Calibration Report

NIRS Analyses of Sensory & Biochemical Traits in Potato Based on Spectra Collected on Raw Intact Tubers

High-Throughput Phenotyping Protocols (HTPP), WP3

Kampala, Uganda, 15/12/2022

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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

Context: This scientific report concerns preliminary NIRS calibrations of potato sensory and biochemical traits. The spectral data were collected from raw-intact tubers, while sensory and biochemical data was collected from cooked tubers.

Place: Uganda

Date: 16/12/2022

Authors: Judith S NANTONGO, Edwin SERUNKUMA, Fabrice DAVRIEUX, Karima MEGHAR, Reuben SSALI (2022)

Content:

A spectral analysis of 30 potato genotypes was undertaken. These were collected from Kenya and Uganda. Spectra were collected from raw-intact samples. Calibrations were done using reference data collected by a sensory panel as well as biochemical parameters assessed using conventional instrumental methods. Up to twelve cooked tubers per genotype were used for sensory evaluation of traits per session.

Average performances were observed of the calibration for yellow color (r2=0.56), moisture in mass (r2=0.57) as well as uniformity of texture (r2=0.66), suggesting that these models could be used for initial screening purposes. Most of the calibrations still need improvement.

Key Words: Potato, NIRS, sensorial profiles, calibrations, chemometrics

1 DATA

1.1 Material

A total of 30 genotypes were collected from Western and Eastern Uganda and Kenya. The samples were collected in 2022. The preparation of the raw-intact tubers for spectral analysis is detailed in the standard operating procedure on NIR spectra collection (Nantongo 2022) .

1.2 Sensory and biochemical parameters

Sensory parameters were assessed by the sensory panel while biochemical parameters were assessed using conventional instrumental methods (Table 1). Up to twelve cooked tubers per genotype were used for sensory evaluation of traits. The protocol for descriptive sensory analysis established for potato that was used, is similar to that used for sweetpotato (Nakitto 2020; Nakitto et al. 2022), where, up to 12 trained panelists consumed small cubes of each cooked potato genotype and rated the overall liking, color and aroma liking of the samples on a 10-point hedonic scale ranging from 1 (dislike extremely) to 10 (like extremely), for each sensory trait per genotypes. They also rated sweetness, mealiness and firmness on scales ranging from 1 to 10. The samples assessed per session were equivalent to the number of panel members. The biochemical properties were also assessed according to WP2 SOPs (eg https://doi.org/10.18167/DVN1/66IEOZ)

Table 1: Descriptive statistics of the sensory and biochemical parameters assessed in cooked potato tubers

	Constituents	Type of variable	N	Mean	SD	Minimum	Maximum
		Sensory					
1	Potato aroma	Quantitative	89	5.91	0.59	4.71	7.36
2	Green vegetable aroma	Quantitative	89	0.67	0.57	0.11	2.89
3	Root vegetable aroma	Quantitative	89	0.78	0.44	0.30	2.51
4	Yellow color	Quantitative	89	5.97	1.14	3.23	7.60
5	Chalkiness	Quantitative	89	1.45	0.98	0.40	5.59
6	Homogeneity of color	Quantitative	89	7.30	0.71	6.05	8.81
7	Transluscency	Quantitative	89	1.31	0.58	0.12	2.77
8	Potato flavor	Quantitative	89	5.88	0.76	2.61	7.29
9	Cooked carrot flavor	Quantitative	89	0.10	0.09	0.00	0.38
10	Green vegetable flavor	Quantitative	89	0.55	0.42	0.08	1.70
11	Root vegetable flavor	Quantitative	89	0.81	0.47	0.26	1.80
12	Sour taste	Quantitative	89	0.31	0.21	0.05	0.78
13	Bitter after taste	Quantitative	89	0.50	0.77	0.00	2.94
14	Hardness by hand	Quantitative	89	4.62	0.65	3.01	6.00
15	Moisture release	Quantitative	89	0.59	0.31	0.06	1.28
16	Cohesiveness (moldability)	Quantitative	89	6.46	0.55	5.40	8.19
17	Stickiness	Quantitative	89	2.88	0.52	1.70	3.84
18	Fracturability	Quantitative	89	2.91	0.73	1.47	4.20

	Constituents	Type of variable	N	Mean	SD	Minimum	Maximum
19	Hardness in mouth	Quantitative	89	3.80	0.53	2.28	4.68
20	Crunchiness	Quantitative	89	0.37	0.26	0.06	1.33
21	Moisture in mass	Quantitative	89	3.98	1.10	2.45	6.79
22	Mealiness	Quantitative	89	3.82	0.86	2.13	5.47
23	Smoothness	Quantitative	89	6.29	0.80	4.72	8.06
24	Uniformity of texture	Quantitative	89	7.37	0.74	6.27	8.39
		Biochemical					
25	Moisture content	Quantitative	160	80.59	1.99	74.54	83.91
26	Dry matter	Quantitative	160	19.41	1.99	16.09	25.46
27	Crude fibre	Quantitative	160	0.97	0.42	0.25	2.02
28	Total starch	Quantitative	160	49.70	9.11	10.83	60.23

2 RESULTS

2.1 Near Infrared Spectroscopy

2.1.1 Exploration

The spectra patterns of raw-intact potatoes from Kenya and Uganda sites are depicted in Figure 1. There are 5 peaks. The shape of the spectra from the different countries did not differ.

