Variation in starch and root quality traits in cassava

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Introduction

There is wide variation in the description of starch quality traits for cassava and little variation has been reported until recently. CIAT, therefore, initiated a project to evaluate and screen for starch quality traits in the cassava germplasm collection. High value traits as amylose-free starch and high protein content, have been identified recently. The objectives of this work were: 1) To grow accessions from the germplasm collection for their phenotypic characterization, 2) To harvest root and extract starch in search of relevant roots and starch quality traits and, 3) Self-pollinate the accessions to obtain S_1 lines to allow recessive traits to express.

Materials and Methods

Up to now, starch samples from more than 4000 accessions, corresponding to 3272 landraces and 772 improved clones, from the CIAT cassava gerplasm collection were obtained and analyzed (Table 1). Each year a group of 500 to 2000 clones from the *in vitro* germplasm collection were "recovered" and grown in the field. Planting material, from these plants, were used for clonal evaluation trials at key environments. Roots and starch were analyzed for the most important quality traits. Plants were also self-pollinated (if they produced flowers and allowed such action). All relevant starch and root quality traits were evaluated in CIAT's laboratory. Figure 1 shows the relevant quality starch traits information obatined from RVA amylograms.

Figure 1. Brief description of relevant information from RVA amylograms

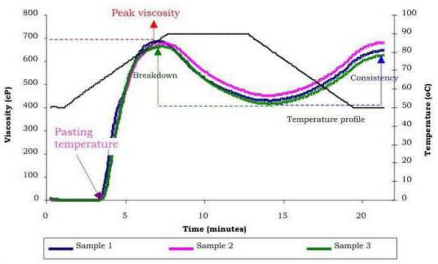

Table 1. Performances of landrace accessions and improved clones for different root and starch quality traits.

Traits	Landraces accessions		Improved clones	
Dry matter content (%)				
Average/St. Dev.	47,9	± 6.4	48,1	± 5.9
Max / Min	32,8	14,3	36,7	14,7
HCN content (ppm)				
Average/St. Dev.	340	± 428	267	± 212
Max / Min	3274	14	2147	28
Total Sugar content (%)				
Average/St. Dev.	3,68	± 2.33	4,06	± 2.26
Max / Min	18,8	0,20	13,45	0,63
Reducing sugar content (%)				
Average/St. Dev.	1,25	± 1.43	1,56	± 1.41
Max / Min	15,7	0	8,24	0,01
Starch content (%)				
Average/St. Dev.	84,5	± 3.4	84,5	± 3
Max / Min	91,0	65,0	91,0	73,0
Amylose content (%)				
Average/St. Dev.	20,89	± 1.6	20,02	± 1.44
Max / Min	26,46	15,15	25	15,75
Water absorption (%)				
Average/St. Dev.	4,58	± 2.36	4,62	± 2.1
Max / Min	15,5	0,81	14,3	2,01
Water solubility (%)				
Average/St. Dev.	2,15	± 1.51	2,25	± 1.85
Max / Min	12,3	0,2	16,6	0,24
Swelling power (%)				
Average/St. Dev.	4,57	± 2.35	4,65	± 2.14
Max / Min	15,4	0,79	14,7	2,08
Clarity (%)				
Average/St. Dev.	44,5	± 10.7	48,1	± 9.25
Max / Min	86,3	12,5	96,6	21,7
Easy cooking (min)				
Average/St. Dev.	2,76	± 0.68	2,98	± 0.84
Max / Min	5,61	1,14	4,89	1,14
Pasting Temperature (°C)				
Average/St. Dev.	65,2	± 1.75	65,4	± 1.69
Max / Min	71,1	58,7	69,7	60,0
Maximum viscosity (cP)				
Average/St. Dev.	776	± 169	783	± 148
Max / Min	1401	152	1505	146
Break down (cP)				
Average/St. Dev.	300	± 109	290	± 99
Max / Min	859	35	795	28
Consistency (cP)				
Average/St. Dev.	158	± 59	147	± 52
Max / Min	626	0	394	1
Setback				
Average/St. Dev.	-142	± 95	-153	± 102
Max / Min	273	-702	103	-584

