Laboratory Standard Operating Procedure

SOP for the Characterization of Instrumental Texture of Matooke

Biophysical Characterization of Quality Traits, WP2

Kampala, Uganda, 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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RTBfoods

WP2: Biophysical Characterization of Quality Traits

SOP: Characterization of Instrumental Texture of Matooke

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ABSTRACT

Matooke, as it is locally called in Uganda is a main staple in the country and commonly consumed in the East African region and in other parts of Africa. It is made from the East African highland cooking bananas and can be consumed in many different forms ranging from boiled fingers, steamed and mashed among others. The quality attributes of matooke which include texture, enormously contribute to its acceptability by the consumers. Instrumental texture was determined by a TMS-pilot texture analyzer to obtain the texture profile analysis (TPA) for 32 matooke genotypes, and the TPA attributes obtained were hardness, adhesiveness and cohesiveness. The tests were done at product temperature of 75 ^{o}C, which was also the tasting temperature. Results showed that hardness was significantly different between the genotypes but cohesiveness and adhesiveness were not. Twelve trained panellists determined the sensory texture of the steamed matooke genotypes by quantitative descriptive analysis during eight sessions. Texture was measured by both touch (hardness moldability, stickiness) and mouthfeel (firmness, moistness, and smoothness) on a scale of 0-10 (low intensity to high intensity, respectively). Sensory and instrumental hardness were significantly correlated. The moistness of matooke was significantly negatively related to the hardness. Hardness of matooke was significantly negatively associated with stickiness. A smooth texture was significantly negatively associated with the adhesiveness, while moldability had significant negative correlation with adhesiveness.

Key Words: Matooke, Texture, Quality traits, Textural Profile Analysis, Discriminant

1 SCOPE AND APPLICATION

This SOP describes the preparation of Matooke samples for texture analysis and the related texture measurement. The objective of this SOP is to measure the instrumental texture of cultivars of bananas prepared as Matooke by using a texture analyser. The protocol is analysed statistically for discriminance between matooke cultivars.

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3 GENERALITIES AND DEFINITIONS

EAHCB- East African Highland Cooking Banana.

The fruits of this crop are usually harvested at mature green state before preparing them for a meal. When cooked, the fruits are characterized by a unique insipid taste and aroma, golden yellow colour and a tender texture. These attributes have endeared an EAHCB meal to consumers and constitute the unique quality described as 'tookeness', originating from the term 'matooke' used to describe a cooked meal of the EAHCB.

Depending on cultivar, the EAHCB fruits mature in 12-15 months from plant sucker emergence. The fruits are harvested when still green. The commonly used indicators of maturity are (a) Fruit skin colour changes from dark green to pale green; (b) Ridges on the fruit surface change from angular to round; (c) Falling off of the dried flower parts at the finger tops and (d) Drying of top-most leaves. Harvesting is done by lopping the pseudostem with a hatchet over half-way through the stem, allowing the bunch to fall slowly to avoid damage. The bunch is then removed by cutting it off at the peduncle, leaving about over 30cm of the stalk to ease handling.

Matooke- Cooked food prepared from East African Highland Cooking Banana.

Matooke samples are weighed, peeled, washed and wrapped in banana leaves before steaming at 100° C for about an hour and 15 minutes. They are then mashed for 2 minutes each before re-steaming on minimum heat just to keep it warm. These two cooking times are selected to ensure the samples do not cool as this would result in hardening.

The textural profile analysis (TPA) attributes associated with Matooke quality are;

Hardness: According to Pons & Fiszman (1996), hardness is "the peak force during the first compression cycle" ("first bite").

Adhesiveness: is defined by Peleg (2019) as the strength of physical attraction between different materials (e.g food material that sticks to the palate of the mouth when eating). It is the first negative area during the first cycle of TPA compression.

Cohesiveness: It is the degree to which a substance is compressed between the teeth before it breaks according to Szczesniak (2002). It is the ratio of the total positive area under the second compression cycle to that of the first compression cycle.

4 PREREQUISITE

- The texture analyser is switched on at least 15 minutes before the measurements.
- The texture analyzer is equipped with a load cell of 50Kg and a compression plate probe of 59mm diameter.
- The matooke should be tightly wrapped in the banana leaves and each time a sample is picked, it is re-wrapped to avoid cooling which causes hardening.

