Calibration Report

NIRS Analyses of Sensory & Biochemical Traits in Potato Based on Spectra Collected on Cooked Mashed 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 cooked-mashed tubers, while sensory and biochemical data was collected from cooked tubers.

Place: Uganda

Date: 16/12/2022

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Content:

A spectral analysis of 30 potato genotypes was undertaken. These were collected from Kenya and Uganda. Spectra were collected from cooked-mashed 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 ($r2 = 0.70$), homogeneity of color ($r2 = 0.48$), moisture in mass ($r2 = 0.40$) as well as uniformity of texture ($r2 = 0.56$), 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 cooked-mashed 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	90	5.91	0.58	4.71	7.36
2	Green vegetable aroma	Quantitative	90	0.67	0.56	0.11	2.89
3	Root vegetable aroma	Quantitative	90	0.78	0.44	0.30	2.51
4	Yellow color	Quantitative	90	5.98	1.14	3.23	7.60
5	Chalkiness	Quantitative	90	1.44	0.97	0.40	5.59
6	Homogeneity of color	Quantitative	90	7.31	0.71	6.05	8.81
7	Transluscency	Quantitative	90	1.30	0.58	0.12	2.77
8	Potato flavor	Quantitative	90	5.88	0.75	2.61	7.29
9	Cooked carrot flavor	Quantitative	90	0.09	0.08	0.00	0.38
10	Green vegetable flavor	Quantitative	90	0.55	0.42	0.08	1.70
11	Root vegetable flavor	Quantitative	90	0.82	0.47	0.26	1.80
12	Sour taste	Quantitative	90	0.31	0.21	0.05	0.78
13	Bitter after taste	Quantitative	90	0.47	0.74	0.00	2.94
14	Hardness by hand	Quantitative	90	4.62	0.65	3.01	6.00
15	Moisture release	Quantitative	90	0.58	0.31	0.06	1.28
16	Cohesiveness (moldability)	Quantitative	90	6.44	0.55	5.40	8.19
17	Stickiness	Quantitative	90	2.87	0.52	1.70	3.84
18	Fracturability	Quantitative	90	2.90	0.73	1.47	4.20

	Constituents	Type of variable	N	Mean	SD	Minimum	Maximum
19	Hardness in mouth	Quantitative	90	3.81	0.53	2.28	4.68
20	Crunchiness	Quantitative	90	0.37	0.26	0.06	1.33
21	Moisture in mass	Quantitative	90	3.97	1.09	2.45	6.79
22	Mealiness	Quantitative	90	3.82	0.85	2.13	5.47
23	Smoothness	Quantitative	90	6.28	0.78	4.72	8.06
24	Uniformity of texture	Quantitative	90	7.38	0.74	6.27	8.39
	Biochemical						
25	Moisture content	Quantitative	153	80.59	2.021	74.54	83.91
26	Dry matter	Quantitative	153	19.41	2.021	16.09	25.46
27	Crude fibre	Quantitative	153	0.973	0.42	0.25	2.02
28	Total starch	Quantitative	153	49.52	9.228	10.83	60.23

2 RESULTS

2.1 Near Infrared Spectroscopy

2.1.1 Exploration

The spectra patterns of cooked-mashed potato tubers from Kenya and Uganda sites are depicted in Figure 1. There are 5 major peaks. The shape of the spectra from the different countries did not differ.

