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Enriching underutilised tuber crops: Emerging opportunities

India is one of the world's richest centres of diversity for tropical tuber crops, including several minor crop species with significant potential for food, nutrition and industrial applications. Despite this potential, most of these crops remain underutilised and are cultivated only on a limited scale. This article highlights crop improvement efforts including germplasm enrichment, identification of promising genetic stocks and varietal development in Queensland arrowroot, West indian arrowroot, Chinese potato, Yam bean and East indian arrowroot. It also discusses the major production and breeding constraints together with emerging opportunities for their commercial utilization.

Keywords: Germplasm, Underutilised tuber crops, Varieties, Value addition

INDIA is one of the world's richest centres of diversity for tropical tuber crops, which play a vital role in food and nutritional security and livelihood support, particularly in tribal and marginal farming systems. While major root and tuber crops such as Cassava, Sweet potato and Yams dominate commercial cultivation, several minor and underutilised crops remain confined to traditional and subsistence farming despite their considerable potential for value addition and industrial use. Although grouped as minor tuber crops, they are botanically diverse and belong to different families, producing storage roots, tubers or rhizomes rich in starch and essential nutrients. Important examples include Queensland arrowroot, West indian arrowroot, Chinese or coleus potato, Yam bean and East indian arrowroot. These crops produce edible rhizomes, roots or tubers, generally yielding 21–38 t/ha, with fresh-matter starch contents of about 9–27%. Traditionally consumed as foods, they are also valued for dietary and medicinal uses. However, their wider cultivation is constrained by crop-specific production problems and breeding limitations, including vegetative propagation, bulky planting material, long crop duration, narrow genetic diversity and poor or absent seed set (except in Yam bean).

Queensland arrowroot: Queensland arrowroot is an edible rhizomatous crop of South American origin and is cultivated in Southeast Asia, Southern China, India and Oceania for its starch-rich rhizomes. In India, it is grown in Darjeeling district of West Bengal, South Sikkim and as a backyard crop in several regions. It is locally known as *'Seeni kalvazhai'* in Tamil, *'Canna koova'* in malayalam and *'Kanda'* in hindi. No varieties of this crop have been released in India to date. Four major edible canna types are recognised globally: Thai green, Japanese green, Thai purple and Chinese purple. The Chinese purple type produces rhizome yield of 30–38 t/ha and starch yield of 4.1–4.9 t/ha.



Queensland arrowroot

At ICAR–CTCRI, green and purple germplasm types have been collected, conserved and evaluated, revealing considerable variation in rhizome yield and starch content. Two promising genetic stocks, Kodalan Green (IC647797) and Manalur Purple (IC647798), have been identified and registered for their desirable agronomic and starch related traits. These genetic resources provide valuable breeding material for future varietal improvement. Commercial cultivation is, however, constrained by tall plants prone to lodging, long crop duration and the requirement for bulky rhizomes as planting material. Crop improvement has remained limited because the crop is cultivated only on a small scale in backyards, receives little breeding attention and is propagated predominantly through rhizomes.

West indian arrowroot: West indian arrowroot belongs to the family Marantaceae and is cultivated primarily for its starch-rich rhizomes, which are used as food and in traditional medicine. In India, the crop is grown mainly in homesteads and backyards under



West Indian arrowroot

partial shade, particularly in Kerala and the North-eastern states, where it fits well into low-input and organic farming systems. It is called *'Koova'* in malayalam and *'Koovai'* in tamil. Its tolerance to shade and marginal soils makes it suitable for fragile and rainfed ecosystems. The crop has a long duration (9–10 months) and requires bulky rhizome pieces for planting. It is propagated exclusively through clonal rhizomes and does not produce botanical seeds, resulting in very limited genetic recombination and breeding opportunities.

West indian arrowroot produces an average rhizome yield of 25–30 t/ha, with a starch content of 16–24% on a fresh-matter basis. On a dry-matter basis, the rhizome contains about 80–90% starch, 0.2–3.7% protein, less than 1–1.4% fat and 1–4% fibre. Arrowroot starch has oval to spherical granules (about 45 µm long), low lipid and protein contents, high viscosity and excellent swelling power.

Systematic evaluation of germplasm has resulted in the release of the improved varieties Sree Aadya, Sree Nakshathra and Sree Karthi, which are characterised by high starch productivity and improved horticultural performance. These varieties provide greater scope for commercial cultivation than traditional landraces. Future improvement should focus on broadening germplasm base for improvement in starch yield, higher number of tillers and reduced planting-material requirement.

Chinese potato: Chinese potato, also known as coleus potato, is a short-duration (4–5 months) tuber crop of african origin, now cultivated in Southeast Asia including India, Sri Lanka, Malaysia, Indonesia and Thailand. In India, it is cultivated mainly as a smallholder crop in Kerala, Tamil Nadu and Karnataka. Chinese potato is locally known as *'Koorka'* in malayalam, *'Sirukizhangu'* in Tamil and *'Sambarani gadde'* in kannada. It is valued for its pleasant aroma, good cooking quality and nutritious tubers. Four improved varieties, namely Sree Dhara, Suphala, Nidhi and CO-1 have been released in India with desirable traits including high tuber dry weight, photo-insensitivity, superior cooking quality and high starch content. Nevertheless, commercial production is constrained by root-knot nematode susceptibility and photoperiod-sensitive tuberisation, while crop improvement is hampered by reproductive sterility and a narrow genetic base. Future research should focus on overcoming these constraints through mutation breeding and modern biotechnological approaches.

