Variability in Taro, *Colocasia esculenta* Starches: Size, Gelation, and Amylose Content

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ABSTRACT

Starch of a large number of taro cultivars was examined. Mean particle sizes were determined by laser light scattering. Additional data on gelation temperature and amylose content were also assayed.

Initial results indicated segregation into two distinct size classes. However, the larger sample size reveals a normal distribution for starch particle size. Gelation temperatures and amylose contents also vary about a generalized mean. Deviation from the mean is greatest for amylose content. There is no correlation between particle size and gelation temperature or amylose content. When morphological similar cultivars are compared the variation seen is less than that in the whole sample. Suggesting possible usefulness of these in characteristics assaying relatedness of closely allied cultivars. Although not of taxonomic significance, results here indicate that breeding taro to produce particular starch qualities should be possible for industrial application.

Introduction

The application of taro, *Colocasia esculenta*, starch to industrial purposes, specifically plastics manufacture, has been discussed in previous reports (Griffin, 1979, 1982). Taro starch has been suggested as a suitable filler for production of LPDE carrier-bag films. Further applications for plant starches have been investigated in areas where the special technical characteristics derived from them make their use desirable. These include coatings and stiffening agents for plastics. Melt rheology of certain polymers can also be modified to enable processing by techniques not otherwise possible (Griffin, 1982).

Two problems are the general unavailability of commercial quantities of taro starch and the relatively poor knowledge of the characteristics of such starches. Early studies indicated that taro starch was generally of small particle size and had a relatively high gelation temperature (Goering and Dehaas, 1972; Griffin, 1979, 1982). Study of gelation, particle size and amylose content for taro starch of a few cultivars further suggested that taro starches might be useful in the resolution of taxonomic questions in taro. Specifically the distinction between the botanical varieties of taro (for review see Plucknett, in press).

This study intends to determine the degree to which such physical data concerning taro starches can be utilized in botanical classification systems. Additionally, the extent of variability of several physical characters of taro are surveyed in anticipation that such information will be useful in development of cultivars with starches of industrial significance.

Materials and Methods

Plant material was supplied by Dr. R. S. de la Peña from the University of Hawaii, Kauai Branch Station germplasm collection (KBS). Additional samples were from taro cultivars supplied by Dr. G. V. H. Jackson, Ministry of Agriculture and Home Affairs, Solomon Islands (SI).

Starch was prepared either from fresh corms or air dried material by procedures described elsewhere (Strauss and Griffin, in preparation). Analysis of particle size by laser light scattering as well as gelation temperature and amylose content was assayed by methods described in a report currently being prepared for publication (Strauss and Griffin, in preparation).

Results and Discussion

Data for particle size, amylose content and gelation temperature of the corm starches of taro used in this study are being reported separately (Strauss and Griffin, in press). Examination of the results for ranges reveals maximum particle size in of 5.1 um and minimum size of 1.79 um. Amylose contents were as high as 43% for several cultivars and as low as 3% for one. For gelation temperatures the range was from 75°C in two cultivars examined to 68° for several others (Table 1).

Table 1. Range of mean and standard deviations for particle size, amylose content and gelation temperature of starch from cultivars of taro, *Colocasia esculenta*. n = number of cultivars examined.

Physical character	Max. value	Min. value	mean	s.d.	n
Particle size, microns	5.10	1.79	3.34	0.56	107
Amylose content, percent	43	3	24.04	7.41	108
Gelation temperature, C	75	68	70.6	3.4	108

Calculation of standard deviations for data from all cultivars reflects the fact that most cultivars have values for particle size, gelation and amylose content which cluster about a single mean value. This is in contrast to earlier speculations that two or more distinct groups existed for each of these parameters

(Griffin, 1982). Deviation from the mean is greatest for amylose where the standard deviation is nearly 31% of the mean value (Table 1).

When amylose or gelation temperature are compared to starch particle size the resultant plot appears to demonstrate weak correlation of these characters with starch grain size (Figures 1 and 2). However, a one-sided F test indicates no significant correlation. Deviation from the regression line suggests little reliability in predicting any one of these characters from values for another (Figures 1 and 2). This would imply that breeding for particular starch characters, independent of others should be possible. Values for amylose, gelation and particle size are not strongly dependent on each other.

