Laboratory Scientific Report

Proof of Concept about Biophysical Bases of Processing and Cooking Ability of Boiled Sweet Potato

Biophysical Characterization of Quality Traits, WP2

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Ethics: The activities, which led to the production of this document, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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ABSTRACT

16 samples of sweet potatoes produced by CIP in Uganda were analysed by CIP in Uganda (cooking time, firmness, dry matter) then freeze-dried. Freeze-dried samples were than analysed by CIP-Peru (free sugars, starch, proteins by NIRS), JHI (beta-amylase activity, PME activity, cell wall characterization), CIAT (free sugars by HPLC, starch, amylose, RVA) and CIRAD (free sugars by HPLC, gelatinization and amylose by DSC and pectin contents by colorimetry).

Unfortunately, no correlation between cooking time and firmness were observed and almost no significant correlation between cooking behaviour (cooking time or firmness) and the biophysical analyses (dry matter, starch characteristics, beta-amylase and PME activities) could be evidenced. In addition, no correlation with pectin level, assessed using the same procedure as for cassava, could be evidenced on a first test of 6 samples.

Several correlations were however evidenced between RVA and biophysical analyses: pasting temperature measured with inhibitor can routinely be used to predict the true gelatinization temperature measured by DSC, and pasting viscosity with inhibitor was clearly correlated with starch content. However, the activity of beta-amylase did not appear correlated with RVA viscosities.

There is clearly a need of more significant samples to test this proof of concept; cooking time and firmness of the studied samples were not evaluated with a suitable procedure; a new SOP for cooking and texture evaluation is now available and new samples characterized with this SOP should be used in year 4 for testing the proof of concept.

Key words: Sweet potato, starch amylose, gelatinization, RVA, free sugars, PME, beta-amylase, pectins, texture, cooking time

16 samples of sweet potatoes produced by CIP in Uganda, among the 60 used from the ring tests (see 4.2) were analysed by CIP in Uganda (cooking time, firmness, dry matter) then freeze-dried. Freeze-dried samples were than analysed by CIP-Peru (free sugars, starch, proteins by NIRS), JHI (beta-amylase activity, PME activity, cell wall characterization), CIAT (free sugars by HPLC, starch, amylose, RVA) and CIRAD (free sugars by HPLC, gelatinization and amylose by DSC and pectin contents by colorimetry).

The most significant results are presented in the table 1.

Table 1 Cooking behaviour and biophysical analyses of the 16 sweet potato samples

Code CIP	CIP Uganda			CIP-Peru	JHI		CIAT						CIRAD					
	Dry matter	Cooking time (mins)	Firmness	Starch NIRS	PME 30 min	beta-amylase	RVA with inhibitor			RVA with water			Fructose	Glucose	Sucrose	Gelatinization		Amylose
	(%, wb)	(min)	Peak force (g)	(g/100g)	(U/g)	(U/g)	Tpk Visc inhib (°C)	Peak inhib (cP)	Final Visc inhib (cP)	Peak water (°C)	Peak inhib-Peak water (cP)	Final Visc water (cP)	(g/100 g)	(g/100 g)	(g/100 g)	Tpic (°C)	DH (J/g)	(g/100 g)
SP19ASE_RD_17	#N/A	#N/A	#N/A	63.0	0.11	115.0	70.1	988	1210	45	943	8	1.8	1.8	16.8	69.3	9.4	12.0
SP19ASE_RD_18	39	27	1798	64.7	0.51	44.4	73.5	1193	1479	69	1124	27	1.2	1.2	14.6	73.2	9.6	13.0
SP19ASE_RD_19	30	24	1709	58.5	0.34	39.3	74.0	800	1036				4.0	3.8	12.5	73.9	8.3	12.3
SP19ASE_RD_20	37	18	1948	65.6	0.24	77.9	72.0	1065	1395	40	1025	2	1.1	0.9	12.1	71.7	9.0	11.6
SP19ASE_RD_21	42	18	1627	63.9	0.53	42.1	71.1	965	1125	48	917	3	2.0	2.1	13.3	70.4	12.3	11.1
SP19ASE_RD_22	37	27	1703	65.6	0.63	21.4	71.0	1094	1520	74	1021	19	1.0	0.8	12.4	69.9	12.4	12.5
SP19ASE_RD_24	35	30	1129	61.5	0.30	144.9	75.0	757	947	44	713	23	1.4	0.8	12.8	73.8	9.3	12.3
SP19ASE_RD_25	36	18	1198	63.4	0.42	45.2	73.0	994	1524	58	935	6	1.8	1.8	11.2	72.1	10.0	10.9
SP19ASE_RD_26	36	18	2850	56.2	0.34	64.9	75.9	475	585	17	458	6	1.5	1.3	15.8	74.7	8.2	12.5
SP19ASE_RD_27	33	24	2330	62.3	0.23	33.6	72.0	896	1067	53	843	6	1.1	1.6	15.3	71.2	9.7	12.6
SP19ASE_RD_30	39	18	1861	67.9	0.20	37.3	71.0	1089	1413	54	1035	6	2.0	1.9	10.0	70.7	10.7	13.0
SP19ASE_RD_42	42	27	2653	64.6	0.29	85.6	73.0	1048	1348	51	997	8	1.3	1.2	13.2	72.5	10.0	13.7
SP19ASE_RD_44	41	24	1686	68.2	0.11	173.1	74.0	1313	1752	112	1201	73	0.9	0.7	10.3	73.5	11.9	14.2
SP19ASE_RD_49	34	18	1354	66.3	0.17	57.5	72.0	1124	1531	154	969	180	0.8	0.4	9.6	70.9	11.1	12.7
SP19ASE_RD_57	34	12	1670	68.9	0.37	92.8	74.0	1092	1444	249	842	345	0.5	0.4	9.7	74.0	9.9	13.8
SP19ASE_RD_64	33	18	1894	68.2	0.37	5.7	71.0	1052	1557	259	792	212	1.4	1.0	10.6	70.6	10.7	13.1