5 APPARATUS

a. Texture analyser is equipped with a plate compression probe (diameter = 59 mm).
b. Gas cooker has several fires enough to accommodate a large saucepan/cooking pot.
c. Large saucepan (capacity at least 10 litres of water) ; (1) to enable steaming several samples in the same pot, ensuring cooking at the same temperature ; (2) to minimize temperature variations within the samples.
d. Timer: to alert when the optimum cooking and mashing time is reached.
e. Thermometer
f. Hollow metallic rod (diameter = 44 mm)

6 PRODUCT PREPARATION: MATOOKE

6.1 Step 1: Peeling

- Remove the banana clusters from the peduncle, separate the fingers and mix them up. Randomly, pick and weigh 6 Kg of unpeeled fingers. You will obtain about 3 kg of peeled matooke fingers.
- Remove the peel by first cutting off the tips at each end. The skin is then removed by cutting along the length of the skin from the upper tip to the lower end. This is done carefully with a knife to ensure it does not cut deeply into the flesh of the banana. Place the peeled fingers into a pan of clean water to minimize browning.


Peeling of banana fingers to obtain the edible portion

6.2 Step 2: Wrapping in banana leaves

- Wrap the peeled fingers in banana leaves. Tie a string to the wrapped sample and label it for identification, in case you are planning to steam many samples.



Wrapping banana fingers in leaves with identification tag

6.3 Step 3. Steaming

- Steaming is done in a big saucepan whose diameter is 585mm. This can accommodate 5 to 6 samples each weighing 3Kg. The wrapped samples are 3 Kg each and 5 to 6 samples of these are steamed in the bigger cooking saucepans at a go.
- Line the bottom of the saucepan with pieces of peduncle to make a “bed” and add 2 banana leaves to cover them. Put just enough to ensure that the matooke does not get in direct contact with the surface of saucepan during steaming but also to keep the wrap(s) suspended so that they do not get soaked with water, especially at the end of the cooking process.
- Add 10 Litres of water; cover the wrapped matooke in the saucepan (diameter=585mm) with more leaves (3-10, depending on the size of saucepan and number of samples). Cover with another saucepan (diameter=555mm) on top to keep the steam trapped inside during the cooking process.

Each variety of matooke is wrapped in a pack and coded with a colour string for identification.

Covering the matooke with banana leaves.

Place the saucepan on a gas cooker and steam for about 60 minutes from the start of boiling. Boiling starts 15 minutes after the pan is set on fire. The total steaming time, therefore, is 75 minutes.

The Matooke saucepan placed on gas oven to steam the Matooke.

6.4 Step 4: Mashing

- Remove the saucepan off the gas oven and each sample is mashed in leaves by squeezing the wrapped banana fingers with hands for 2 minutes (*Caution: The wrap is hot, protect your hands with industrial gloves or any other heat proof material*). Do this for all the samples.

Mashing of Matooke

6.5 Step 5: Re-steaming after Mashing

The samples are placed back in the saucepan and kept steamed for a total of about 60 minutes in between sample collection for measurements, to avoid cooling and hardening of matooke prior to measurement. The gas flame is reduced to minimum to keep samples hot. Traditionally, it is believed that re-steaming gives it a better taste and aroma and prevents the matooke from cooling.

Keeping of the matooke under steaming on the gas cooker to avoid cooling.

6.6 Step 6: Sampling

- Pick a sample of the *cooked and mashed matooke* using a spoon. Pick randomly from different parts of the bulk to ensure representativeness

Removing of samples from banana leaves.

- Place the sample in a round metallic container (thickness = 0.45 mm, Diameter =71 mm, Height =14 mm) and flatten the top using a ruler to eliminate any possible air spaces.

Shaping of samples of matooke in a metallic mold.

- Press a cylindrical hollow metallic rod to cut out the sample into a cylindrical uniform-sized shape (as shown in picture below). The same metallic rod is used to ensure a uniform size (Thickness = 2.36mm, Diameter = 43mm, height = 73mm).

Cutting out samples using a cylindrical hollow metallic rod.

