EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 3
Issue: 4
459-463
Year: 2016

AROIDS FOR ENSURING LIVELIHOOD SECURITY IN INDIA: A REVIEW

Amit Kumar Singh*[1], A. K. Chaurasiya[2] and Surajit Mitra[3]

[1]M S Swaminathan School of Agriculture, CUTM, Gajapati, Odisha -761211, (India).
[2]North Eastern Hills University Tura, Meghalaya-794002 (India).
[3]Bidhan Chandra Krishi Viswavidyalaya Mohanpur-741252, Nadia, WB (India).

***Author for Correspondence: Dr. Amit Kumar Singh**
M S Swaminathan School of Agriculture, CUTM, Gajapati, Odisha -761211, (India).

Article Received on 19/02/2016 **Article Revised on 10/03/2016** **Article Accepted on 01/04/2016**

ABSTRACT
We live in a crazy world. On the one hand we read of a surplus of wheat and mountain of butter and meat, and on the other we see on our TV screens the spectre of starving people. We can attempt to rationalise this by pointing to the unequal distribution of food and wealth between the developed (rich) and the developing (poor) countries, and the further inequalities of wealth between individuals within any particular developing country. India support more than 17 % of the population with only 2.4 % land share. At the global level, it appears that we are slowly moving towards global food crisis. Recently published special report of UN on the "Right to Food" estimated that nearly one billion people sleep without food across the world, and among every six seconds a chield dies of malnutrition. Agricultural production is an important contributor to India economy and providing nearly 67% of the country's employment. Aroids comprise a small group of plants adapted to a wide range of ecological condition that exists in the tropics. It comprises five main genera Alocasia, Amorphophallus, Colocasia, Christospama and Xanthosoma of which Colocasia, Amorphophallus and Xanthosoma grown in India for their edible corm/cormels. Aroids along with other tropical tuber crops has now become an obvious candidate as food security crop because of its capacity to do well on marginal soils even with low annual rainfall and its ability to give some return even in the years of droughts and flood.

KEYWORDS: Alocasia, Amorphophallus, Colocasia, Christospama and Xanthosoma of which Colocasia, Amorphophallus and Xanthosoma grown in India for their edible corm/cormels.

INTRODUCTION

With ever-increasing population pressure and fast depletion of natural resources, it has become extremely important to diversify the present-day agricultural in order to meet various human needs (Janardhanan *et al.* 2003). The world food crisis has been and will continue to be a major obstacle to humanity. The observed interest in search for alternative / additional food and feed ingredients is of paramount importance mainly for two reasons, one is the low production of oil seeds and grains, and another is the stiff competition between man and the livestock industry for existing food and feed materials (Siddhuraju *et al.* 2000). Aroids comprise a small group of plants adapted to a wide range of ecological condition that exists in the tropics. It comprises five main genera Alocasia, Amorphophallus, Colocasia, Christospama and Xanthosoma of which Colocasia, Amorphophallus and Xanthosoma grown in India for their edible corm/cormels. Taro (*Colocasia esculenta* var. *esculenta* and *Colocasia esculenta* var. *antiquorum*, and *Xanthosoma*) are the most important members of the edible aroids which form part of the Araceae family (Bradbury and Holloway, 1988). Root and tubers are the most important food crops since time immemorial in the tropics and subtropics (Behera *et al.* 2009). Roots and tubers refer to any growing plant that stores edible material in subterranean root, corm and tuber. The nutritional value of roots and tubers lies in their potential ability to provide one of the cheapest sources of dietary energy in the form of carbohydrates in developing countries (Ugwu, 2009). Their contribution to the world food security, in particular in developing countries, is essential. Their importance in the future might come from either their potential to substitute cereals, their use as a source of new starches, or just as a basis for yet undefined processed products. However, a number of their characteristics hinder greater industrial exploitation, i.e. they have no uniform shape, making mechanical peeling difficult; skin and flesh, colour and texture do vary; and there is limited data on starch content and composition.

Notwithstanding their high starch content, edible aroids have a higher content of protein and amino acids than many other tropical root crops (Kay, 1987). Protein quality is essentially the same for all aroids determined with lysine as first limiting amino acid (chemical score 57-70) (Bradbury and Holloway, 1988). The mature corms and young shoots of edible aroids are mostly used as boiled vegetables, but the corms are also roasted, baked, or fried. Roasted or boiled corms can be eaten alone or with stew. Aroids are also processed into flour, which is used to prepare "fufu" that is commonly eaten in Nigeria with stew. Taro chips and "luau" is another important secondary product. Despite their considerable potential as animal feed, renewable energy source and industrial raw material, the development of agro-industries based on aroids as major inputs remains a theoretical concept despite several positive indicators from research and development.