Cooking time and firmness appear on different axes (3 and 1, respectively) when variables are displayed on a PCA (Figure 1).

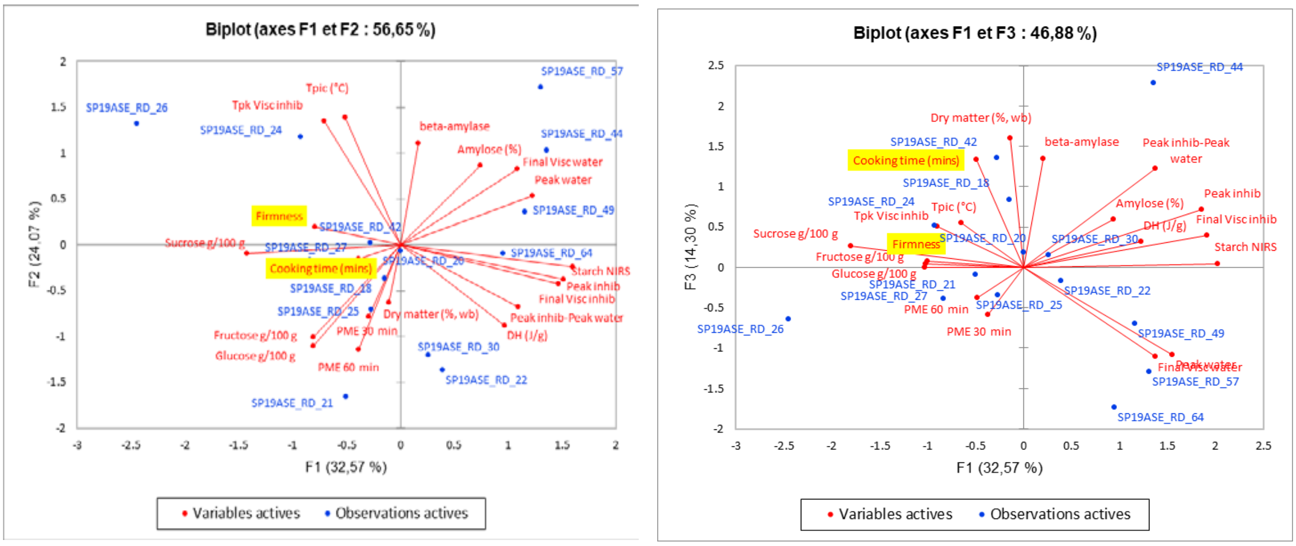

Figure 1 PCA of cooking behaviour (highlighted in yellow) and biophysical analyses

No correlation cooking time and firmness (r=0.002) were indeed observed and almost no significant correlation between cooking behaviour (cooking time or firmness) and the biophysical analyses could be evidenced (Table 2).