- Remove the sample from the hollow metallic rod by gently forcing any blunt object through the other end of the hollow metallic rod

Gently forcing out the samples from the hollow metallic rod.

Important to note:

- Each sample is labeled and replicated 5 times to ensure representativeness
- Physical changes are minimized by keeping the sample wrapped in banana leaves to control temperature loss.
- Perform sample preparation quickly to minimize cooling.

7 TEXTURE MEASUREMENT

Equipment: Texture analyzer (TMS-PILOT Texturometer)

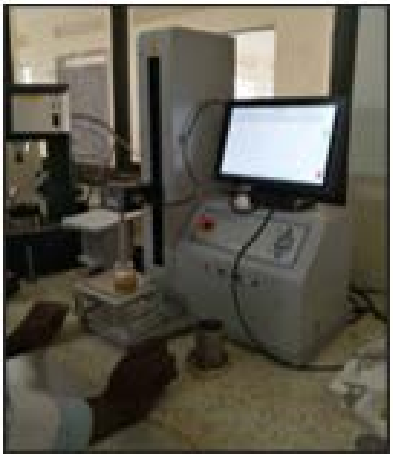
Method: Double compression using a compression plate probe with a diameter of 59mm

Test Speed	1 mm/s
Triger force (when the probe touches the surface of the sample)	50 g
Strain	20% (height of the sample = 14 mm and distance of compression = 2.8 mm)
Holding time between compression and withdrawal cycles	10 s
Temperature of test	75°C in heart of product

1. The texture analyzer is switched on using the main switch located on the rear panel and the PC tablet by pressing the small push-button switch located on the top and bottom respectively.
2. Open the test program on the pc tablet and name the program for easy tracing after the analysis.
3. The texture analyzer was put in TPA mode and the target, trigger load, hold time, test speed and return speed were preset.
4. The most appropriate probe for Matooke texture analysis was selected. A round flat compression plate probe was preferred over a penetration probe.
5. The temperature of the sample is also taken by inserting a thermometer into the sample block towards the middle of the sample before texture measurement. Appropriate sample temperature is 75 ^{o}C (not too hot to handle with bare hands and not cold to harden). The sample weighs 27.3 g on average.
6. The prepared sample to be analyzed is placed on the stable sample platform on the stand (centered).

Sample placed on the stand

Move the intelligent load cell with the probe This is done by pressing the jog button with an arrow facing down.



7. When the probe touches the sample and force equal to 50 g, calibration is done, then press the play button on the PC tablet to start analyzing until it displays results on the pc screen (Note: The texture analyzer does not have an auto-calibration feature).
8. A second pressing is done after 10 s of resting on the same sample until the PC tablet displays results.
9. The readings are recorded automatically on the PC tablet and are transferred using a flash disk for further sorting and organizing of the data.

