FUNCTIONAL PROPERTIES OF A PROMISSORY *DIOSCOREA TRIFIDA* WAXY STARCH FOR FOOD INNOVATION

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INTRODUCTION

The *Dioscorea trifida* L is by far the most important of the indigenous American yams. Its starch has been reported having amylose content in the 34.7-43.3% range for white and purple varieties (Bou Rached *et al.*, 2006). Starch physicochemical and functional properties have been reviewed on yam crops, such as *D. alata*, *D. cayenensis*, *D. esculenta*, *D. rotundata*, *D. dumetorum* with average amylose content above 7% (Hoover *et al.*, 2001). In South America, amylose contents of 11.1% to 36% are reported (Freitas *et al.*, 2004). Starches with lower amylose content are well appreciated by the food processor due to their functional properties. Thereby, the objective of this work was to characterize the functional properties of waxy starches isolated from three *Dioscorea trifida* cultivated in the Venezuelan Amazon.

MATERIALS AND METHODS

Starches from three *Dioscorea trifida* cultivars were isolated (Pérez *et al.*, 2010) from crops of the years 2005 and 2009 and were designed as "Amazonian white AW2005 and AW2009", "Amazonian light purple ALP2005 and ALP2009", "Amazonian dark purple" ADP2005 and ADP2009. Purity (AACC, 2003), starch granular size, gel clarity, swelling power, solubility, dispersed volume fraction measurement, gelatinization profile and pasting properties, amylose content (Larson *et al.*, 1953; Rolland-Sabaté *et al.*, 2003; Dufour *et al.*, 2009; Sanchez *et al.*, 2010), microstructure, X-ray Diffractometry (Pérez *et al.*, 2010) were also determined.

RESULTS AND DISCUSSION

The purity percentage values in the four starches were quite high in the 99.7-99.9% range, corroborating that the isolation method was simple and efficient. With a monomodal distribution, granule sizes ranged in the 24.5-35.5 μm of the same order of magnitude than those obtained for yam starches (Tetchi *et al.*, 2007). The starch gelatinization profile measured by DSC showed an Onset temperature of 69.1 to 73.4 °C (**Table 1**), thus was lower than the estimate of 69.0 to 78.8% reported

by Amani *et al.* (2004). The gelatinization enthalpy variation (ΔH) was in the 22.4-25.3 J g^{-1} range, as the highest enthalpy reported in the literature for *Dioscorea* species. The six Amazonian genotypes studied by DSC exhibited a low amylose variability between 2005 and 2009 (1.4 to 3.6%, close to the detection limit), whereas the starch isolated from commercial "mapuey" CW2009 exhibited about 8.7% amylose. Starch amylose contents determined by Amperometric method IBC ranged in the 2.2-9.5% on defatted samples (Table 1). λmax values ranged in the 547-593 *n*m for ADP2009, and CW2009, respectively. λmax values were in accordance with those reported by Tetchi *et al.*, 2007, and thus confirmed that ADP2009, ALP2009 and AW2005 starches contained the lowest amount of amylose or chains with shorter length. This is the first report on waxy *Dioscorea sp.*, whereas the amylose contents of starches from different cultivars of *Dioscorea* are usually reported being in the 7.0-36.2% range (Freitas *et al.*, 2004).

All starches investigated exhibited a B-type crystallinity, which well agreed with the literature (Srichuwong *et al.*, 2005). Contrary to some earlier reports, the absence of A-type crystals was here reported with varieties exhibiting low amylose contents. Gel clarity from *Dioscorea trifida* starches varied considerably (from 22.4 to 79.2%). The amylose-free *Discorea trifida* clone has the clearest yam gel, with an intermediate clarity between cassava (50%), waxy cassava (61%), potato (88%) and waxy potato starch (92%) according to Sánchez *et al.* (2010). These waxy starches exhibited substantially different solubility and swelling powers when compared with non-waxy starches isolated from other *Dioscorea* varieties (Larson *et al.*, 1953), or with the same species but grown at different locations (Bou Rached *et al.*, 2006). Solubility was relatively lower, but a higher swelling power was obtained than those reported above. Except for the AW2005 and CW2009, the overall profiles were different with each other with the presence of a peak viscosity for all Amazonian starches and a high breakdown during the holding stage at 90°C. Starches isolated from 2009 harvest exhibited the highest viscosity. In comparison with another study, the *Dioscorea trifida* "Mapuey" starches presented a lower viscosity than normal and waxy potato, but significantly higher viscosities than those of maize and waxy maize, rice, and cassava starches. Similarly to potato starch, *Dioscorea* starches exhibited high viscosities but with higher pasting temperatures.

