Starch Distribution in Cocoyam (*Xanthosoma* spp.) Corms and Cormels

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ABSTRACT

Starch concentration, percent dry weight and specific gravity determinations were made on *Xanthosoma caracu*, *X. atrovirens* and *X. violaceum*. *X. atrovirens* had highest starch concentration in both corms and cormels with 35.1% and 46.2% starch, respectively. In all cases cormels were higher in starch than corms. Variation in starch concentration within corms and cormels was less than that between species and the corms and cormels. Specific gravity of corms and cormels explained 89% and 72% of variability in starch concentration; thus, high specific gravity can be used as a selection parameter for high starch content.

Cocoyam is an important staple crop in several lowland tropical areas, including southern Florida where production of *X. caracu* is estimated as much as 2,000 ha. In the Araceae family, this crop, like its relatives, is well adapted to moist soils and partial shade. Nonetheless, some cultivars can be successfully grown in full sun. Even though it is grown for its starch-filled cormels, little is known of the variation in starch content.

Materials and Methods

Three cocoyam species *Xanthosoma caracu*, *X. atrovirens* and *X. violaceum* were selected for starch evaluation. Field grown 12-month-old plants were harvested and cleaned prior to analysis. The plants were divided into main corm and cormels. Each corm was divided into upper, middle, and lower one-third section. The cormels were also divided into thirds, proximal to the main corm, central and distal from the main corm. Specific gravity measurements were made on each section. A cross section disk of 10 g was taken from each part for dry weight determination. For starch determination, a second cross section disk was taken and divided into four 100 mg wedges as sub-samples. Starch determination was made through enzymatic hydrolysis of starch to glucose followed by glucose quantification (Dekker and Richards, 1971; O'Hair, 1981). To measure the variation in lateral starch distribution a standard 9 mm cork bore was used to take a sample from the central section of both the corm and cormel of each species. The bore was positioned to pass through the center of the storage organ. The extracted core sample was divided into 7 sequential, 100 mg pieces (Table 1) and analyzed for starch concentration as before. Statistical analysis of the data was done through least squares regression with general linear models.

Table 1. Lateral distribution of starch concentration (%) according to species and storage organ.

Storage organ	Sequential section	Relative location	Species caracu	violaceum	atrovirens
Corm	1	Outer edge	6.3	4.1	15.3
	2		14.2	11.0	30.9
	3		16.0	11.7	38.7
	4		17.0	10.7	39.9
	5		14.0	10.9	34.9
	6		14.7	10.5	23.9
	7	Center	11.8	9.5	26.9
Cormel	1	Outer edge	25.7	17.4	52.3
	2		33.0	23.4	53.1
	3		24.4	24.0	46.4
	4	Center	27.6	23.9	51.7
	5		29.2	24.9	53.1
	6		31.9	23.5	56.7
	7	Outer edge	33.5	18.4	57.5

Results and Discussion

Overall, cormels were significantly higher in starch concentration, percent dry weight and specific gravity than the corms (Table 2). The greater difference in starch concentration in comparison to the dry weight is attributed to the age of the tissue sampled. Corms probably were higher in fiber content than the cormels. In the corm, the starch concentration ranged from a low of 7.2% in the lower section of *X. violaceum* to a high of 49.6% in the lower section of *X. atrovirens* (Table 3). In the cormels, the starch concentration ranged from a low of 20.9% in the proximal (closest one-third to the corm) section of *X. violaceum* to a high of 52.4% in the central one-third section of *X. atrovirens*. In both corms and cormels, *X. atrovirens* was significantly higher in starch than *X. violaceum* and *X. caracu*. The dry weights ranged from a low of 16.4% in the lower corm section of *X. caracu* to a high of 53.4% in the central cormel section of *X. atrovirens*. In all cases the cormels were higher in percent dry weight than the corms. All parts tested had less than 1% glucose.