8 EXPRESSION OF RESULTS

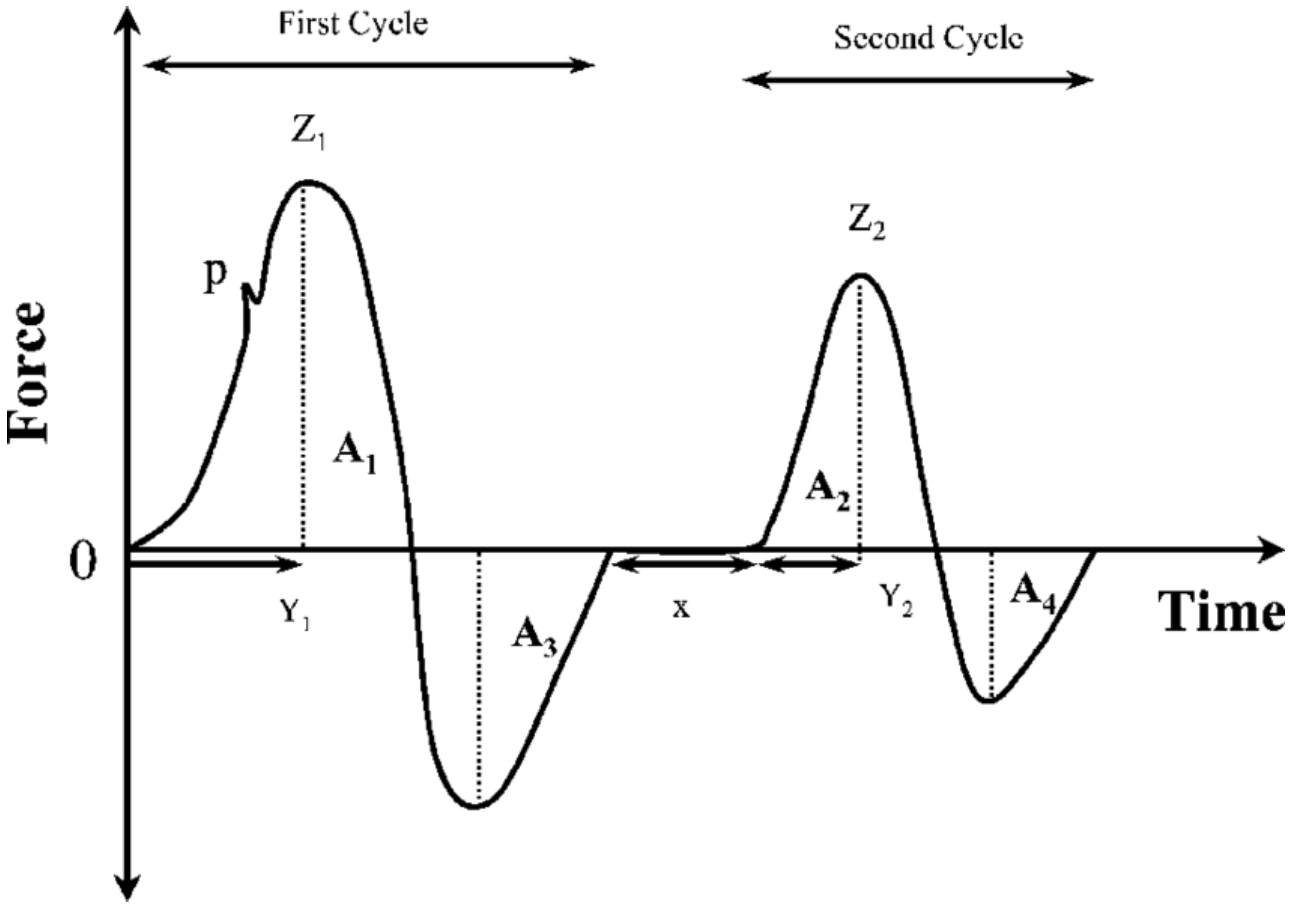


Fig 1. A force-time curve showing instrumental texture profile analysis (TPA). (Rahman, 2005)

- **A_1 (N.s);** The area underneath the first compression and withdrawal curve
- **A_2 (N.s);** The area underneath the second compression and withdrawal curve
- **Adhesiveness (N.s) = A_3;** The negative area under the curve for the first cycle
- **Hardness (N) = Z_1;** The highest peak force measured during first cycle
- **Cohesiveness (-) = A_2/A_1;** The ratio of positive area underneath the second cycle divided by the positive area underneath the first cycle
- **Fracturability (N) = P;** The first significant peak in first compression cycle
- **Y_1 (mm) = Distance to first compression peak;** probe descends onto the sample, once contact is detected measurement begins and the probe descends at a defined speed, for a set distance or a set time.
- **X (s) = The wait period;** this is the time between when a sample is allowed to recover after first cycle ends and when the second cycle begins
- **Y_2 (mm) =** Distance to second compression peak.

9 CRITICAL POINTS OR NOTE ON THE PROCEDURE

- The texture analyzer force and distance should be calibrated before measurements
- The texture analyzer is switched on at least 15 minutes before the measurements.
- Bringing the probe into contact with the sample surface is a critical step and should be carefully carried-out: the probe should slightly touch the sample before pressing the jog button to start the measurement
- The matooke should be tightly wrapped in the banana leaves and each time a sample is picked, it is re-wrapped to avoid cooling, which cause hardening
- Each laboratory sample is labeled and replicated 5 times to give an estimate of the true sample value

