

# NIRS Analyses of Sensory & Textural Traits in Sweetpotato based on Spectra Collected on Raw Freeze-dried Roots

High-Throughput Phenotyping Protocols (HTPP), WP3

**Kampala, Uganda, 29/11/2022**

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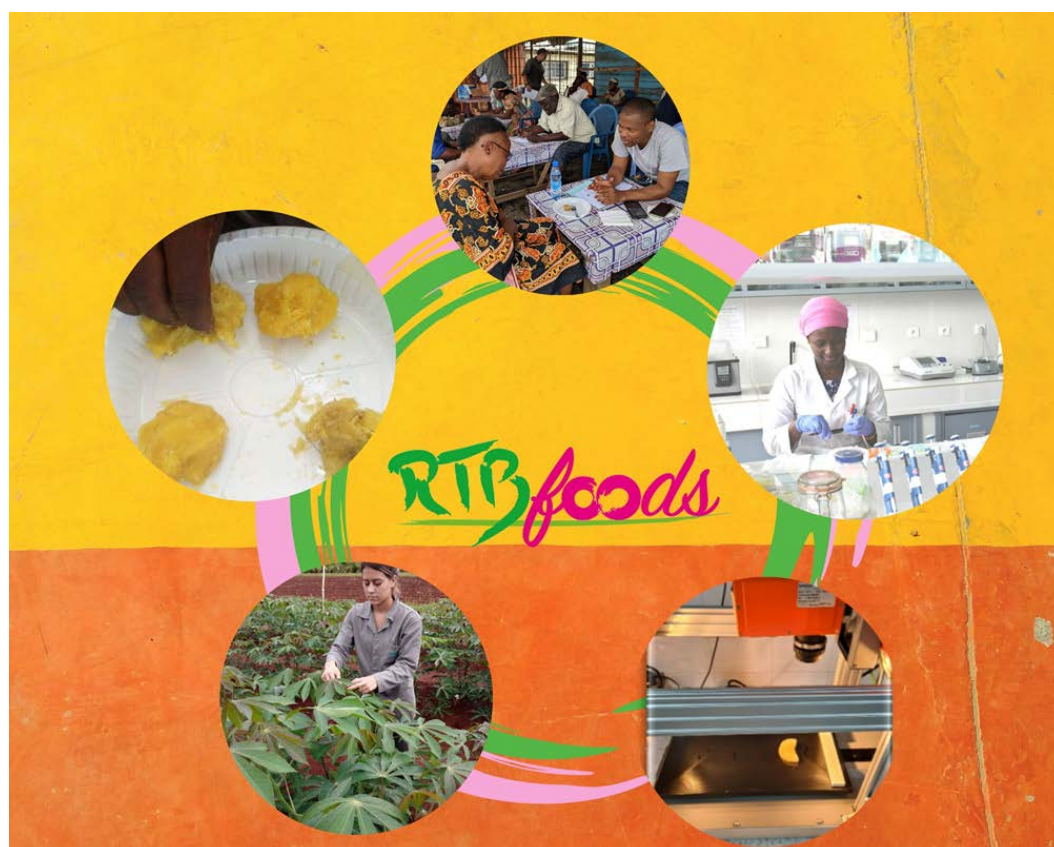
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Ethics: The activities, which led to the production of this manual, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing 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

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**Context:** This scientific report concerns NIRS calibrations of sweetpotato sensory traits. The spectral data were collected from raw freeze-dried roots, while sensory data was collected from cooked roots.

**Place:** Uganda

**Date:** 29/11/2022

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

## **Content:**

A spectral analysis of 217 sweetpotato genotypes was undertaken. These were collected from different CIP sweet potato genetic trials (GT) located in different agroecological zones (AEZ); West Nile AEZ (Abii GT; L. Albert AEZ (Hoima and Buling GTs); Southern highlands (Kabale GT); Lake Victoria Crescent (Namulonge MDP); Western highlands (Rwebitaba MDP); and L. Kyoga basin (Serere GT). The samples were collected in two different seasons of 2021 and 2022. Harvests took place in the second season of 2021 (94 genotypes) (and the first season of 2022 (123 genotypes). Calibrations were done using reference data collected by a sensory panel as well as texture parameters assessed using a texture analyser. Up to twelve cooked roots per genotype were used for sensory evaluation of traits per session.

High performances were observed of the calibration for orange color intensity ( $R^2 = 0.83$ ), suggesting that the model is sufficient for field application. The moderate performances of pumpkin aroma and pumpkin flavor ( $R^2 > 0.50$ ) could be used for initial screening purposes. Most of the calibrations still need improvement.

