quoting Simon [7] elaborated this as it was due to taro`s exceptionally high yield, resistance to disease and pests, wide ecological adaptation, ease of management, storage for a longer period and availability when needed for consumption.

Taro can be grown as a root crop, as a leafy vegetable, as an ornamental and as medicinal plant and it is not only used in times of food shortage [8-11]. Beside, Mandal et al. [9] and Melese et al. [12] described role of taro in food security, income generation and in earning foreign currency reported and the authors also reported as taro corms, leaves, and petiole are rich in carbohydrate, fiber, and minerals and as it has been produced in Africa by small holder farmers and plays important roles in livelihood of many poor people in less developed countries. Besides, Verma and Chao reported similarly as taro was cultivated in Asia by small scale farmers and used as staple food crop [13]. On the other hand, taro peels and wastes used as an animal feed and use of its tops left after corms harvested for silage preparation [1].

However, crop production process is not easy task because of the existence different challenges. The most common challenges are from biotic and abiotic factors. Taro is one of the important crops grown under such circumstances. Thus the declining trend in taro production due to biotic and abiotic stresses was reported by Singh et al. [14]. On the other hand, taro is underutilized potential root crop in Ethiopia as there is limited information on its production status particularly in agronomy, protection, post-harvest management and socio-economic values.

Moreover, despite of the fact that many genotypes of taro scattered in diverse environments their conservation, genetic diversity status and improvement through breeding strategies are not fully documented [5]. Hence, for crops like taro, which are not fully characterized, knowledge of generic variability among the existing germplasm helps to develop conservation and breeding strategies for further improvements and utilization of the resources. Therefore, the objective of this paper is to review genetics and breeding of taro for further information dissemination and utilization.

Literature Review

Taro taxonomy and morphology

Taxonomy: Taro belongs to genus *Colocasia* and family Araceae which is made up of at least 100 genera and more than 1500 species [1,9]. According to Tumuhimbise et al. and Ubalua et al. [15,16] the two most widely cultivated taxonomic varieties include *Colocasia esculenta* var esculenta and *Colocasia esculenta* var antiquorum which is commonly known as the dasheen type (*Colocasia esculenta* var. esculenta), which has a large central corm with suckers and stolons and the second is the eddoe type (*Colocasia esculenta* var. antiquorum), which has a small central corm and a large number of smaller cormels [17,18]. The available growing genotypes of taro categorized in to wild and cultivated type. The wild type is not used for food. Quero-Garcia et al. reported as corms of the wild taro cannot be used as food due to an extremely high concentration of calcium oxalate crystals [19].

Morphology: Taro is naturally a perennial monocotyledonous herb, but for practical purposes is harvested after 5-12 months of growth [20]. Taro grows to a height of 1-2 m consisting of a central corm, lying just below the soil surface, from which leaves grow upwards, roots grown down wards, while cormels, daughter corms and runners grow laterally [16]. It has heart-shaped green or purple leaves together with long petioles, fibrous roots and cylindrical or often irregular nutrient storage organ (corm) and the nature of flowering, fruiting and seed production by wild or cultivated taros (*Colocasia esculenta*) has not been fully [21].

However, Castro reported as taro seldom flowers and when flowers occurs the inflorescence consists of a cylindrical spadix of flowers enclosed in a 12-15 cm spathe resulting unisexual with the female flowers located at the base of a spadix and the male flowers at the top [22]. According to Ivancic et al., because of poor flowering ability sexual reproduction is rare unless assisted by discipline of plant physiology and modern breeding technologies [10].

Genetic diversity in Taro

Mace and Godwin reported diploids (2n=2x=28) and triploids (2n=3x=42) chromosomes in taro while diversity study using simple cytological techniques [17]. However, Dastidar reported existence of taro chromosome number 2n=14, 28, and 42 and 2n=36 and 48 in India and suggested as the genetic instability might be due to cultivation for long period of time in the region of center of diversity [23]. Furthermore, Quero-Garcıa et al. stated as taro is highly polymorphic, allogamous and protogynous species [19]. Genetic resource of a crop consists of land races, improved verities, and elite lines and related wild species. Taro germplasm collection, characterization and evaluation under different agro-ecology plays great role for variability identification, conservation of desirable genotypes and utilization in crop improvement through breeding [24]. The importance of germplasm banks and genetic diversity in crop conservation and in making decision in taro breeding was reported [25].

