Laboratory Standard Operating Procedure

SOP for Characterization of Instrumental texture of Steamed Sweetpotato - Version B

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 panellists and from consumers participating in activities.

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WP2: Biophysical Characterization of Quality Traits

SOP: Characterization of Instrumental Texture of Steamed Sweetpotato

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ABSTRACT

Findings from Work Package 1 revealed that sweetpotato consumers in Uganda prefer firm and mealy steamed sweetpotato. It can be interpreted that consumers of steamed sweetpotato prefer moderate effort to bite through the product. This SOP describes a laboratory-based method, Texture profile analysis (TPA) analysis, developed to evaluate the hardness of steamed sweetpotato and other textural attributes such as cohesiveness, adhesiveness, and chewiness. The method describes steps to follow during sample preparation, as well as the set-up and settings of parameters for instrumental texture analysis. When preparing the samples, sweetpotato roots were washed, and then at least three sample pieces of 30 X 30 X 25 mm were cut from each root. The pieces were then carefully placed between sheets of banana leaves and steamed over boiling water for 35 minutes. After the steaming step, the mucilage coatings were removed from each sample piece by carefully slicing off 5 mm from either end of the vertical height to remain with pieces of 30 X 30 X 20 mm dimension. For instrumental texture analysis, samples were analysed following a double compression Texture Profile Analysis (TPA) procedure where samples were compressed to achieve 25% strain by a plate probe. The hardness, cohesiveness, adhesiveness, springiness, gumminess, chewiness, and resilience of the steamed sweetpotato samples were calculated. This method was reproducible for all the textural parameters and discriminating between the various sweetpotato genotypes considered, especially for hardness and cohesiveness. It can therefore be applied to investigate the texture of sweetpotato samples in breeding programs.

Key Words: steamed sweetpotato, steaming, texture profile analysis, texture analyser, discriminant

1 SCOPE AND APPLICATION

This SOP describes the steps to follow during sample preparation and instrumental texture analysis of steamed sweetpotato samples. During sample preparation, at least three 30 X30 X25 mm pieces of samples are cut from each clean sweetpotato root, carefully placed between sheets of banana leaves and steamed for 35 minutes. For instrumental texture analysis, samples are analysed following a double compression Texture Profile Analysis (TPA) procedure where samples are compressed to achieve 25% strain by a plate probe.

2 DEFINITIONS

- **Firmness / Hardness (g or N):** The highest positive force measured during the first compression **(F1)**.
- **Adhesiveness (g·s or N·s):** The total area under the first negative peak **(c)**.
- **Cohesiveness (-):** The ratio of total area under the second compression curve to the area underneath the first compression curve [**(d+e)/(a+b)**].
- **Springiness (%):** A ratio of a product's recovery to its original height expressed as a percentage [**(Distance 2)/(Distance 1)]*100** or **(Time 2/Time 1)*100**.
- **Gumminess (g or N):** Product of hardness and cohesiveness **F1*[(d+e)/(a+b)]**. May also be expressed as percentage.
- **Chewiness (g or N):** Product of hardness and cohesiveness and springiness **F1*(Distance 2/Distance 1)*[(d+e)/(a+b)]**. May also be expressed as percentage.
- **Resilience (-):** Ratio of area under curve when peak force is surpassed to the area under curve before peak force is reached in the first cycle **(b/a)**. May also be expressed as percentage.
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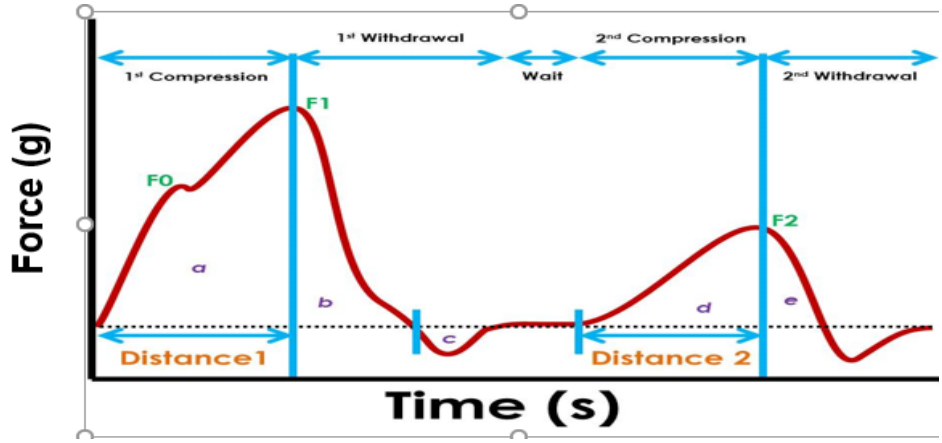