Different Crops Under Aroids

S.No	Name of crop	B.N.	Family	Origin	2n	Avg. Wt.	Parts used
1.	EFY	*Amorphophallus paeoniifolius*	Araceae	South east Asia	26	1500-3500g	corms
2.	Colocasia	*Colocasia esculenta* (L.) Schott	Araceae	South east Asia	28	200-400g	corms
3.	Tannia	*Xanthosoma sagittifolium*	Araceae	Tropical America	26	200-500g	corms

(Source- Trech, 1996).

Elephant foot yam

Amorphophallus paeoniifolius (Dennst.), syn. *A. campanulatus* (Roxb.) BL. ex Dence (also elephant foot yam) is an herbaceous, perennial crop and it is locally used as staple food in many Asian countries (Jansen *et al*., 1996). An elephant foot yam is a potential new cash crop because the tuber contains high starch (O'hair and Asokan, 1986). It is basically a crop of south eastern Asian origin. It serves as a source of protein as well as starch. It has long been used as a local staple food in many countries such as the Philippines, Java, Indonesia, Sumatra, Malaysia, Bangladesh, India, China and south eastern Asian countries (Chandra, 1984; Sugiyama and Santosa, 2008). The leaves are used as a vegetable by local tribes in India because they contain high amount of vitamin A (Rajyalakshmi *et al*. 2001). It is an important vegetable crop and grown in most of the states in India. Amorphophallus is usually propagated with offsets of corms. These offsets are the miniature tubers which grow out of mother corms and are called buds or daughter corms. These are initially about 20 -25 gms each and take about 3-4 seasons to develop into corms weighing 8-10 kg each. The planting time of Elephant's foot yam in South India is February-March, while in eastern and other parts of the country is in March-April provided irrigation facilities are ensured as the crop needs irrigation during the summer months. The crop matures in 8 to 10 months and propagated vegetative. Thus, 30% of total commercial produce 'corm' is being utilized as seed material. Besides this, the productivity of the crop is affected by various factors associated with its conventional propagation (Mukharjee *et al*. 2009).

Taro / Colocasia: Taro (*Colocasia esculenta* (L.) Schott) is a traditional crop with a long history of cultivation in Asia and the Pacific. Taro (*Colocasia esculenta*) is deeply rooted in the agriculture and food culture of Japan. Its name in Japanese - *satoimo* - is composed of the words "sato" meaning village or home and "imo" meaning root or tuber, reflecting the central role it plays as a staple food crop in small-scale farming systems. It is also thought that the Japanese owe their predilection for slimy foods, such as glutinous or sticky rice, to the high appreciation they hold for taro (Rao *et al*. 2010). India being one of the centres of origin of taro is blessed with an immense genetic wealth of the crop. Taro is cultivated throughout the country for the use of its corms, cormels and the leaves as vegetable. Taro is ordinarily grown in the homestead garden and its cormels, petiole and leaves serve the important purpose as an instant vegetable. The root, also called a corm or tuber, as well as the petioles and leaves are consumed. All parts of the plant must be cooked prior to eating because of the acridity associated with a compound on the calcium oxalate crystals (raphides) (Paull *et al.* 1999). Even though there is no statistical data available on the area and production of taro in India, it is a fact that taro commands a higher price than cassava or sweet potato. There are several kinds of taro: swamp taro (*Cyrtosperma chamissonis*), tannia (*Xanthosoma sagittifolium*), giant taro (*Alocasia macrorrhiza*) and ordinary or true taro (*Colocasia esculenta*) prevalent in India, of which tannia is the most similar to the ordinary taro, and is characterized by relatively large, sagittate leaves, a large main corm and several cormels, which are used as food. Ordinary taro is the most important species in the group. There exists differing opinions regarding the original home of the crop as well as its taxonomy and common names (Spier 1951; Mehta, 1959; Coursey, 1968; Harian, 1975; Plucknett, 1970; Onwume, 1979; Kuruvilla and Singh, 1983; Jos and Sreekumari, 1990 and Sreekumari, 1993). Numerous vernacular languages are prevalent in India and the common (local) name of taro in different parts of the country are: arvi (Hindi), chempu (Malayalam), seppan kizhangu (Tamil), kachchi (Kannada), chamadumpa (Telugu), alu (Marathi) and kachu (Bengali). The corms are primarily a source of energy in the form of easily digested starch. They are high in carbohydrates and low in fat and protein. Fresh corms are composed of about 69% moisture, 25% starch, 1.5% dietary fibre, 1.1% protein and 1% sugar (rounded averages from Bradbury and Holloway 1988).