Results

Information obtained showed high variation for some root and starch quality traits within landrace accession and improved clones (Table 1). For quality roots average dry matter content of the landraces was 32.8% ranging from 47.9 to 14.3% whereas for improved clones it was 36.7% and ranged from 48.1 to 14.7%. However, starch content was about the same (84.5%). Cyanogenic potential ranged from 14 to 3274 ppm for an overall average of 325ppm. Averages for landraces were slightly higher (349ppm) than for improved clones (267ppm). Total sugars and reduced sugar were 3.68 and 1.25%, respectively, for landraces and 4.05 and 1.56% for improved clones.

Table 2 presents the results by country/region for dry matter content (%), cyanogenic potential (ppm) and starch content(%). Averages for dry matter content and starch content presented little variation among contry/region. Cyanogenic potential shows high variation between and within countries/regions.

Starch quality traits show little variation between landraces and improve clones for water absorption (4.58% vs 4.62%); water solubility (2.15% vs 2.25%); paste temperature (65.2°C vs 65.4 °C) and clarity (44.5% vs 48.1%). Average easy cooking of the landraces was 5.61min whereas for improved clones it was 2.98min. Maximum viscosity ranged from 1401 to 152cP for landraces and 1505 to 146cP for improved clones. Average consistency was 158 cP for landraces ranging from 626 to 0cP and 147cP for improved clones ranged from 394cP to 1cP. Average amylose content (colorimetric method) was 20.7%.

Table 2. Variation in root quality traits evaluated in 4044 cassava CIAT's accessions from different contries/regions.

Country/region	Number of clones	Dry matter content (%)	Cyanogenic potential (ppm)	Starch content (%)
Brazil	919	33.0 (14.6 - 46.8)	508 (22 - 3274)	84.6 (65 - 91)
Colombia	1230	32.6 (14.3 - 47.9)	300 (15 - 3117)	84.3 (71 - 91)
Peru	281	33.0 (14.3 - 46.7)	162 (19 - 1348)	84.8 (74 - 91)
Ecuador	83	32.8 (16.6 - 45.9)	158 (29 - 476)	84.2 (76 - 91)
Venezuela	158	33.1 (15.1 - 46.2)	310 (28 - 2751)	84.7 (73 - 91)
Bolivia	4	29.9 (25.3 - 32.5)	337 (108 - 835)	85.2 (81 - 89)
Cono Sur	138	33.4 (16.9 - 44.5)	219 (14 - 1639)	85.2 (78 - 91)
Caribbean	68	33.5 (19.0 - 46.2)	222 (16 - 1595)	84.5 (75 - 91)
Central America	199	32.1 (15.2 - 44.2)	306 (27 - 2762)	84.7 (74 - 91)
North America	73	33.1 (16.0 - 44.7)	247 (18 - 1068)	84.1(74 - 91)
Indonesia	33	33.0 (16.6 - 45.6)	480 (57 - 2463)	84.2 (69 - 91)
Asia	70	33.4 (21.5 - 47.0)	292 (24 - 1336)	85.7 (77 - 91)
Other *Manihot* species	16	31.2 (19.2 - 37.8)	397 (85 - 1455)	84.0 (75 - 89)
Landrace Accessions	3272	32.8 (14.3 - 47.9)	339 (14 - 3274)	84.5 (65 - 91)
Improved clones	772	36.7 (14.7 - 48.1)	267 (28 - 2147)	84.5 (73 - 91)

Conclusion

Information of this work will help the Genetic Reosurces Unit at CIAT to improve and complete data files of accessions in the collection. There are useful information for roots and starch traits that can help breeders to select best clones for further evaluation or incorporate them to breeding program for specific industrial porpouses.

Acknowledgement

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