Picture 1. Graphical representation of Texture Profile analysis (TPA) parameters

3 PRINCIPLE

The SOP follows the principle that firmer (harder) samples require more force to compress. Thus, the higher the peak force, the firmer or harder the sample. If firmness is significantly different between genotypes, it can be considered as an attribute to discriminate the sensory firmness and make conclusions on the consumer acceptability. The same applies for the other textural attributes.

4 REAGENTS AND MATERIALS

- Sweetpotato roots
- Portable water
- Banana leaves

5 APPARATUS

The texture analyzer was calibrated for force using a 5kg load cell and 2 kg standard weight. The distance was also calibrated following the directions of the operation manual.

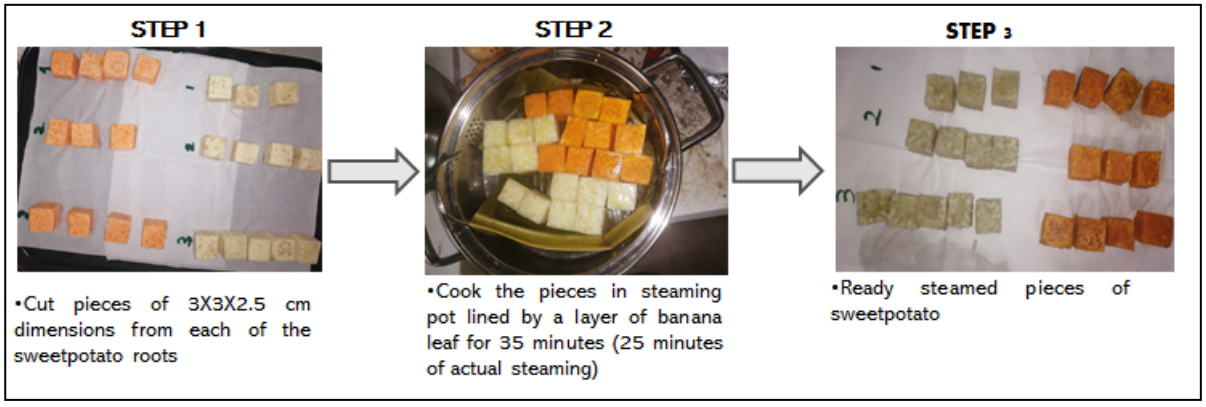
1. Texture analyser (the model used for the development of this SOP is a TA-XTPlus by Stable Microsystem).
2. Plate probe - Aluminium (P/75 Plate by Stable Micro Systems)
3. Steam cooker
4. Sharp knives
5. Meter/rule
6. Food grade thermometer

6 PROCEDURE

6.1 Product preparation

Three representative roots were selected from each sweetpotato genotype, and at least three cuboid sample pieces of 30 X30 X 25 mm dimension were cut from each root (Picture 1).

About 2 L of water were poured into a steaming pot. With a sheet of banana leaf laid on the base of the pot, the sweetpotato pieces were placed on the leaf and covered with another layer of banana leaf followed by the pan lid. The steaming pot was put on a lit gas stove set at high heat to steam samples for 35 minutes. It is estimated that this cooking time includes 25 minutes of actual steaming.