Morphological characterization

Morphological taro characterization can be done based on its corm, stolon, leaf, petiole and floral characters and other quantitative traits. According to Lebot et al. there was high morphological variability in taro accessions in Southeast Asia and Oceania [26]. The variability with regard to morphological traits includes colour, shape and size of tuber, petiole length and colour, and stolon formation. Moreover, Manzano et al. reported presence of greatest morphological variability in root colour, cormel flesh colour, corm dry matter percentage, corm shape and cormel shape in *Colocasia esculenta* collected from Asia, Africa and America [27]. Concentration on morphological variability study in Asia might be due to large cultivation area and growing in the region.

Similarly, Bhattacharjee et al. reported wide degree of variation in leaf colour and shape corm weight and number of petiole per plant existed among different selected genotypes in India indicating greater possibility of improvement through selection [28]. Such quantitative and qualitative morphological variation might contribute desirable character that has to be included in breeding for further improvement of the crop. Furthermore, agro-morphological evaluation of taro accessions resulted in variability in Sierra Leone [29] and among 2,298 accessions collected in Indonesia, Malaysia, Thailand, Vietnam, the Philippines, Papua New Guinea and Vanuatu [30]. On the other hand, Orji and Ogbonna reported as morphological analysis of five taro cultivars in Nigeria resulted in limited variability except that three were able to flower and the authors recommended observed variability for further utilization in breeding [31].

In Ethiopia, Tewodros et al. evaluated taro genetic variability among domestic accessions collected in growing areas and indicated the existence of variability in their report [5]. The variability might be due to its long term cultivation in the country. Wild type taro exists but its natural range not well documented. The report can be used in improving genotypes, enhancing conservation and cultivation for economic advantages as well as provide reasonable status diversity including the wild type.

Chemical and molecular characterization

Multiple techniques used in identifying crop genetic diversity. From the findings of Mace and Godwin, Lakhanpaul et al., Dai et al. random amplified polymorphic DNA genetics analysis of taro accessions resulted in high diversity and heterogeneous forms [17,18,32]. Furthermore, Chaïr et al. reported variability in cultivars of Asia, Africa and America out of total of 321 cultivars collected and analyzed indicated as most West Africa taro cultivars were found to have originated from India and as this might be introduced by human migration [3]. Polymorphic microsatellite analysis helps in depth evaluation of genetic situation of crop and divergence analysis used in reducing genetic loss through supporting crop improvement. Bhattacharjee et al. suggested taro genotypes for further utilization up on the result of molecular characterization done in India [28].

Taro breeding and achievements

Classical breeding: The important targets of taro breeding might be genetic variability, corm yield, wider adaptability and resistant to disease and insect pests. Taro is vegetative propagated crop and rarely flowers and the flowers are protogynous, which makes the use of classical breeding methods difficult [22]. Developing variety by classical breeding is challenging because of its nature of flowering habit and breeding work depends on selection methods.

In Ethiopia Bolos-one is taro variety developed and registered through selection and strong evaluation as variety for mid altitude agro-ecology of Ethiopia [6]. This was effort made in getting superior high yielding variety. In addition, taro genotype with good yield performance and stability was identified and recommended in Nigeria [33].

Furthermore, conventional breeding conducted not only for looking for higher yield advantage but also for quality traits and resistant genotype to disease, stress and for wider adaptability of the crop to different agro climates. Research findings resulted the availability of taro resistance cultivars against the taro leaf blight and possibility of yield improvement described in Nigeria [34] and in Cameroon [35] where it largely produced in Africa.

Molecular breeding: Genotypic characterization of taro germplasm accessions under different ecological zones for comparative assessment of its genotype performances for crop improvement and the selection of desirable genotypes for breeding plays a vital role. Screening of causal agents of corm and root rot of *Colocasia esculenta* plant growing in Antalya and Mersin provinces of Turkey were isolated and identified using molecular characterization [36]. Besides, Miyasaka reported as cultivars were identified for high corm yields, taro leaf blight resistance, and low severity of corm rots among 119 cultivars collected from different places up on multi location trial in Hawii [37]. Breeding lines from Southeast Asia and Oceania were tested in American Samoa for resistance to taro leaf blight using a detached- leaf bioassay and field trials and the effectiveness of bioassay for taro cultivars in post penetration resistance recommended [38].