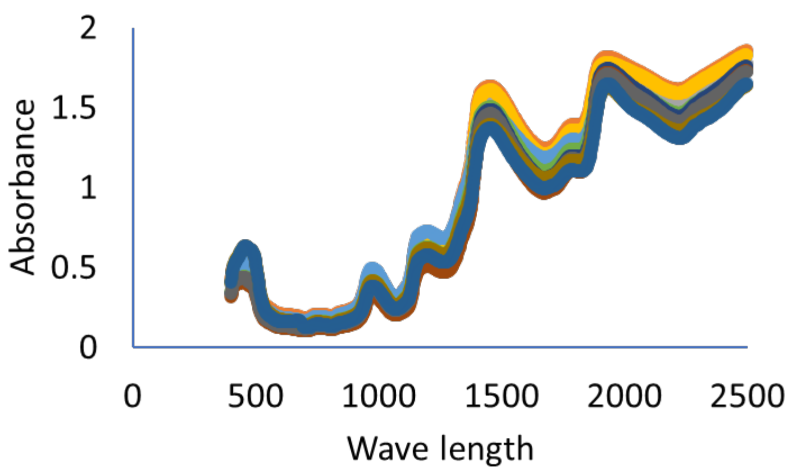

Figure 1 : NIRS spectra of raw intact potato

2.1.2 Spectra: Principal Components Analysis

A PCA calculated on the spectra (spectral range NIR) of the samples shows that 92 % of variance is explained by the 2 first PCs. The spectra collected on potatoes sampled in Kabale (Uganda) appeared to separate themselves from those collected on Kenya potatoes. However, the significance of the clustering was not tested (Figure 2).

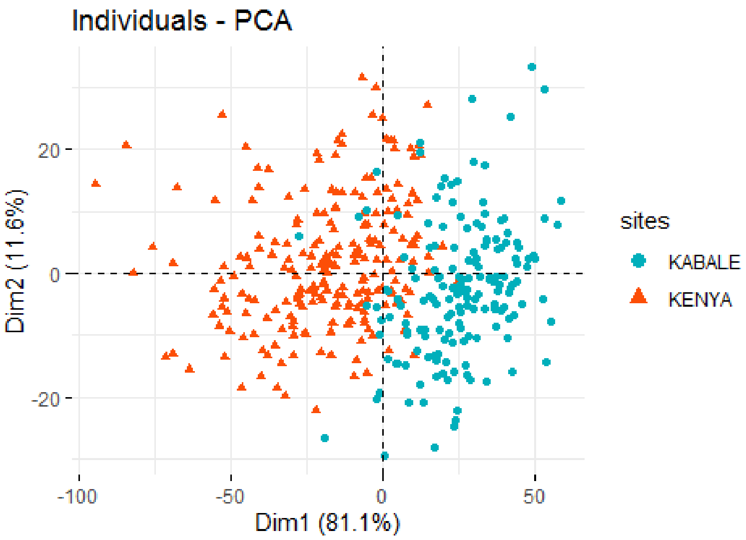

Figure 2 : PCA plot of the spectra collected from different sites

2.1.3 Quantitative analysis

The different parameters were calibrated using classical linear regression such as PLS regression, based on the full spectral range with no pre-treatments (Table 2). Due to small sample size, all samples were used to train the model and no external validation was made. The models were evaluated based on r^2. NIRS shows some potential to predict selected sensory parameters such as yellow color (r^2=0.56), moisture in mass (r^2=0.57) as well as uniformity of texture (r^2=0.66).

Table 2: R^2, standard error of cross validation (SECV) and number of components of NIRS calibrations for the sensory and biochemical parameters of potato tubers based on full spectra collected from raw-intact tubers

#	Parameter	r^2	SECV	# components
	Sensory			
1	Potato aroma	0.02	0.61	1
2	Green vegetable aroma	0.03	0.57	1
3	Root vegetable aroma	0.10	0.43	1
4	Yellow color	0.56	0.80	3
5	Chalkiness	0.07	0.97	1
6	Homogeneity of color	0.39	0.56	3
7	Transluscency	0.12	0.57	3
8	Potato flavor	0.12	0.75	2
9	Cooked carrot flavor	0.06	0.09	1
10	Green vegetable flavor	0.21	0.37	3
11	Root vegetable flavor	0.12	0.45	2
12	Sour taste	0.32	0.19	3
13	Bitter after taste	0.16	0.75	3
14	Hardness by hand	0.14	0.60	1
15	Moisture release	0.28	0.27	1
16	Cohesiveness (moldability)	0.08	0.53	1
17	Stickiness	0.10	0.49	1
18	Fracturability	0.22	0.66	1

#	Parameter	r²	SECV	# components
19	Hardness in mouth	0.22	0.50	3
20	Crunchiness	0.08	0.27	1
21	Moisture in mass	0.57	0.74	2
22	Mealiness	0.17	0.82	1
23	Smoothness	0.34	0.68	2
24	Uniformity of texture	0.66	0.45	2
	Biochemical			
25	Moisture content	0.19	1.88	3
26	Dry matter	0.16	1.89	3
27	Crude fibre	0.09	0.41	3
28	Total starch	0.05	8.69	2

3 CONCLUSION

NIRS shows some potential to predict selected sensory parameters such as color, moisture in mass and uniformity of texture. However, most of the sensory and biochemical calibrations are still poor and may be improved by adding additional samples. Collecting spectra from other sample types such as freeze-dried samples is encouraged.

A classification of sensory parameters based on spectral fingerprints should be tested. Indeed, by defining thresholds, or classes, by criterion, it will be interesting to investigate the possibility of classifying the genotypes in order to carry out a rapid selection. For this, methods such as PLSDA, SVM or SIMCA can be applied to spectral and sensory data sets.

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