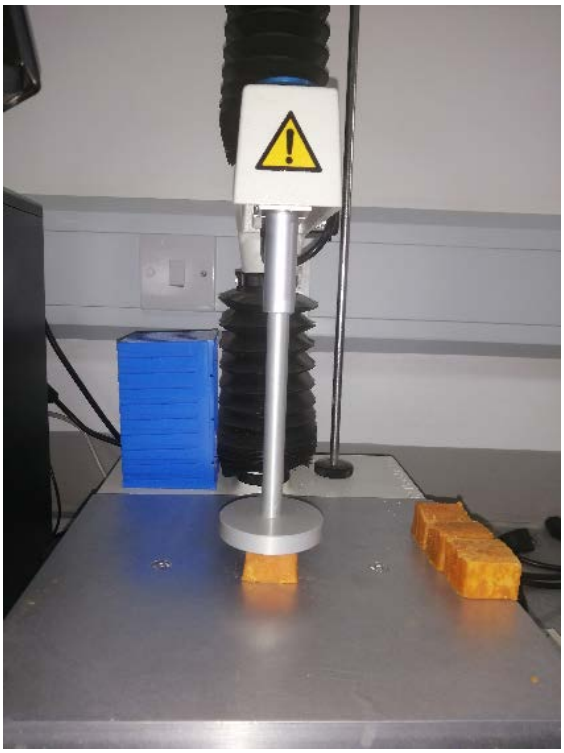


Picture 2. Steps in sample preparation

During steaming there is amylose leaching and the pieces tend to have a sticky mucilage coating covering the surface. After the steaming step, the mucilage coatings are removed from each sample piece by carefully slicing off 5mm from either end of the vertical height to remain with pieces of 30 X 30 X 20 mm dimension. These are the pieces on which texture analysis was conducted.

6.2 Texture analysis conditions

Instrumental texture analysis was conducted on samples following a double compression Texture Profile Analysis (TPA) procedure where samples were compressed to achieve 25% strain by a plate probe (Picture 2). Additional texture analyzer settings are indicated in Table 1.



Picture 3. Texture analysis of steamed sweetpotato by TPA double compression

Table 1. Settings for TPA procedure used to analyse instrumental texture of steamed sweetpotato

Pre-Test Speed	1.0 mm/s
Test speed	1.6 mm/s
Post-test speed	2.0 mm/s
Trigger force	0.49 N
Time between cycles	5 s
Compression (strain)	25 %
Temperature of test	25°C

7 EXPRESSION OF RESULTS

7.1 Method of calculation

7.1.1 Calculation

Instrumental texture parameters were calculated in the Exponent software (Stable Microsystems) using a macro for calculation from the TPA graphs. Parameters of interest are hardness (peak positive force), adhesiveness, cohesiveness, springiness, gumminess, chewiness, and resilience. Statistical analyses such as analysis of variance (ANOVA), principal components analysis (PCA) and discriminant analyses were conducted.

8 CRITICAL POINTS OR NOTE ON THE PROCEDURE

- The steaming procedure starts with cold water as the cooking time indicated here (35 minutes) includes the time taken for the steaming water to start boiling and actual steaming time (25 min).
- The measurement of texture must be carried out at ambient / room temperature,25°C. Temperature of the samples can be monitored indirectly by probing a thermometer in one of the pieces of sweetpotato which will not be used for texture analysis.
- Ensure the texture analyzer is switched on for at least 15 min before calibration and measurements
- Calibration of force and distance on texture analyzer should be done before taking measurements
- Clean plate probe with wet and dry towel to remove residues after each measurement

9 APPENDICES

9.1 Annex 1: Example of repeatability and discriminance of instrumental texture of steamed sweetpotato using TPA

Objective

The experiment was conducted to test the reproducibility of measurements and discrimination between genotypes for the instrumental texture parameters of steamed sweetpotato using the TPA.

