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Rhizome Yield and Starch Properties of *Canna edulis*

The major tropical tuber crops are cassava, sweet potato, yams and aroids. In addition to these major crops there are many types of lesser known starchy tuber crops available in different parts of the country and Queensland arrowroot (*Canna edulis* Ker Gawler) is one among them. It is a perennial herb, growing to a height of 1.0-2.5 m. The leaves are arranged spirally with a prominent midrib and numerous lateral veins. It is widely distributed throughout the tropics and sub-tropics. It is grown for the branched, fleshy rhizomes (Joseph and Peter, 1985). The plant is hardy and in view of the low incidence of pests and diseases as well as wind resistance of the crop, it is considered to be grown best in the typhoon prone regions (Kurtia, 1967). It is commercially cultivated in Australia for its starch. The crop is lesser known to people or remain restricted only to certain areas. Reports are available on morphological and anatomical features of *Canna* (Jayakumari and Princymol Stephen, 2009). Duration of the crop varies from 8-12 months. The fleshy rhizomes are formed in a compact mass and are eaten boiled or baked. Previous studies have revealed the presence of arbuscular mycorrhizal fungal (*Glomus microcarpum*) association with edible *Canna* growing naturally under field condition (Jayakumari and Potty, 2007). This mycorrhiza is inferred to possess the potential to boost rhizome yield even in unfertilized fields (Jayakumari and Potty, 2008; 2009). Young rhizomes can also be used as a vegetable. The crop is very important due to its high productivity and starch value. The starch is easily digestible and used as food for children and invalids. The starch granules are oval or polyhedral in shape (Kay, 1987). There are two types of *Canna*, ornamental and edible. The flowers of ornamental *Canna* are larger, more beautiful and variable in colours than the edible types. Although both types of *Canna* store starch in the root-stocks, the edible types have more fleshy rhizomes with better flavour, taste, low fibre and less tannin content than the ornamental types (Arbizu, 1994). The Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala, India, maintains five accessions of *Canna* in the minor tuber crops germplasm (Vimala and Bala Nambisan, 2005). Based on leaves, emerging leaf colour and other morphological characters, they are grouped as dark purple, purple and green accessions. Out of the five accessions, only two accessions (dark purple and green accession) produced edible rhizomes. The physico-chemical properties of one edible and two non-edible accessions of *Canna* were studied by Moorthy et al. (2002). The present paper deals with the evaluation of the dark purple and green accessions for rhizome yield and starch properties.

The two accessions were planted on 10 rows, which in turn had 10 mounds. The small terminal portions of the rhizomes were used for planting. Two rhizomes were planted on each mound. The distance within and between rows was 90 X 90 cm accommodating 100 plants per accession. Farmyard manure was applied @ 10 t ha^{-1} before the preparation of mounds. Earthing up and intercultural operations were carried out two months after planting. No chemical fertilizer was applied to the crop. The yield trial was conducted for three years (2006-2009) by planting in April-May in each year and harvested after 10 months. The rhizome yield was recorded at the time of harvest. The dry matter and starch content of the rhizomes were analysed (AOAC, 2000). The harvested rhizomes were washed, peeled and pulped. The pulp was mixed with five volumes of water, strained through a 150 μm mesh sieve and allowed to settle. Resuspension and resettling of the starch was carried out several times till the pure starch was obtained. The deposited starch was dried in sun light and stored in moisture-proof containers. The starch properties were studied using Brabender Visco Analyser at a concentration of 10%.

Flowering was observed in both the accessions. Dark purple and green accession produced red and yellow flowers respectively. However, no seed set was found in

Table 1. Rhizome yield, dry matter and starch content of *Canna*

Accessions	Rhizome yield (t ha^{-1})				Dry matter (%)	Starch (%) (FW basis)
	2007	2008	2009	Mean yield		
Green	23.50	26.00	24.50	24.67	34.50	26.17
Dark purple	30.80	34.50	33.00	32.77	36.40	27.85

both the accessions. The rhizome yield for three years are given in Table 1. The yield data over three years showed that maximum yield of 30.8-34.5 t ha^{-1} was recorded in the dark purple accession with a mean yield of 32.77 t ha^{-1}. In the green accession, the mean yield (24.67 t ha^{-1}) was lower than the dark purple accession. The rhizomes of green accession were cream in colour whereas the rhizomes of dark purple accession possessed dark purple tinge since the terminal buds and rhizomes were covered with purple scales. The dry matter and starch content varied between 34.5 and 36.4% and between 26.17 and 27.85% respectively. There was not much difference in the dry matter and starch content in both the accessions. The dry matter and starch content value was similar to cassava and sweet potato (Moorthy, 1994).

The rheological properties of starch (Table 2) revealed that both the accessions had very high viscosity properties. In fact, the viscosity was even higher than that of cassava at the same concentration. The green accession had slightly higher viscosity (4419 cP) compared to dark purple accession (3560 cP). The break down viscosity ranged from 973 to 1302 BU, which is lower compared to reports in cassava starch (50 - 60 s). Thus the starch has higher stability, set back viscosity and relatively low viscosity break down, which are useful properties that can lead to very good applications in food industry. Cooled paste was non-cohesive in texture and set into a strong gel free from syneresis.

The starch from the green accession was more stable than the dark purple accession since the former possessed high viscosity, recrystallisation and low break down of the starch. However, there was not much difference in the pasting temperatures of both the accessions. A similar result on the properties of *Canna* starch was reported by Soni et al. (1990). In most of the functional properties, *Canna edulis* starch resembled yam starch. The properties indicated that *Canna* starch has good application in the preparation of food products especially in canned food, which require higher paste stability, viscosity and gel strength. Preliminary studies showed that bakery products like biscuits, cakes and cookies can be prepared from *Canna* starch. Hermann (1994) reported that the bakery products prepared from *Canna* starch was much lighter and crispier than similar products from wheat. The evaluation of *Canna* indicated that both the accessions have high rhizome yield and the starch has good potential in food applications.

Table 2. Rheological properties of *Canna* starch

Properties	Accessions	
	Green	Dark purple
Peak viscosity (cP)	4280	3950
Holding viscosity (BU)	3327	2654
Final viscosity (cP)	4419	3560
Set back viscosity (s) 1%	1092	908
Break down viscosity (BU) 4%	973	1302
Pasting temperature (°C)	75.35	75.50

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