Tannia: Tannia (*Xanthosoma sagittifolium*) is also known as new cocoyam and in the region is important in the islands of Dominica, St Vincent and the Grenadines, St Lucia and Grenada. Both the leaves and subterranean tubers are eaten, but the tubers are the preferred plant part eaten. The tubers are said to contain the irritant substance calcium oxalate and saponins which are destroyed in cooking. Tops, sprouted corms and suckers can all be used in propagating tannias. The suckers and tops are reported to give higher yields than the cormels. The planting material most commonly used are portions of the central corm, from 100 to 150 g, with three or four buds. They give greater yields than the cormels which are also sometimes used. The most serious problem at present is "dry disease", a complex produced by fungi (*Rhizoctonia*, *Phytium*) and bacteria (*Erwinia*, *Pseudomonas*) which attack the young plants, causing leaf wilt and tuber rot and resulting in the complete loss of the harvest. Harvesting is carried out ten to 12 months after planting, when the leaves have turned yellow and are beginning to dry. The crop is harvested by hand or by a semi-mechanized method.

Table 5: Characteristics of tropical root and tuber crops

Characteristics	**Cassava** *Manihot esculenta* **Euphorbiaceae**	**Sweet potato** *Ipomea batata* **Convolvulaceae**	**Yam** *Dioscorea spp.* **Dioscoreaceae**	**Aroids** *Colocasia esculenta* **and** *Xanthosoma sagittifolium* **Araceae**
World production in 2007 (millions tons)*	226	124	51	13
World cultivated area (millions ha.)	18.6	9.0	4.6	1.9
World avg. Yield (fresh tons/ha)	12.2	13.7	11.2	6.7
Yields potential (fresh tons/ha)	90	120	110	110
Planting material (Propagule)	Stems	Vine cuttings	Tubers	Corms, Suckers
Growth period (Months)	8-36	3-6	8-36	6-16
Optimum rainfall (mm)	1000-1500	750-1000	1200-1500	2500-3500
Optimal temp. (^{O}C)	25-30	20-25	30	20-35
Drought resistant	Yes	Yes	Yes	No
Water logged tolerant	No	No	No	Yes
Shade tolerant	No	No	No	Yes
Soil fertility requirement	Low	Low	High	High
Post harvest storage life	Very short	Short	Long	Moderate
Leaves used for human consumption	Yes	Yes Common in West Africa and East Asia	No	Yes
Leaves used for animal feed	Yes	Yes	No	Yes

(Sorce: Lebot, 2009)

Table 6: Nutritional value of aroids

Constituents	**Taro**	**Tannia**	**Giant taro**	**Giant swamp taro**	**Elephant foot yam**
Moisture %	69.1	67.1	70.3	75.4	77.8
Energy kJ./100g	480	521	449	348	336
Protein %	1.12	1.55	2.15	0.51	2.24
Starch %	24.5	27.6	21.5	16.8	16.6
Sugar %	1.01	0.42	0.96	1.03	0.14
Dietary fibre %	1.46	0.99	1.85	2.78	1.45
Fat %	0.10	0.11	0.10	0.16	0.06
Ash %	0.87	1.04	0.92	0.67	1.36
Ca (mg/100g)	32	8.5	38	182	97
P (mg/100g)	70	53	44	16	67
Mg (mg/100g)	115	27	52	21	47
Na (mg/100g)	1.8	6.6	30	72	4.1
K (mg/100g)	448	530	267	67	622
S (mg/100g)	8.5	7.9	12	3.3	12
Vitamin A (mg/100g)	0.007	0.005	0	0.005	0.07
Thiamin (mg/100g)	0.032	0.024	0.021	0.025	0.06

Riboflavin (mg/100g)	0.025	0.032	0.018	0.019	0.05
Total oxalate (Ox) mg/100g	65	42	42	288	18
Soluble oxalate (mg/100g)	35	44	17	45	-
Calcium oxalate (mg/100g)	43	23	37	399	-
Trypsin inhibitor (mg/100g)	14	0.3	269	2.5	0.56

Source: (Bradbury and Holloway, 1988)

Importance and major uses

Economic and Social Impact of Edible Aroids

Edible aroids contribute an important part to the carbohydrate content of the diet in many regions in developing countries. They produce edible starchy storage corms or cormels. Although they are less important than other tropical root crops such as yam, cassava and sweet potato, they are still a major staple in some parts of the tropics and sub-tropics. In the South Pacific Island countries in particular, edible aroids represent a very high proportion of the root crops. In the South Pacific and parts of Africa taro is a staple food crop, and in the Caribbean and West Africa in particular, tannia is the main edible aroid. Despite the economic importance of edible aroids as a food material in these regions, there is limited scientific information on their post-harvest characteristics, which perhaps contributes to the very limited application of improved post-harvest technologies to maintain quality and improve marketing potential.