On the other hand, Das and Das reported karyotype analysis of ten drought resistant cultivars of Indian taro revealed the number secondary constricted chromosomes [39]. Mutation breeding helps in crop improvement inducing variability for breeding. Its advantageous goes more with for crop that can propagate vegetative like taro. Genetic improvement of taro (*Colocasia esculenta*) through *in-vitro* mutagenesis resulted optimum protocols for disease resistance against in Mauritius Phytophthora *Colocasia* [40]. In Ethiopia, major taro research works concentrated on germplasm collection, characterization and selection for desirable character [6,41,42] and application of modern breeding technique is at young stage.

Breeding achievements: Kiyak, Denu and Boloso-one are taro varieties registered at different time and being under production in Ethiopia based on characterization and evaluation among available accessions in the country [6] and genotype with good yield performance and stability in Nigeria [33]. Furthermore, effective result of detached-Leaf Bioassay for evaluating taro resistance to Phytophthora *Colocasiae* was reported [38]. Disease resistant cultivars identified using molecular characterization [34,36-37]. Breeding for drought resistant was done in Indian cultivars identified and recommended [39].

Conclusion

Taro is one of the root and tuber crops grown for various purposes. It is cultivated largely by small scale farmers and used as staple food crop in many developing nations of Asia and Africa. However, the availability of genetic variability has not been studied and documented in Africa as compared to that of Asia. This might be due to the assumption of its place of originality linked with long history of production in Asia countries. Taro cultivated as either garden or field crop for its corms, cormels and leaves. Propagation has been conducted by using its vegetative parts which is time consuming and laborious making its production less conducive in large scale production strategies. Knowledge of taro genetics and application of appropriate breeding strategy play great role in maintaining and improving available genotypes. Many studies conducted in evaluation of taro accessions in different country. Breeding conducted in evaluation of the crop with respect to yield, quality, adaptation and resistance to pest and stresses. Most of them done for morphological traits using classical methods and few were conducted for modern approaches.

In Ethiopia *Colocasia esculenta* is cultivated in southern and southwestern parts of the country. It is used for food security and income generation for people engage in its cultivation in the areas. Research has been started in assessing the socioeconomic impacts, characterizing and examining variability of available accessions in the country, and concerned in the identification of appropriate agronomic practices. As a result three taro varieties namely Kiyak, Denu and Boloso-one have been under production in the country.

Future Prospects

Current efforts have to be appreciated and supported by science of biotechnology to widen taro genetic base and to improve the crop with respect to yield, quality, disease resistance and to set cost effective way of agronomic strategies. Multi-disciplinary attentions have to be given to taro breeding and exploitation of its potential for better production and productivity through considerable evaluation under different agro ecology of the country.