10 APPENDICES

10.1 Exemplary data on TPA instrumental & sensory texture of matooke

10.1.1 ANOVA of instrumental textural attributes

Hardness (N) By Genotype

One-way ANOVA of instrumental textue

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Genotype	31	178.8	5.8	3.6	1.7e-4**
Error	35	56.1	1.6		
C. Total	66	234.9			

Means for Oneway Anova

Genotype	N	Mean	Std Error	Lower 95%	Upper 95%	CV, mean (%)
17914S-24	1	1.46	1.26	-1.10	4.03	86
29586S-4	1	7.39	1.26	4.82	9.96	17
29820S-4	1	5.74	1.26	3.16	8.31	22
ENZIRABAHIMA	1	4.75	1.26	2.17	7.32	27
KABUCURAGYE	2	3.01	0.89	1.19	4.82	30
KIBUZI	2	4.56	0.89	2.75	6.38	20
KISANSA	3	5.38	0.73	3.90	6.86	14
M32	1	2.91	1.26	0.34	5.48	43
M33	1	4.00	1.26	1.43	6.57	32

Genotype	N	Mean	Std Error	Lower 95%	Upper 95%	CV, mean (%)
MBWAZIRUME	2	4.41	0.89	2.60	6.23	20
MPOLOGOMA	1	3.23	1.26	0.66	5.80	39
MUSAKALA	3	4.65	0.73	3.17	6.14	16
MUVUBO	2	3.01	0.89	1.19	4.82	30
N2	1	4.43	1.26	1.86	7.00	28
N4	3	3.99	0.73	2.50	5.47	18
N6	1	8.66	1.26	6.09	11.23	15
N7	4	3.28	0.63	1.99	4.56	19
N8	5	3.84	0.56	2.69	4.99	15
N11	2	1.71	0.89	-0.09	3.53	52
N12	3	3.64	0.73	2.15	5.12	20
N14	2	3.49	0.89	1.67	5.31	26
N15	2	7.64	0.89	5.82	9.46	12
N18	3	6.00	0.73	4.52	7.49	12
N19	1	7.04	1.26	4.47	9.61	18
N21	2	1.34	0.89	-0.47	3.16	66
N23	2	6.99	0.89	5.17	8.81	13
N24	2	2.21	0.89	0.39	4.03	40
NAKAWERE	3	4.33	0.73	2.84	5.81	17
NAKINYIKA	4	5.37	0.63	4.09	6.66	12
NAKITEMBE	2	3.49	0.89	1.67	5.31	26
NANDIGOBE	1	8.24	1.26	5.66	10.81	15
NFUUKA	3	3.17	0.73	1.68	4.65	23

The genotypes had significant influence on hardness, but the cohesiveness and adhesiveness were not significantly different between the genotypes. Among the instrumental texture attributes, only the hardness was discriminant, with up to three significantly different classes of hardness. Each class groups a number of genotypes that are similar based on the particular instrumental texture attribute, such as hardness, in this case.

Discriminance between varieties based on textural attributes

10.1.2 Principal Component Analysis (PCA)

The first two components of the PCA of instrumental and sensory texture for matooke explained 85% of the variation (Fig 2). The PCA analyses show the genotypes clustered in different components spaces. Instrumental hardness is related to sensory hardness in same component, and associated with genotypes such as N18, N19, N23, N6, & N12, Kisansa, and Nakinyika. The genotypes N21 & Kabucuragye are associated with cohesive texture. Adhesiveness is associated with the genotypes N11, Nakitembe, Muvubo, M32, M33, N4, Nfuuka etc. The sensory texture attributes in opposing component spaces reveal that they are significantly correlated.