Nutritional Facts

Notwithstanding their high starch content, edible aroids have a higher content of protein and amino acids than many other tropical root crops (Kay, 1987). Protein quality is essentially the same for all aroids determined with lysine as first limiting amino acid (chemical score 57-70) (Bradbury and Holloway, 1988). The nutritional values of the major edible aroids are presented in Table 2. A summary of comprehensive chemical analysis of large samples of aroids from different countries is also presented (Table 3). The highlights of the nutritional and chemical composition are presented (Table 4). The purpose of these data is to assist food process engineers and many other scientists in developing improved food processing operations as well as new food products, particularly those aimed at enhancing the nutritional status of people living in regions that produce cocoyam. Considering the huge variation in compositional data of raw material in general, these data must be used only as a guide in making nutritional calculations.

Primary products

Aroids are grown mainly for food. The mature corms and young shoots of edible aroids are mostly used as boiled vegetables, but the corms are also roasted, baked, or fried. Roasted or boiled corms can be eaten alone or with stew. In parts of West Africa, the boiled corms are mashed and used as weaning diet. Mature edible aroids are also processed into flour, which is used to prepare “fufu” that is commonly eaten in Nigeria with stew. In south-eastern part of Nigeria in particular, tannia is used in small quantity as soup thickener after boiling and pounding to obtain a consistent paste. Taro chips are another important secondary product. In the South Pacific, young taro leaves are used with coconut cream to prepare a dish called “luau”, which is then used to eat the boiled or roasted taro, breadfruit and banana.

Secondary and derived product

Despite their considerable potential as animal feed, renewable energy source and industrial raw material, the development of agro-industries based on aroids as major inputs remains a theoretical concept despite several positive indicators from research and development.

Post harvest management of aroids:

Table 7: Storage life of Aroids

Sl. No.	Crop	Storage life (Months)
1.	EFY	3
2.	Colocasia	3
3.	Tannia	4

Processed products

Table 8: Explanatory summary on processed products of main edible aroids.

Sl. No.	Edible aroid	Processed Products
1	Taro (*Colocasia esculenta*)	Taro paste (fufu), Poi, Taro flour, Chips
2	Tannia (*Xanthosoma* spp)	Tannia flour, Chips
3	Giant taro (*Alocasia* spp.)	Roasted, Baked, Flour, Boiled form
4	Giant swamp taro (*Cyrtosperma chamissonis*)	Roasted
5	Elephant foot yam (*Amorphophallus campanulatus*)	Pickles, Chips, Dry form, Fried, Powder, Flakes Preserved Candy, Beverage, Jam and Dehydrated fruits

Summary and conclusion: Only a limited number of crops produce the bulk of food consumed in the world. Many neglected and under-utilized species are extremely important for food production in low income food deficit countries (LIFDCs). They are locally well adapted to marginal lands and constitute an important part of the local diet, providing valuable nutritional elements (e.g. protein, vitamins, minerals) and spices, often lacking in staple crops. Their role in traditional medicine is also well known. Neglected and under-utilized crops also represent an important source of revenue for local economies and are part of the rich cultural and traditional heritage of communities around the world. In addition, these crops are important sources of resistance genes for biotic and abiotic stress breeding that can be utilized also for the genetic improvement of commodity crops. As compared to the major crops, they require relatively low inputs and, therefore, contribute to sustainable agricultural production.