Table 2. Starch, dry weight and specific gravity of *Xanthosoma*, excluding differences between species.

Storage organ	Starch(%)	Dry weight(%)	Specific gravity
Cormel	31.9a*	38.8a	1.0565a
Corm	19.9b	29.2b	1.0260b

*Mean separation in columns by Duncan's multiple range test, 5% level.

Table 3. Storage organ starch, glucose and dry weight comparisons in *Xanthosoma*.

Species	Storage organ	Section	Starch(%)	Glucose(%)	Dry weight(%)
caracu	Corm	Upper	12.4	0.0	17.2
		Central	14.4	0.0	18.0
		Lower	13.5	0.0	16.4
	Cormel	Distal	21.7	0.0	21.2
		Central	24.9	0.0	25.8
		Proximal	22.0	0.0	22.6
violaceum	Corm	Upper	13.3	0.0	25.7
		Central	11.3	0.0	34.1
		Lower	7.2	0.4	45.7
	Cormel	Distal	32.3	0.2	43.6
		Central	25.2	0.0	52.4
		Proximal	20.9	0.0	44.8
atrovirens	Corm	Upper	22.6	0.9	25.7
		Central	33.2	0.5	34.1
		Lower	49.6	0.2	52.7
	Cormel	Distal	44.0	0.2	44.6
		Central	52.4	0.0	53.4
		Proximal	42.4	0.6	44.8

Excluding differences between the species and plant part tested, 84% of the variability in starch concentration was explained by the differences in dry weight and specific gravity ($Y = -296.29 + 0.25\ X1 + 300.89\ X2$; where Y = percent starch, X1 = percent dry weight and X2 = specific gravity). When only the specific gravity is considered, 80% of the variability in starch is explained ($Y = -300.31 + 341.94\ X1$; where Y = percent starch and X1 = specific gravity). Only 35% of the variation in starch concentration was explained when the dry weight value alone was used.

When evaluations were separated between the corms and cormels, 89% of starch variability in corms and 72% in cormels was explained by differences in specific gravity alone ($Ycorm = -459.20 + 466.78\ X1$ and $Ycormel = -241.65 + 258.77\ X1$; where Y = percent starch and X1 = specific gravity). This indicates that specific gravity readings can be substituted for actual starch measurement when large numbers of corms and cormels are to be screened for starch content.

In both corms and cormels, *X. atrovirens* had a significantly higher starch concentration than the other two species (Table 4). The upper portion of the corm had significantly less starch than the lower section, while the distal section of the cormel was significantly higher in starch concentration than the proximal section (Table 5). This suggests that corm and cormel starch concentrations may be related. These results also indicate that starches are not evenly distributed within corms and cormels.

The core sample taken through the central part of the corms and cormels revealed that the outside edge and center of corms tend to have a lower starch concentration than the parts in between (Table 1). This did not appear to be so

Table 4. Starch concentration (%) of Xanthosoma storage organs.

Species	Corm	Cormel
atrovirens	35.1a*	46.2a
caracu	13.4b	26.2b
violaceum	10.6b	22.9b

*Mean separation in columns by Duncan's multiple range test, 5% level.

Table 5. Starch distribution within corms and cormels of Xanthosoma.

Storage organ	Section	Starch (%)
Corm	Lower	23.4a*
	Central	19.6ab
	Upper	16.1b
Cormel	Central	34.2a
	Distal	32.7a
	Proximal	28.4b

*Mean separation within storage organs by Duncan's multiple range test, 5% level.

in X. atrovirens cormels. In this case, no specific trends were detected. The outside edge of the X. violaceum cormel tended to have a lower starch concentration than the parts in between. However, variation did not appear to be major in any case.

Major differences in starch concentration are attributed to genetic variation. Since all species can be crossed to produce fertile progeny (Volin and Beale, 1981), it should be possible to breed and select for high starch. Screening and selection could be facilitated by using specific gravity as a reflection of starch concentration.

References

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