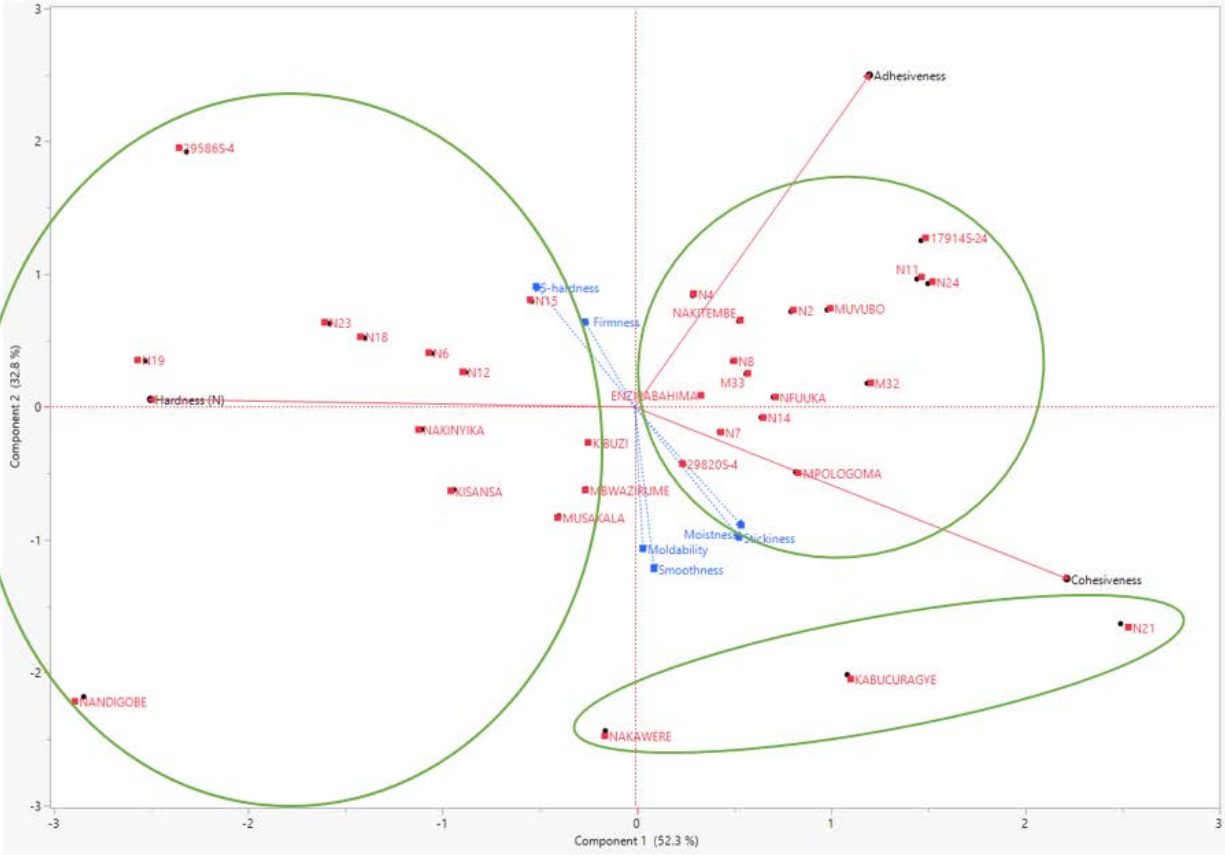


Fig 2. PCA (components 1 & 2) of steamed matooke – Instrumental and sensory texture

10.1.3 Correlations between Instrumental and Sensory texture of Matooke

	Coefficient					
	Firmness	**Moistness**	**Smoothness**	**S-hardness**	**Moldability**	**Stickiness**
Hardness	0.34	-0.35	-0.26	0.42	-0.25	-0.39
Cohesiveness	0.05	0.13	0.02	-0.05	-0.02	0.10
Adhesiveness	0.27	-0.27	-0.46	0.31	-0.42	-0.32
	Probability					
Hardness	0.05	0.04**	0.13	0.01**	0.15	0.02**
Cohesiveness	0.75	0.47	0.91	0.76	0.88	0.56
Adhesiveness	0.12	0.13	0.01**	0.07	0.02**	0.07

** Significant at 5 % level

Significant correlations exist between a number of instrumental and sensory textural attributes, such as hardness by touch, moistness in the mouth, stickiness by touch, adhesiveness, smoothness in the mouth and moldability by touch.

Summary

The genotypes are significantly different in hardness, but not in cohesiveness or adhesiveness. Hardness was the only discriminant instrumental textural attribute. Discriminant analyses show that the genotypes can be discriminated by TPA protocol. PCA showed the relationships between the textural attributes, and how they are associated with certain genotypes.

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