References

1. Macharia WM, Nuro MS, Muchugi AN, Palapala V (2014) Genetic structure and diversity of East African Taro *Colocasia esculenta* L. Afr J Biotechnol 139: 2950-2955.
2. Hunt VH, Moot HM, Matthews PJ (2013) Genetic data confirms field evidence for natural breeding in a wild taro population (*Colocasia esculenta*) in northern Queensland, Australia. Genet Resour Crop Evol 60: 1695-1707.
3. Chaïr H, Traore RE, Duval MF, Rivallan R, Mukherjee A, et al. (2016) Genetic diversification and dispersal of Taro (*Colocasia esculenta* (L.) Schott). PLoS ONE 11: 1-19.
4. Ayogu CJ, Ike CU, Ogbonna OI, Nnaemeka GK (2015) Agricultural extension roles towards adapting to the effects of Taro leaf blight (Tlb) disease in Nsukka Agricultural Zone, Enugu State. J Biol Agr Health 5: 59-72.
5. Tewodros M, Getachew W, Kifle B (2013) Genetic diversity of Taro (*Colocasia esculenta* (L.) Schott) genotypes in Ethiopia based on agronomic traits. Time J Agric Vet Sci 1: 23-30.
6. Yared D, Tewodros M, Asfaw K (2014) Development of high yielding Taro (Colocacia esculenta L.) variety for mid altitude growing areas of Southern Ethiopia. J Plant Sci 2: 50-54.
7. Adebo S (1992) Taro root in North Omo. FPR Technical Pamphlet No. 2. FARM Africa, Ethiopia.
8. Prajapati R, Kalariya M, Umbarkar R, Parmar S, Sheth N (2011) *Colocasia esculenta*: A potent indigenous plant. Int J Nutr Pharmacol Neurol Dis 1: 90-96.
9. Mandal R, Mukherjee A, Mandal N, Tarafdar J, Mukherjee A (2013) Assessment of genetic diversity in Taro using morphometrics. Curr Agr Res J 1: 79-85.
10. Ivancic A, Quero Garcia J, Lebot V (2004) Genetically controlled branching corms of taro (*Colocasia esculenta*). New Zealand J Crop Hortic Sci 32: 167-177.
11. Paul KK, Bari MA, Islam SMS, Debnath SC (2014) Genotypic and Phenotypic correlation coefficient studies for Taro (*Colocasia esculenta*). Bangladesh J Bot 43: 113-117.
12. Melese T, Negussie R, Etalem T, Rikard L (2015) Effect of pre-Gelatinization on nutritive and non-Nutritive constituents of Taro (*Colocasia esculenta* L.) Corm. J Nutr Food Sci pp: 1-8.
13. Verma VM, Cho JJ (2010) Plantlet development through somatic embryogenesis and organogenesis in plant cell vultures of *Colocasia esculenta* (L.) Schott. Asia-Pac J Mol Biol Biotechnol 18: 167-170.
14. Singh D, Guaf J, Okpul T, Wiles G, Hunter D (2006) Taro (*Colocasia esculenta*) variety release recommendations for Papua New Guinea based on multilocation trials. New Zealand J Crop Hortic Sci 34: 163-171.
15. Tumuhimbise R, Gwokyalya R, Kazigaba D, Basoga M, Namuyanja V, et al. (2016) Assessment of production systems, constraints and farmers'

preferences for Taro (*Colocasia esculenta* (L.) Schott) in Uganda. Am Eurasian J Agr Environ Sci 16:126-132.