Experimental design

The set up was completely randomised design where 14 sweetpotato genotypes (D11, D15, D20, D26, Ejumula, NASPOT 8, NASPOT 10, NASPOT 11, New Kawogo, NKB3, NKB105, S36, S47, and S97) of varying flesh colours were analysed by instrumental texture analysis following the procedure described in previous sections of this document. A macro was developed and used to calculate the hardness, cohesiveness, adhesiveness, springiness, gumminess, chewiness and resilience of the samples from the TPA graphs. Data means were compared by ANOVA and separated using multiple comparison test. Discriminativeness of the method was explained using principal component analysis (PCA), and discriminant analysis, while hierarchical clustering was used to classify the genotypes into groups of similar characteristics.

Results

One-way and Two-way analysis of variance

There was significant difference between the genotypes for all TPA texture parameters except springiness. Means of replicates (roots of the same genotype) were not significantly different for all the textural parameters by one-way and two-way ANOVA, therefore the measurements were reproducible. Differences between the texture parameters of the steamed sweetpotato was significantly due to the differences among genotypes. The most discriminatory textural parameters were hardness (Table 2, Table 3) and cohesiveness.

Table 2. One way ANOVA of hardness of steamed sweetpotato

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Genotype	13	182784759	14060366	16.9	1.2e-17
Error	78	64797321	830735		
C. Total	91	247582080			

Table 3. Effect test for hardness of steamed sweetpotato

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Genotype	13	13	179390621	16.7	<.0001*
Replicate	1	1	2115716	2.6	0.11
Genotype*Replicate	13	13	9860888	0.9	0.54

Discrimination between varieties based on textural attributes

PCA analysis: The first two components of the PCA showing steamed sweet potato texture by TPA explained 77.7% of the variation (Figure 1). Genotype D26 was gummy and chewy. NASPOT 10, S97, S47 and Ejumula were associated with springiness and cohesiveness. S36, NASPOT 8 and New Kawogo were adhesive and resilient.