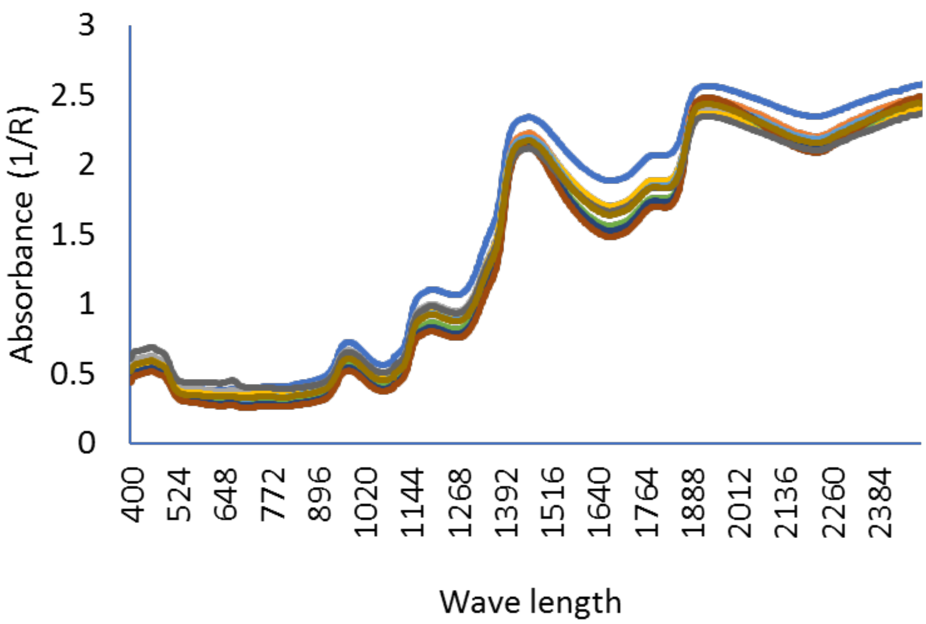

Figure 1 : NIRS spectra of cooked-mashed potato

2.1.2 Spectra: Principal Components Analysis

A PCA calculated on the spectra (spectral range NIR) of the samples shows that 86.4 % of variance is explained by the 2 first PCs. The spectra on potatoes collected from Kenya seemed separate into two clusters, where one, clustered with the spectra collected on Ugandan samples. These two clusters may need further investigation in terms of biochemical changes that occur during cooking. However, the significance of the clustering was not tested (Figure 2).

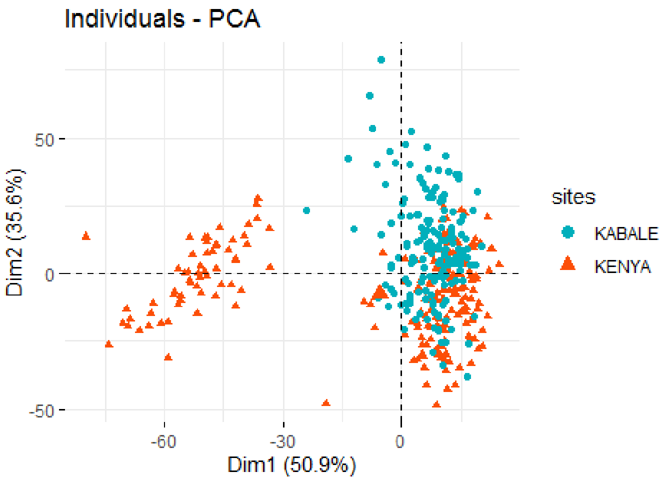

Figure 2 : PCA plot of the spectra collected from different sites

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=0.70), homogeneity of color (r^2=0.48), moisture in mass (r^2=0.40) as well as uniformity of texture (r^2 =0.56).

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 cooked-mashed tubers

#	Parameter	r^2	SECV	# components
		Sensory		
1	Potato aroma	0.04	0.63	1
2	Green vegetable aroma	0.06	0.57	1
3	Root vegetable aroma	0.04	0.42	1
4	Yellow color	0.70	0.63	3
5	Chalkiness	0.18	0.93	1
6	Homogeneity of color	0.48	0.53	3
7	Transluscency	0.15	0.56	1
8	Potato flavor	0.02	0.71	1
9	Cooked carrot flavor	0.04	0.09	2
10	Green vegetable flavor	0.12	0.42	3
11	Root vegetable flavor	0.04	0.48	1
12	Sour taste	0.28	0.19	3
13	Bitter after taste	0.16	0.72	3
14	Hardness by hand	0.08	0.63	1
15	Moisture release	0.22	0.29	1
16	Cohesiveness (moldability)	0.09	0.55	1
17	Stickiness	0.14	0.49	2
18	Fracturability	0.20	0.67	2

#	Parameter	r^2	SECV	# components
19	Hardness in mouth	0.11	0.52	2
20	Crunchiness	0.06	0.26	1
21	Moisture in mass	0.40	0.89	2
22	Mealiness	0.19	0.82	1
23	Smoothness	0.28	0.71	3
24	Uniformity of texture	0.56	0.51	3
	Biochemical			
25	Moisture content	0.12	1.94	2
26	Dry matter	0.08	1.96	2
27	Crude fibre	0.03	0.43	2
28	Total starch	0.06	9.01	3

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.

4 REFERENCES

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