**Key Words:** NIRS, Sweet potato, sensorial profiles, textural properties, phenotyping, Chemometrics, calibrations

# 1 DATA

## 1.1 Material

A total of 217 genotypes were collected from different CIP sweet potatoe genetic trials (GT) located in different agroecological zones (AEZ); West Nile AEZ (Abii GT; L. Albert AEZ (Hoima and Buling GTs); Southern highlands (Kabale GT); Lake Victoria Crescent (Namulonge MDP); Western highlands (Rwebitaba MDP); and L. Kyoga basin (Serere GT). The samples were collected in two different seasons of 2021 and 2022. Harvests took place in the second season of 2021 (94 genotypes) (and the first season of 2022 (123 genotypes). The preparation of freeze-dried roots for spectral analysis is detailed in the standard operating procedure on NIR spectra collection (Nantongo 2022). However, data analysis is based on a partial dataset.

## 1.2 Sensory and texture parameters

Sensory parameters were assessed by the sensory panel while texture parameters were assessed using a texture analyser (Table 1). Up to twelve cooked roots per genotype were used for sensory evaluation of traits. The protocol for descriptive sensory analysis established for sweetpotato that was used has been previously described (Nakitto 2020; Nakitto *et al.* 2022), where, up to 12 trained panelists consumed small cubes of each cooked sweetpotato 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 just-about-right scales ranging from 1 to 10. The samples assessed per session were equivalent to the number of panel members. In addition, the average peak positive force for the first and second compressions texture of each piece were analysed using a TA-XT texture analyzer (Stable Macro Systems, Godalming, UK) with 10 kg load cell, following a texture profile analysis (TPA) procedure.

Table 1: Descriptive statistics of the sensory parameters assessed in raw freeze-dried sweetpotato roots

#	Parameter	N	Mean	SD	Minimum	Maximum
1	Sweetpotato aroma	150	6.04	0.82	3.57	7.27
2	Caramel aroma	150	0.26	0.26	0	1.2
3	Pumpkin aroma	150	0.13	0.32	0	1.5
4	Off odour	150	0.26	0.35	0	1.86
5	Orange color intensity	150	2.54	2.39	0.1	8.67
6	Uniformity of color	150	7.1	0.86	4.88	8.57
7	Degree of translucency	150	1.1	0.55	0	3.25
8	Fibrous appearance	150	0.78	0.5	0	2.88
9	Sweetpotato flavor	150	6.28	0.87	2.63	7.53
10	Pumpkin flavor	150	0.17	0.32	0	1.25
11	Cooked carrot flavor	150	0.04	0.16	0	1
12	Floral flavor	150	0.12	0.17	0	0.6
13	Sweet taste	150	5.45	0.96	2	7
14	Bitter taste	150	0.07	0.12	0	0.5
15	Hardness by hand	150	4.18	1.17	1.94	6.89
16	Moisture release	150	0.39	0.37	0	1.6
17	Cohesiveness	150	6.41	2	0.94	8.83
18	Crumblieness/Mealiness by hand	150	5.28	1.82	0.33	8.8
19	Fracturability	150	3.9	1.66	1	7.53

#	Parameter	N	Mean	SD	Minimum	Maximum
20	Firmness/ Hardness	150	3.74	0.89	2.06	5.35
21	Crunchiness	150	0.45	0.41	0	1.44
22	Moisture in mass	150	4.48	1.59	1.27	8.07
23	Crumbliness	150	5.07	1.85	0.33	8.18
24	Adhessiveness (Stickiness)	150	1.2	0.49	0.11	2.3
25	Fibrousness	150	0.5	0.66	0	4
26	Smoothness	150	6.8	1.21	3.25	8.57
27	Rate of breakdown	150	6.27	0.99	4.6	8.31
28	Dry matter	150	36.14	3.45	28.05	44.24
29	Peak positive force 1	138	4625	2039	1694	8527
30	Peak positive force 2	138	3428	1526	1156	7074
31	Positive Area 1	138	8353	3572	2948	14707
32	Positive Area 2	138	3458	1748	1142	8178
33	Optimal cooking time (OCT)	84	23.3	8.2	15	45
34	Water absorption1	102	1.7	2.1	-3.5	9.1
35	Water absorption2	12	2.6	3.2	0	7.7

## 2 RESULTS

### 2.1 Near Infrared Spectroscopy

#### 2.1.1 Exploration

The spectra patterns are depicted in Figure 1. The spectra seem to differ from the fresh samples.