16. Ubalua AO, Ewa F, Okeagu OD (2016) Potentials and challenges of sustainable taro (*Colocasia esculenta)* production in Nigeria. J Appl Biol Biotechnol 4: 053-059.
17. Mace ES, Godwin ID (2002) Development and characterization of polymorphic microsatellite markers in taro (*Colocasia esculenta*). NRC Res Press 45: 823-832.
18. Dai HJ, Zhang YM, Sun XQ, Xue JY, Li MM, et al. (2016) Two-step identification of taro (*Colocasia esculenta* cv. Xinmaoyu) using specific psbE-petL and simple sequence repeat-sequence characterized amplified regions (SSR-SCAR) markers. Genet Mol Res 15: 1-10.
19. Quero-Garcia J, Courtois B, Ivancic A, Letourmy P, Risterucci AM, et al. (2006) First genetic maps and QTL studies of yield traits of taro (*Colocasia esculenta* (L.) Schott). Euphytica 151: 187-199.
20. Mwenye OJ (2009) Genetic diversity analysis and nutritional assessment of Cocoyam genotypes in Malawi. An M.Sc. Thesis presented to University of Free State, Bloemfontein, South Africa.
21. Matthews PJ, Agoo EMG, Madulin DA, Tandang DN (2012) Ethnobotany and ecology of wild Taro (*Colocasia esculenta*) in the Philippines: Implications for domestication and dispersal. Senri Ethnol Stud 78: 307-340.
22. Castro GR (2006) Studies on Cocoyam (*Xanthosoma* spp.) in Nicaragua, with emphasis on Dasheen mosaic virus. Doctoral thesis presented to Swedish University of Agricultural Sciences, Uppsala.
23. Dastidar SG (2009) *Colocasia esculenta*: An account of its ethno botany and potentials. An M.Sc. Thesis presented to The University of Texas, Austin.
24. Rao RM, Hunter D, Eyzaguirre PB, Matthews PJ (2010) Ethnobotany and global diversity of Taro. The global diversity of Taro, biodiversity international, Rome, Italy.
25. Akwee PE, Netondo G, Kataka JA, Palapala VA (2015) A critical review of the role of Taro *Colocasia esculenta* L. (Schott) to food security: A comparative analysis of Kenya and Pacific Island taro germplasm. Sci Agr 9: 101-108.
26. Lebot V, Hartati S, Hue N, Viet N, Nghia N, et al. (2010) Characterizing taro using isozymes and morpho-agronomic descriptors. The global diversity of taro, Biodiversity International, Rome, Italy pp: 39-55.
27. Manzano AR, Nodals AAR, Gutiérrez MIR (2001) Morphological and isoenzyme variability of Taro (*Colocasia esculenta* L. Schott) germplasm in Cuba. The global diversity of Taro, Biodiversity International, Rome, Italy pp: 69-91.
28. Bhattacharjee M, Tarafdar J, Sadhukhan R (2014) Assessment of genetic diversity of some indigenous collections of upland taro *Colocassia esculenta* var. antiquorium (L.) Schott for selection of genotypes aiming at improvement in breeding programme. IOSR J Agr Vet Science 7: 31-34.
29. Norman PE, Bebeley JB, Beah AA, Sellu EF (2015) Assessment of agro-morphological diversity and affinities in cocoyam species from Sierra Leone. Int J Biodiver Conservation 7: 408-419.
30. Lebot V, Prana MS, Kreike N, Heck H, Pardales J, et al. (2004) Characterization of Taro (*Colocasia esculenta* L. Schott) genetic resources in Southeast Asia and Oceania. Genet Res Crop Evol 51: 381-392.
31. Orji OK, Ogbonna PE (2015) Morphological correlation analysis on some traits of Taro (*Colocasia esculenta*) in plains of Nsukka, Nigeria. J Glob Biosci 4: 1120-1126.
32. Lakhanpaul S, Velayudhan KC, Bhat KV (2003) Analysis of genetic diversity in Indian taro *Colocasia esculenta* L. Schott using random amplified polymorphic DNA (RAPD) markers. Genetic Res Crop Evol 50: 603-609.
33. Eze CE, Nwofia GE, Onyeka J (2016) An Assessment of Taro yield and stability using Ammi and GGE Biplot Models. J Exper Agr Int 14: 1-9.
34. Bandyopadhyay R, Sharma K, Onyeka TJ, Aregbesola A, Kumar PL (2011) First Report of Taro (*Colocasia esculenta*) Leaf Blight Caused by Phytophthora Colocasiae in Nigeria. Plant Dis 95: 618.
35. Charles F, Grace M, Evelyn M, Estella T, Hanna R (2016) Screen house and field resistance of Taro cultivars to Taro leaf blight disease (Phytophtora Colocasiae). Br Biotechnol J 15: 1-15.
36. Dervis S, Soylu S, Serce CU (2014) Corm and root rot of *Colocasia esculenta* caused by *Ovatisporangium vexans* and *Rhizoctonia solani*. Romanian Biotechnol Letters 9: 9868-9874.
37. Miyasaka SC, McCulloch C, Nelson SC (2012) Taro germplasm evaluated for resistance to Taro leaf blight. Hortic Technol 22: 838-849.
38. Brooks FE (2008) Detached-leaf bioassay for evaluating Taro resistance to Phytophthora *Colocasiae*. Am Phytopathol Soc 92: 126-131.
39. Das A, Das AB (2014) Karyotype analysis of ten draught resistant cultivars of Indian taro-*Colocasia esculenta* cv. antiquorom Schott. Nucleus 57: 113-120.
40. Seetohul S, Puchooa D, Ranghoo-Sanmukhiya VM (2008) Genetic Improvement of Taro (*Colocasia esculenta* var esculenta) through *in-vitro* mutagenesis. UoM Res J 13A: 79-89.
41. Tewodros M (2013) Morpho-agronomical Characterization of Taro (*Colocasia esculenta*) accessions in Ethiopia. Science Publishing Group 1: 1-9.
42. Yeshitila M, Temesgen D (2016) Exploration and collection of root and tuber crops in East Wollega and Ilu Ababora zones. Indian J Trad Knowledge: Rescuing Decling Gen Resources 15: 86-92.