REFERENCES

1. Behera, KK. Maharana, T. Sahoo, S. Prusti, A. Biochemical quantification of protein, fat, starch, crude fibre, ash and dry matter content in different collection and greater yam (Dioscorea alata L.) found in Orissa. Nature and Science. 2009; 7: 24-32.
2. Bradbury, JH. Holloway, WD. Chemistry or Tropical Root Crops: significance for nutrition and agriculture in the Pacific. 1988; ACIAR Monograph No. 6, 201 p.
3. Chandra, S. Edible aroids. Clarendor Press, Oxford, 1984; 252.
4. Coursey, DG. The edible aroids. World Crops, 1968; 20(4): 25-30.
5. Harian, JR. Crops Mass. American Soc. Agron. Crops Sci. Soc. America. Madison, Wisconsin, 1976; 1-295.
6. Janardhanan, K. Vadivel, V. Pugalenti, M. Biodiversity in Indian underexploited/tribal pulses. In: Improvement Strategies for Leguminosae Biotechnology, P.K. Jaiwal and R.P. Singh (eds.). Kluwer Academic Publishers. Printed in Great Britain, 2003; 353-405.
7. Jansen, PCM. Wilk, CVD. Hetterscheid, WLA. Amorphophallus Blume ex Decaisne. In M. Flach and F. Rumawas (Eds.). PROSEA 9: Plant Yielding Non-seed Carbohydrates. Backhuys Publ. Leiden, 1996; 45-50.
8. Jos, JS. Sreekumari, MT. Cytogenetics of tuber crops. In. Advances in Horticulture, Chadda, K.L. and Nayar, G.G. (Eds.), 1991; 8: 162-189.
9. Kay, DE. Crop and product digest No. 2 Root crops. 2nd Edition. London: Tropical Development and Research Institute, 1987; 380.
10. Kuruvilla, KM. Singh, A. Karyotype and electro phoretic studies on taro and its origin. Euphytica, 1981; 30: 405-415.
11. Lebot, V. Tropical root and tuber crops: cassava, sweet potato, yams and aroids. Crop production science in Horticulture no. 17, CABI Publishing, UK, 2009; 413.
12. Mehra, YR. In. Production Technology of Vegetable Crops. Oxford and IBH Pub. Co.Pvt. Ltd., 1959; 617-627.
13. Mukharjee, A. Naskar, SK. Nedunchezhiyan, M. Rao, KR. In vitro propagation of Elephant foot yam. Indian Journal of Horticulture, 2009; 66(4): 530-533.
14. O'Hair, SK. Asokan, MP. Edible aroids: botany and horticulture. In J. Janick (ed.). Horticultural Reviews Vol. 8. ASHS, AVI Publ. Co., Westport, Connecticut, 1986; 34-99.
15. Onwueme, IC. The Tropical Tuber Crops. John Wiley and Sons Ltd., 1979.
16. Paull, RE. Tang, CS. Gross, K. Uruu, G. The nature of the taro acridity factor. Postharv. Biol. Technol. 1999; 16: 71-78.
17. Plucknett, DL. Pena, RS. Dele. Obrero, RT. Taro (Colocasia esculenta) Field Crop Abstracts 1970; 23: 413-426.
18. Rajyalakshmi, P. Vankatalaxmi, K. Venkatalakshmamma, K. Jyothsna, Y. Devi, KB. Suneetha, Y. Total carotenoid and beta-carotene contents offorest greenleal)rvegetables consumed by tribals of south India. Plant Foods for Human Nutrition, 2001; 56: 225-238.
19. Rao, VR. Matthews, PJP. Eyzaguirre, B. Hunter, D. The Global Diversity of Taro: Ethnobotany and Conservation. Bioversity International, Rome, Italy, 2010; ISBN 978-92-9043-867-0.
20. Siddhuraju, P. Becker, K. Makkar, HPS. Studies of the nutritional composition and antinutritional factors of three different germplasm seed materials of an underutilized tropical legume, Mucuna pruriens var. utilis. Journal of Agricultural and Food Chemistry. 2000; 48: 6048-6060.
21. Spier, RFG. Some notes on the origin of taro: South Western J. Anthropol. 1951; 7: 69-76.
22. Sreekumari, MT. Cytomorphological and cytogenetic studies on Edible Aroids Ph.D. Thesis, University of Kerala, Trivandrum, 1993.
23. Sugiyama, N. Santosa, E. Edible Amorphophallus in Indonesia -Potential crops in Agroforestry, Gadjah Mada Univ. Press, PO. Box. 14, Bulaksumur, Yogyakarta 55281, 2008; 125.
24. Trech, ES. Tropical root and tuber crops as human staple food Confirenee présentèe au I Congresso Latino Americano de Raizes Tropicals (7-10 Octobre 1996, Sa0 Pedro - SP - Brésil); 1996.
25. Ugwu, FM. The potentials of roots and tubers as wearing food. Pakistan Journal of Nutrition, 2009; 8: 1701-705.