Table 2 Correlation coefficient between cooking behaviour and biophysical analyses of the 16 sweet potato samples

Variables	Fructose	Glucose	Sucrose	Tpic (°C)	DH (J/g)	Amylose	PME 30 min	PME 60 min	beta-amylase	Starch NIRS	Tpk Visc inhib	Peak inhib	Final Visc inhib	Peak water	Peak inhib-Peak water	Final Visc water	Dry matter
Glucose	**0.96**	**1**	0.28	-0.01	-0.32	-0.41	0.06	0.06	-0.33	**-0.52**	-0.07	-0.36	-0.38	**-0.52**	-0.05	**-0.61**	-0.19
Sucrose	0.18	0.28	**1**	-0.04	-0.43	-0.30	0.06	0.05	0.01	**-0.69**	0.04	**-0.52**	**-0.65**	**-0.62**	-0.32	**-0.58**	0.10
Tpic (°C)	0.06	-0.01	-0.04	**1**	**-0.53**	0.35	-0.01	-0.23	0.38	-0.37	**0.97**	-0.35	-0.33	0.02	-0.33	0.18	-0.16
DH (J/g)	-0.35	-0.32	-0.43	**-0.53**	**1**	0.12	0.25	0.18	-0.07	**0.63**	**-0.51**	**0.62**	**0.60**	0.24	**0.53**	0.11	0.47
Amylose	-0.37	-0.41	-0.30	0.35	0.12	**1**	-0.28	-0.16	0.32	0.41	0.27	0.36	0.32	0.47	0.19	0.48	0.08
PME 30 min	0.05	0.06	0.06	-0.01	0.25	-0.28	**1**	**0.67**	**-0.55**	-0.08	0.00	-0.07	-0.02	0.03	-0.09	-0.02	0.06
PME 60 min	0.01	0.06	0.05	-0.23	0.18	-0.16	**0.67**	**1.00**	**-0.72**	-0.01	-0.22	0.00	-0.01	-0.23	0.08	-0.27	0.10
beta-amylase	-0.27	-0.33	0.01	0.38	-0.07	0.32	**-0.55**	**-0.72**	**1**	0.05	0.41	0.10	0.01	-0.13	0.11	0.00	0.27
Starch NIRS	**-0.53**	**-0.52**	**-0.69**	-0.37	**0.63**	0.41	-0.08	-0.01	0.05	**1**	-0.47	**0.88**	**0.87**	**0.66**	**0.68**	**0.56**	0.26
Tpk Visc inhib	0.01	-0.07	0.04	**0.97**	**-0.51**	0.27	0.00	-0.22	0.41	-0.47	**1**	-0.46	-0.42	-0.08	-0.43	0.08	-0.15
Peak inhib	-0.39	-0.36	**-0.52**	-0.35	**0.62**	0.36	-0.07	0.00	0.10	**0.88**	-0.46	**1**	**0.95**	0.39	**0.92**	0.28	0.37
Final Visc inhib	-0.37	-0.38	**-0.65**	-0.33	**0.60**	0.32	-0.02	-0.01	0.01	**0.87**	-0.42	**0.95**	**1**	0.50	**0.82**	0.36	0.24
Peak water	-0.51	**-0.52**	**-0.62**	0.02	0.24	0.47	0.03	-0.23	-0.13	**0.66**	-0.08	0.39	0.50	**1**	0.01	**0.95**	-0.48
Peak inhib-Peak water	-0.13	-0.05	-0.32	-0.33	**0.53**	0.19	-0.09	0.08	0.11	**0.68**	-0.43	**0.92**	**0.82**	0.01	**1**	-0.09	0.51
Final Visc water	**-0.61**	**-0.61**	**-0.58**	0.18	0.11	0.48	-0.02	-0.27	0.00	**0.56**	0.08	0.28	0.36	**0.95**	-0.09	**1**	-0.52
Dry matter	-0.25	-0.19	0.10	-0.16	0.47	0.08	0.06	0.10	0.27	0.26	-0.15	0.37	0.24	-0.48	0.51	-0.52	**1**
Cooking time	0.13	0.06	0.44	0.10	-0.01	0.14	0.11	0.19	0.23	-0.28	0.17	-0.02	-0.10	-0.46	0.21	**-0.53**	0.15
Firmness	-0.05	0.05	**0.56**	0.15	-0.31	0.29	-0.10	0.16	-0.16	-0.31	0.14	-0.34	-0.41	-0.24	-0.31	-0.22	0.20

The only significant correlations were between firmness and sucrose, and cooking time and final RVA viscosity in water (Figure 2); even significant these correlations does not appear usable for predicting cooking behaviour. No correlation were evidenced between cooking behaviour and dry matter, starch characteristics, PME, and pectins (first test on 6 samples).