Yam bean: Yam bean is native to Mexico and Central America and has spread to Asia, Africa and parts of India. It is cultivated mainly in Bihar, Odisha, West Bengal and the North-eastern states. This multipurpose leguminous root crop produces nutrient-rich storage roots; its protein-rich seeds, however, contain toxic rotenone and must not be consumed. The relatively low root dry matter and the presence of rotenone in the seeds are major production constraints. As a legume, it fixes atmospheric nitrogen and improves soil fertility. The genus *Pachyrhizus* includes three cultivated species, *P. erosus*, *P. ahipa* and *P. tuberosus* among which interspecific hybridisation is feasible. Only *P. erosus* is available in India, and because the crop is predominantly self-pollinated, the available germplasm possesses limited genetic diversity, restricting breeding progress. Introducing the other cultivated species would broaden the genetic base for improvement.



Chinese potato



Yam bean

At ICAR–CTCRI, 55 accessions are maintained at the headquarters and 165 at the Regional Centre, Bhubaneswar, in field gene banks. A promising genetic stock, Havelock local (IC635945), has been identified from the NAGS, Thiruvananthapuram. Recently, Bhu Sakarkanda new variety has been released from research centre of CTCRI, Bhubaneswar and recommended for cultivation for Odisha. Several improved varieties, namely RM-1, RM-2 and RM-3 have been developed with desirable traits such as high tuber yield and early maturity from RPCAU, Dholi, Bihar under All India Coordinated Research Project on Tuber Crops (AICRP-TC).

East indian arrowroot: East indian arrowroot is a perennial rhizomatous herb cultivated mainly in Chhattisgarh, Madhya Pradesh, Jharkhand and parts of South India. It is propagated through rhizome pieces, and its rhizomes are valued for edible starch extraction. Commercial cultivation is constrained by the requirement for bulky planting material (approximately 1.8–2.0 t/ha) and long crop duration. Crop improvement has progressed slowly because of vegetative propagation, limited germplasm characterisation and the non-availability of improved varieties in most growing regions. From the minor tuber crops field gene bank maintained at ICAR–CTCRI, a promising genetic stock, TVM Local (IC641835; INGR25038), has been identified and registered with ICAR-NBPGR for its long primary rhizomes and high starch content (16.8%).



East indian arrowroot

Emerging commercial opportunities: Several minor tuber crops have demonstrated considerable commercial value, although their cultivation remains largely subsistence-oriented. Starches from Queensland, West indian and East indian arrowroot are often marketed under the generic name 'Arrowroot powder' despite their different botanical

Promising genetic stocks and released varieties in selected minor tuber crops

Crop	Genetic stocks identified and registered	Varieties released	Distinguishing trait(s) of genetic stock and varieties
Queensland arrowroot	Kodalan green (IC647797) Manalur purple (IC647798)	-	High rhizome starch and vigorous growth
West Indian arrowroot	-	Sree Aadya Sree Nakshathra Sree Karti	High starch yield (5.95 t/ha) High starch yield (8.59 t/ha) High starch yield (5.07 t/ha)
Chinese potato	-	Sree Dhara Suphala Nidhi CO-1	High tuber dry weight Photo insensitive variety Oblong tubers & cooking quality High tuber starch (21.5%)
Yam bean	Havelock local (IC 635945)	RM-1 RM-2 RM-3 Bhu Sakarkanda	High tuber yield (36-40 t/ha) Early tuber maturity (100-110 days) High tuber yield (35-40t/ha) Early tuber maturity (110 days)
East Indian arrowroot	TVM local (IC641835; INGR25038)	-	Long primary rhizome, high rhizome starch (16.8%)

The crop-wise information presented above shows substantial variation in yield, starch content and nutritional composition among collected germplasm and released varieties. These differences, arising from genetic constitution and targeted improvement, influence suitability for specific end uses. Understanding these functional attributes provides a basis for identifying and promoting value-added, market-oriented applications.

origins. Studies have highlighted the exceptional quality of Queensland arrowroot starch for both food and non-food applications. Its rhizomes contain about 73–85% starch on a dry-matter basis, with 25–31% amylose and very large starch granules (40–80 µm). The starch also contains a resistant-starch fraction and has been reported to possess potential for moderating glycaemic response, making it a promising ingredient for functional-food research. Owing to these properties, Queensland arrowroot starch is suitable for the preparation of noodles, vermicelli, gluten-free products and other health-oriented functional foods, and the crop also has potential as animal feed.

West indian arrowroot starch exhibits excellent gelling, pasting, thickening and stabilising properties, making it particularly suitable for biscuits and a wide range of processed food products.

Chinese (coleus) potato starch, characterised by a high amylose content (about 30.44%) and favourable pasting behaviour, has considerable potential for the manufacture of snacks, extruded products and biodegradable films.

Yam bean root starch has potential as an ingredient in functional foods and as a raw material for biodegradable bioplastics. In addition, rotenone containing seed extracts may serve as botanical biopesticides, provided they are used with appropriate safety precautions.

East indian arrowroot starch possesses desirable hydrocolloid properties and is traditionally used in the preparation of cakes, fruit preserves and biscuits, as well as a binder in sweets and milk puddings

These applications show that minor tuber crops can move beyond subsistence use. Strengthening quality planting-material supply, genetic improvement, varietal development, processing technologies and market linkages is therefore essential for expanding their commercial and industrial utilisation.

SUMMARY

Minor tuber crops possess useful diversity in yield, starch content and nutritional quality. Germplasm evaluation and varietal development have identified variation for important horticultural and quality traits, demonstrating clear scope for targeted improvement and value addition. Wider adoption is nevertheless constrained by a narrow genetic base, vegetative propagation, reproductive sterility, bulky planting material requirements and limited availability of improved varieties. Germplasm enrichment, systematic characterisation and breeding for higher yield, starch quality, early maturity, stress tolerance and market-preferred traits are therefore priorities. Such a coordinated approach can raise farm productivity, create processing opportunities and enable the sustainable commercial exploitation of these underutilized crops.

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