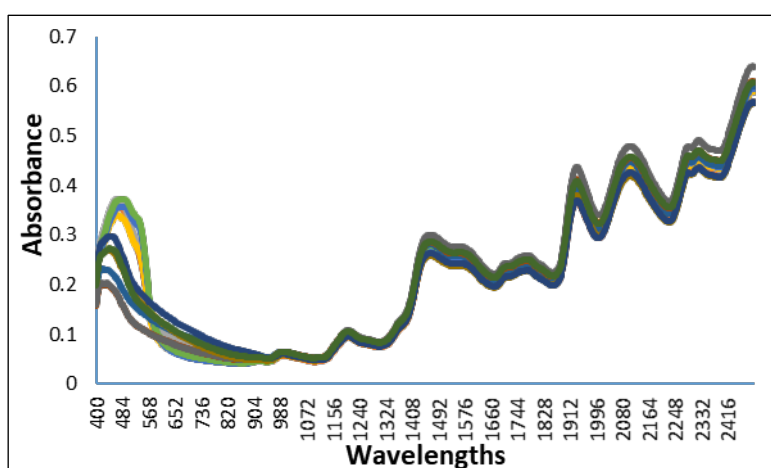


Figure 1 : NIRS spectra of raw freeze-dried sweetpotato

Spectra: Principal Components Analysis

A PCA calculated on the spectra (spectral range NIR) of the samples shows that 91% of variance explained by the 2 first PCs. The spectra from Namulonge (Figure 2) appeared to be distant from the others.



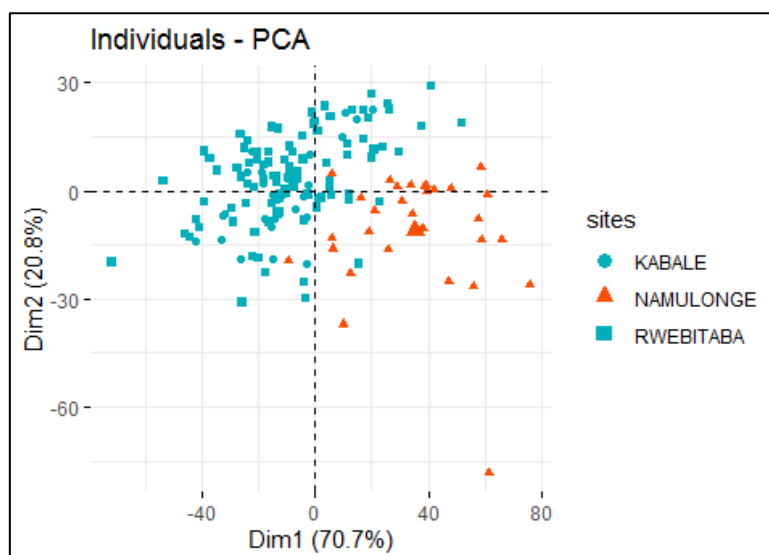


Figure 2 : PCA plot of spectra collected from freeze-dried samples of different sites

## 2.2 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). A maximum of 4 components were allowed due to a limited sample size. All samples were used to train the model and no external validation was made.

#	Parameter	R <sup>2</sup>	SECV	# components
1	Sweetpotato aroma	0.2	0.77	4
2	Caramel aroma	0.3	0.23	4
3	Pumpkin aroma	0.6	0.19	4
4	Off odor	0.3	0.3	4
5	Orange color intensity	0.8	0.93	4
6	Uniformity of color	0.3	0.77	4
7	degree of translucency	0.2	0.52	4
8	Fibrous appearance	0.2	0.44	3
9	Sweetpotato flavor	0.2	0.73	3
10	Pumpkin flavor	0.6	0.18	4
12	Floral flavor	0.2	0.16	2
13	Sweet taste	0.3	0.85	4
14	Bitter taste	0.2	0.11	1
15	Hardness by hand	0.4	0.98	4
16	Moisture release	0.3	0.31	3
17	Cohesiveness	0.3	1.73	4
18	Mealiness by hand	0.2	1.67	4
19	Fracturability	0.4	1.38	4
20	Firmness/Hardness	0.3	0.78	4
21	Crunchiness	0.3	0.38	2
22	Moisture in mass	0.3	1.37	4
23	Crumbliness	0.2	1.72	4
24	Adhesiveness	0.3	0.44	2
25	Fibrousness	0.4	0.52	3
26	Smoothness	0.3	1.11	1
27	Rate of breakdown	0.4	0.8	4
28	Dry matter	0.3	2.94	4
29	Peak positive force 1	0.4	1737	4
30	Peak positive force 2	0.3	1351	4
31	Positive Area 1	0.4	2826	4
32	Positive Area 2	0.3	1573	4
33	OCT	0.4	7.62	2
34	Water absorption	0.2	2.01	2

Table 2 : Calibration for the sensory parameters of sweetpotato roots (R<sup>2</sup>, SECV and number of components for regression)



### 2.2.1 Statistics parameters for calibrations:

High performances were observed of the calibration for orange color intensity ( $R^2 = 0.83$ ), suggesting that the model is sufficient for field application. Moderate performances for pumpkin flavor and pumpkin aroma ( $R^2 > 0.50$ ) were detected. Most of the calibrations still need improvement ( $R^2 < 0.50$ ).

## 3 CONCLUSION

Despite of the low number of reference data available, the NIRS shows some potential to predict selected sensory parameters such as orange color intensity. However, most of the calibrations are still poor and may be improved by adding additional samples, especially to minimise the seasonality effect.

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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