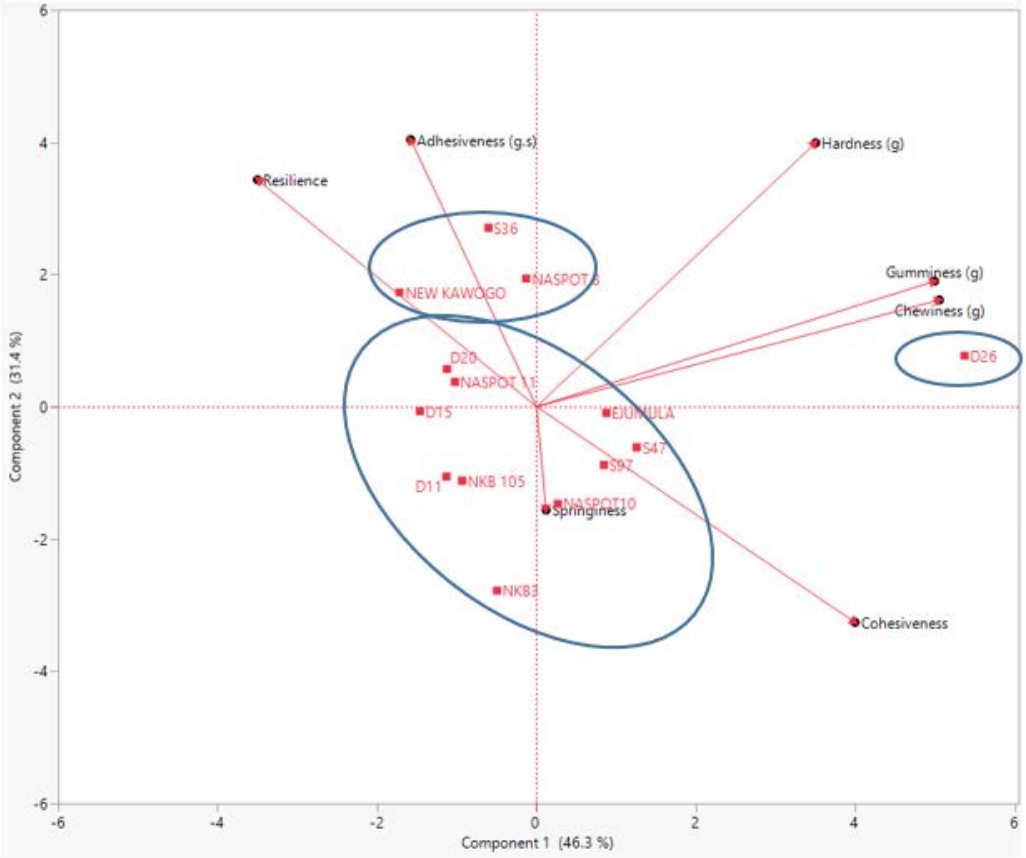


Figure 1. PCA of instrumental TPA parameters of steamed sweetpotato

Discriminance

Discriminant analysis showed that D26, D11 and S36 were the most different genotypes given that they were farthest from one another in the canonical space. Most of the remaining genotypes were clustered more closely, with similar textural character.

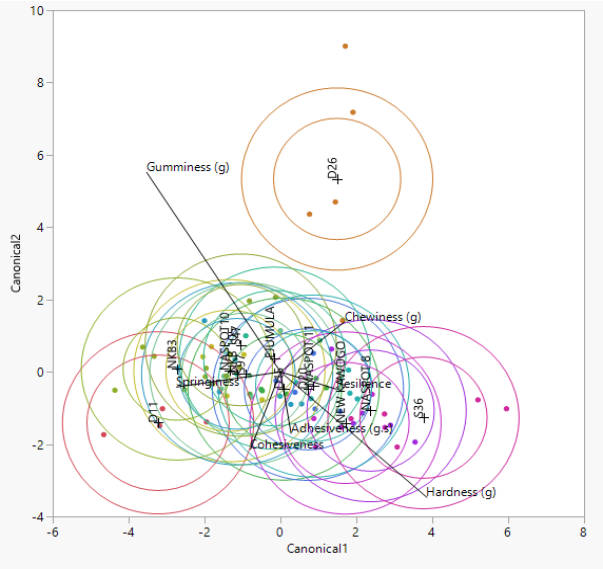


Figure 2. Discriminance by sweetpotato genotype

Hierarchical classification of genotypes

The hierarchical classes of the genotypes are clustered similarly to the discriminant clustering. Genotype D26 is particularly distinct in texture compared to other genotypes. NASPOT 8, S36 and NEW KAWOGO were clustered together. These distinct clusters indicate that it may be possible to associate genotypes of similar textural characteristics, and classify genotypes into 3-tier clusters of good, poor and intermediate genotypes for steamed sweetpotato.

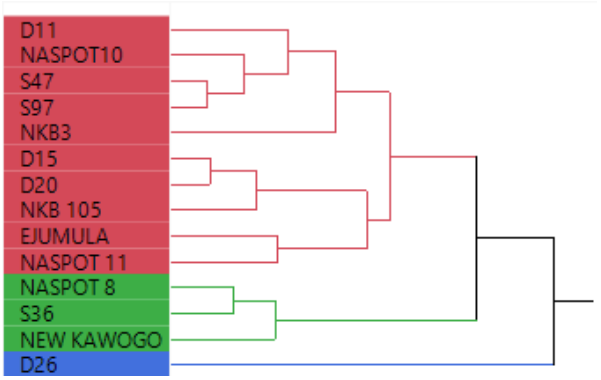


Figure 3. Hierrachical clustering of sweetpotato genotypes by texture

Conclusion

There was good discrimination between genotypes of 14 steamed sweetpotato, and their textural data were repeatable. Therefore, the steamed sweet potato genotypes can be discriminated based on the texture determined by TPA protocol. The genotypes have the most significant effect on differences between the texture of the steamed sweetpotato. The most discriminatory textural parameters are hardness & cohesiveness. PCA and hierarchical clustering classified the genotypes in different groups of similar textural character.

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