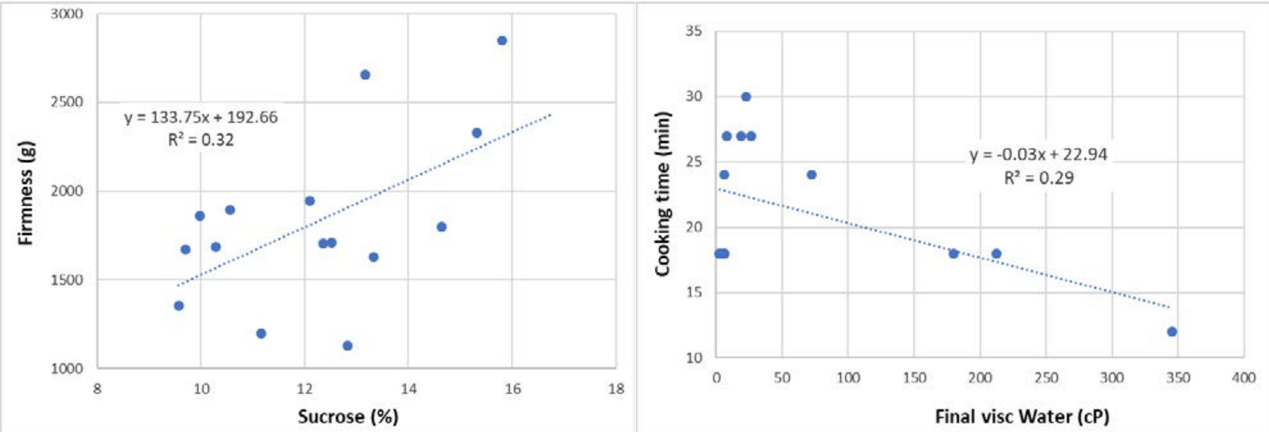

Figure 2 Correlation between sucrose content and firmness (a), and between final RVA viscosity in water and cooking time (b).

Several correlations were however evidenced between RVA and biophysical analyses (Figure 3):

- Tpeak measured with RVA with inhibitor and Tpeak measured by DSC; RVA can thus be used routinely by several partners to determine starch gelatinization temperature,
- Viscosity with inhibitor and starch content,
- the RVA viscosities were much lower without inhibitor due to starch hydrolysis, but the activity of beta-amylase did not appear correlated with RVA viscosities with water and/or difference of viscosities with and without inhibitor.

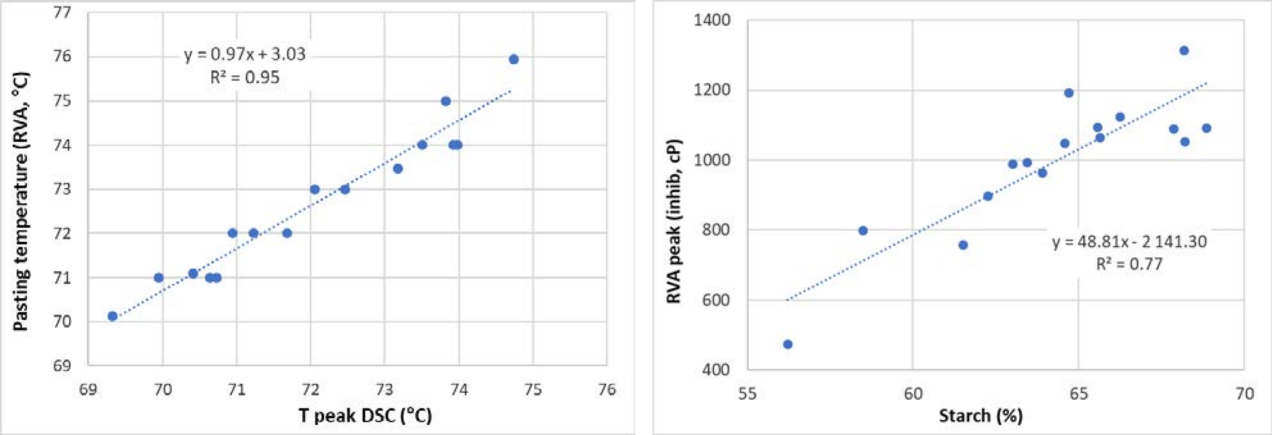

Figure 3 Correlation gelatinization temperature (Tpeak, DSC) and pasting temperature with inhibitor measured with RVA (a), and between starch content and pasting peak viscosity peak with inhibitor measured with RVA (b).

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