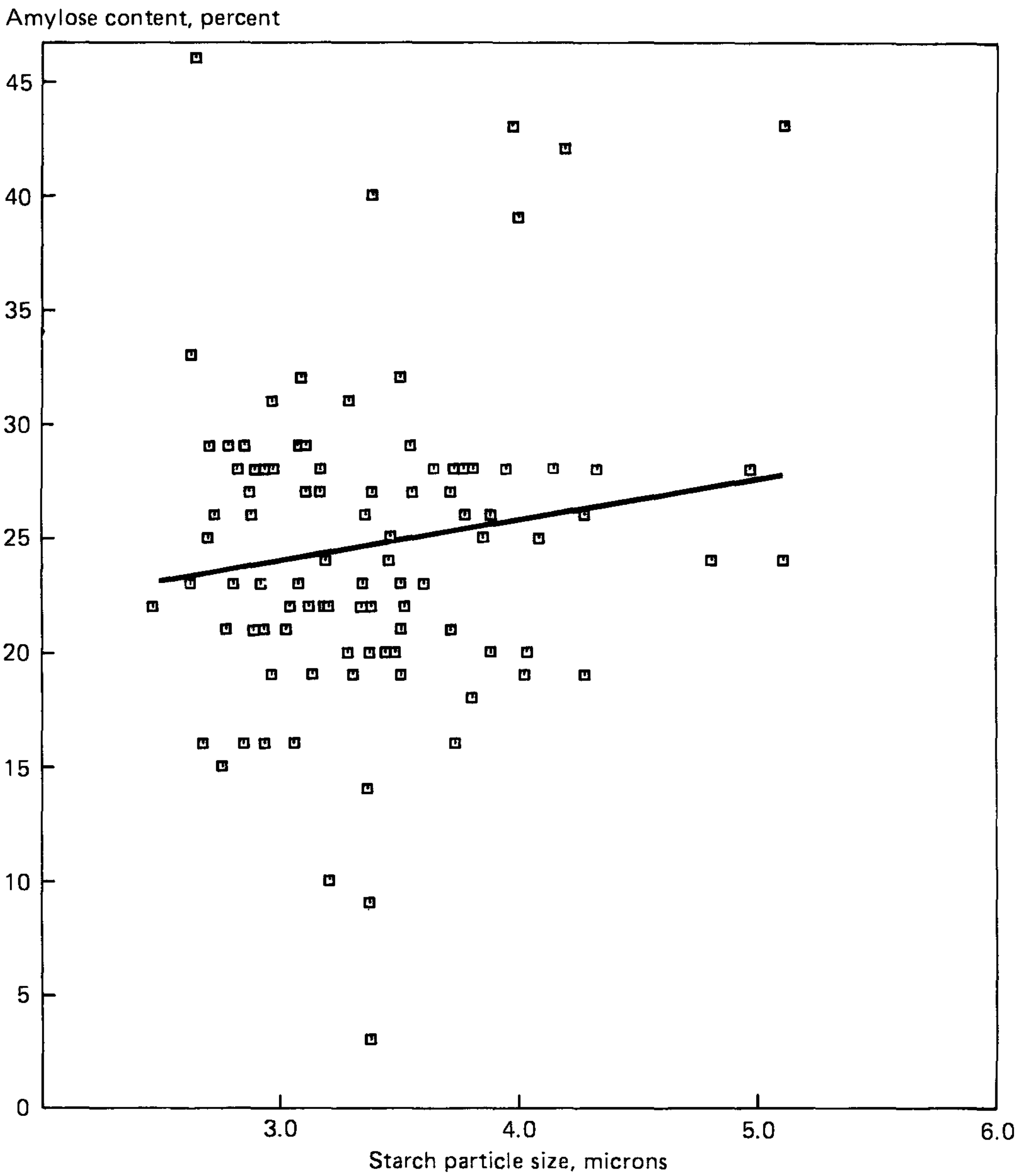

Figure 1. Illustration of the relationship of starch particle size and amylose content for several cultivars of taro, Colocasia esculenta. Regression equation: Y = 18.690 + 1.777X; Coeff. of determination: 0.02022[illegible]; F: 2.1064, one-sided test; 1, 102 degrees of freedom; n = 104.