CONCLUSION

Starches were white and waxy with quite low amylose being detected, and exhibiting homogeneous rheological behavior. The patterns of solubility and swelling power were different to those of non-waxy starches. The most important result consisted in revealing special and unreported physical and functional properties, concerning the amylose contents, gel clarities, paste viscosities and crystallinity of starches isolated from the Venezuelan *Dioscorea trifida* genotypes.

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Table 1. Granular structure, amylose content, physico-chemical properties, solubility, swelling power, and dispersed volume fraction of *Dioscorea trifida* starches harvested in 2005 and 2009

Parameters		commercial white	amazonian white		amazonian light purple		amazonian dark purple	
		CW2009	AW2005	AW2009	ALP2005	ALP2009	ADP2005	ADP2009
Granule size distribution (μm) [a,b]		*ND*	29.9	24.5	*ND*	33.5	35.5	33.5
DSC amylose (%) [c]		8.66±0.71	1.37±0.88	2.71±0.20	3.55±0.26	2.02±0.07	2.60±0.07	1.51±0.22
Ampero. amylose (%) [a]		9.5	2.4	2.2	3.7	3.4	5.9	2.2
λ_{max} (nm) [a]		593	550	565	558	550	575	547
Onset temperature (°C) [c]		71.9±0.2	71.4 ± 0.4	73.4 ± 0.4	69.1 ± 0.6	72.3±0.4	72.8±0.1	71.0±0.0
Enthalpy change (J g^{-1}) [c]		22.4±1.7	22.5 ± 0.2	24.8 ± 0.9	23.3 ± 1.2	25.0±0.9	25.1±1.1	25.3±0.1
Peak gel (°C) [c]		76.90±0.19	75.2 ± 0.4	75.2 ± 2.3	73.7 ± 1.2	73.0±2.8	77.3±0.1	73.8±1.7
End gel (°C) [c]		83.20±0.02	81.4 ± 1.9	83.6 ± 1.1	79.80 ± 1.3	81.9±0.1	83.4±0.1	81.9±0.9
Gel clarity (%) [c]		22.40±1.12	50.8 ± 1.0	55.6 ± 0.8	48.3 ± 1.3	79.2±0.2	24.3±1.0	62.1±0.4
Crystallinity (%) [a]		33	29	28	29	26	24	40
Moisture content (%)		22.9	22.4	23.1	22.5	22.6	21.5	23.3
Solubility (%) [c]	75°C	3.4±0.3	2.4±0.1	2.7±0.4	4.3±0.4	3.9±0.3	2.8±0.2	2.1±0.1
	90°C	4.4±0.2	2.4±0.0	2.1±0.3	4.4±0.0	2.8±0.2	3.7±0.0	2.5±0.2
Swelling power [c]	75°C	13.8±1.0	19.2±0.4	22.8±0.7	20.1±0.2	26.5±0.8	8.6±0.4	22.7±0.7
	90°C	20.5±0.7	20.8±2.0	31.4±1.3	28.1±0.2	37.0±0.4	21.4±0.1	32.2±1.4
Dispersed Phase (**Φ**) [c]	75°C	0.4±0.0	0.5±0.0	0.6±0.0	0.6±0.0	0.7±0.0	0.3±0.0	0.6±0.0
	90°C	0.6±0.0	0.6±0.0	0.8±0.0	0.7±0.0	0.9±0.0	0.6±0.0	0.8±0.0

[a] The experimental uncertainties were about 5% for amylose contents, crystallinities and granule sizes; and less than 1% for λ_{max} values. [b] The granule size corresponded to the average granule diameter. *ND* = not determined. [c] Results are the means three determinations.