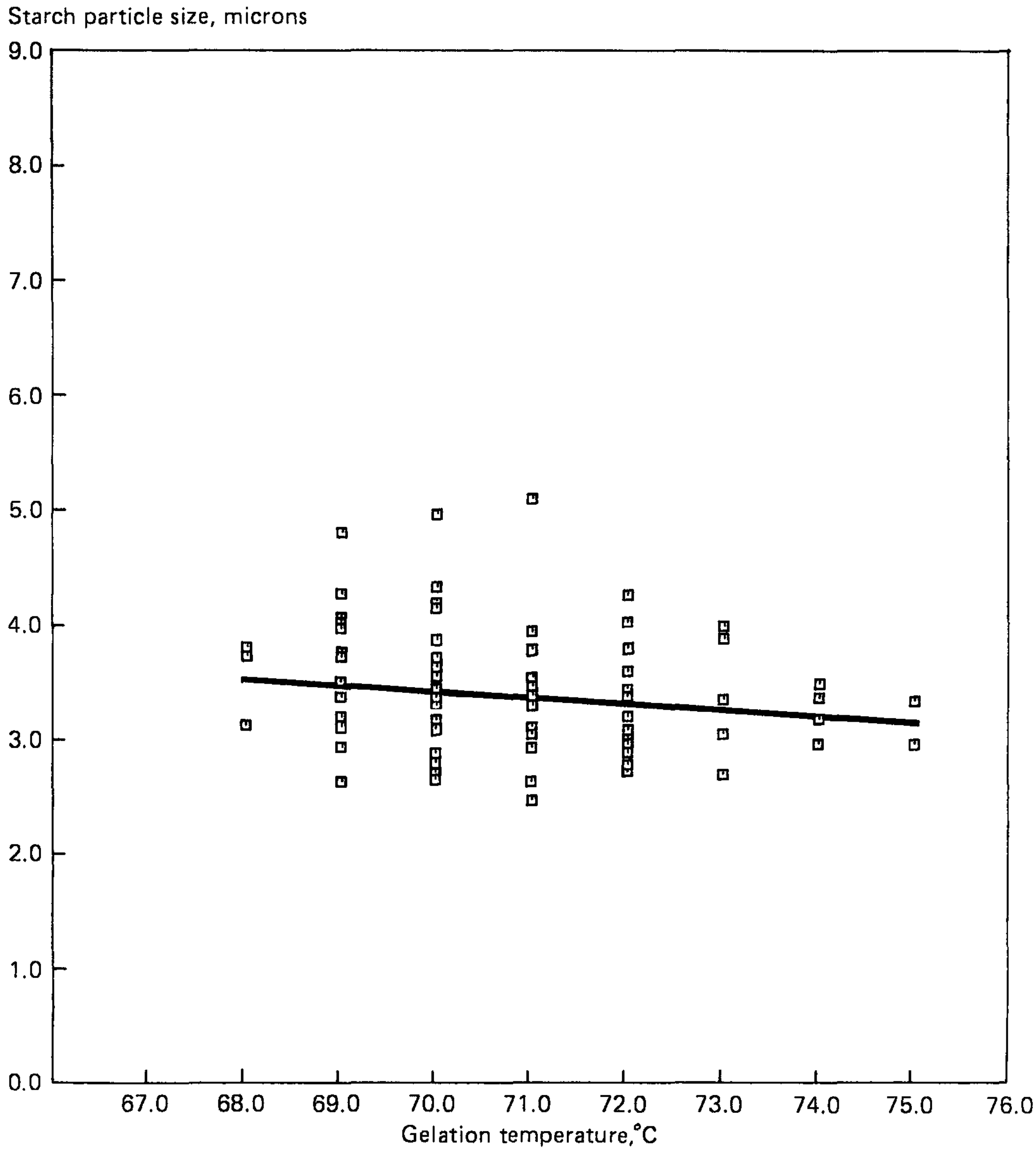

Figure 2. Relationship of particle size to gelation temperature for starches of taro, Colocasia esculenta. Regression equation: Y = 72.355 - 0.455X; Coeff. of determination: 0.023695; F: 2.4027, one-sided test; 1, 99 degrees of freedom; n = 101.

Comparing the parameters studied in two large, morphologically similar groups revealed a close similarity for some of the characters (Table 2). In the cv 'lauloa' group particle size showed little variation from the mean of 2.92 um while in the cv 'mana' group data had a standard deviation greater than that found in the sum of all samples tested. For amylose the cv 'lauloa' group showed lesser and the cv 'mana' group greater deviation from the mean than in the whole sample. Gelation temperatures for both groups varied less than the range seen in the sum of all samples studied (Tables 1 and 2).

Table 2. Comparison of physical characteristics of starch from two groups of taro, Colocasia esculenta from the University of Hawaii, Kauai Branch Station (KBS).

Cultivar	Particle size, um	Amylose, percent	Gelation, C
Lauloa dala	2.96	28	72
Lauloa keokeo	2.96	31	74
Lauloa palakea-eleele	2.80	23	70
Lauloa palakea-keokeo	2.89	21	72
Lauloa palakea-papamu	2.85	29	72
Lauloa palakea-ula	3.06	16	72
mean	2.92	24.7	72
s.d	0.09	5.7	1.3
Mana eleele	3.45	24	70
Mana kea mata	5.10	24	71
Mana keokeo	3.18	22	70
Mana lauloa	3.48	20	69
Mana okoa	4.80	24	69
Mana piko	4.03	20	69
Mana ulaula	5.10	43	71
Mana uliuli	3.94	28	71
mean	4.10	25.6	70
s.d.	0.77	7.5	0.93

It seems unlikely that the physical characteristics of starch in taro will, by themselves, be able to taxonomically separate taro cultivars or the botanical varieties. Our separate comparison of C. esculenta var antiquorum and C. esculenta var esculenta (Purseglove, 1972) plants revealed little unusual between the two cultivars which could serve to separate them on the basis of starch characters (Strauss and Griffin, in preparation). It is also evident that while some groups of taro can be inferred to be more closely related, on the basis of similarities in starch properties, plants cannot confidently be placed in those cultivars on the basis of such information alone. However, such information could be useful in determining the degree of relatedness of closely allied cultivars.

Weak relationships between particle size and the other characters investigated is of significance in the development of specialized cultivars for specific industrial application. Knowledge of the inheritance of these characters would aid breeding efforts to produce cultivars with specific starch qualities. Data demonstrate that, with respect to starch, the genetic base for breeding programs is varied and wide ranging. This has also been shown to be true for other structural and chemical characters in taro (Arditti, et al., 1980; Strauss, et al., 1980). A study of seedling starches of taro is still necessary to determine the mode of inheritance and the degree to which certain of these characters can be easily manipulated.

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