IMPROVED CORRELATION BETWEEN INSTRUMENTAL AND SENSORY TEXTURE OF BOILED SWEET POTATO

Kampala, Uganda, 23/12/2024

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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.

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ABSTRACT

Sensory texture drives consumer liking among sweetpotato consumers globally prompting the need to integrate consumer preferences in sweetpotato breeding. The study aimed to (1) revisit correlation between sensory texture, particularly firmness and instrumental texture parameters and (2) compare instrumental texture parameters to consumer acceptability and establish thresholds. To compare sensory texture and instrumental texture, sweetpotato roots were harvested from Advanced Yield Trials (AYT) planted in season 2023B from Rwebitaba (n=17) and 2023B Elite clones from Namulonge (n=11). To compare between instrumental texture and consumer acceptability, seven genotypes of contrasting texture were grown and harvested on-station in Namulonge. Instrumental texture analysis was conducted following a TPA double compression procedure to compress pieces of cooked sweetpotato (steaming time = 25 minutes) with a dimension of 30 X30 X 20 mm. Descriptive sensory analysis was performed by trained panelists and 100 consumers participated in the consumer testing survey in Kawempe division (Kampala – Uganda) where they rated samples for firmness on 5-point just-about-right (JAR) scales. Pearson correlations was used to explore the relationship between averages of sensory texture attributes and those of instrumental texture parameters. Results indicated that instrumental texture hardness was correlated with hardness by hand (r = 0.809) and in mouth (r=0.758) as well as mealiness by hand (r=0.768) and in mouth (r=0.746). The intersection of the JAR curves corresponds to an instrumental hardness of 28N which is the ideal proposed threshold for firmness pending validation. Considering a consumer acceptability of 70%, the threshold for instrumental hardness is 52-120N. These results confirm the validity of the established instrumental texture method for evaluating boiled sweetpotato quality.

Key Words (10 maximum): Consumer acceptability, JAR, Boiled sweetpotato, Texture, Correlations

1 INTRODUCTION

Sensory texture is an important driver for consumer liking among sweetpotato consumers globally. In Uganda, consumers have been shown to like sweetpotato whose cooked texture is firm and mealy. In a bid to increase the adoption of released sweetpotato genotypes, the sweetpotato breeding program in CIP has been preparing to integrate consumer preferences in routine breeding. Mealiness and firmness have been included in food product profile for sweetpotato for the national and regional market segments. Various methods have been developed to objectively evaluate, measure and quantify the texture of sweetpotato starting with descriptive sensory analysis following quantitative descriptive analysis procedure where a group of individuals are trained to rate sweetpotato samples for various sensory attributes including firmness by hand and in mouth. Sensory texture analysis using trained human panels can be conducted for all samples at later stages of breeding where there are fewer samples, each with many roots. However, at earlier stages, using human panels is challenged by the few roots given the plot sizes of the trials and the many genotypes under study which could be in the hundreds. To overcome this challenge, it was part of the priority of RTB Foods to develop and validate instrumental methods that could be used in lieu of human panels to measure and quantify the texture of the samples. Following a series of experiments, an instrumental texture method where texture profile analysis procedure is conducted on cooked pieces of a standard dimension was adopted for use with sweetpotato. The procedure was shown to be accurate and repeatable (https://doi.org/10.18167/agritrop/00749). However, the Person correlation coefficient values between sensory texture ratings by the human panel and instrumental texture parameters were moderate and the regression model using instrumental texture parameters to predict sensory texture ratings by the human panel explained about 60% of the variation among samples. Second, there is limited evidence about the correlation between instrumental texture analysis and consumer hedonic responses. In this report we present evidence about the application of the established method on a new set of materials to reassess: (1) the correlation between sensory texture, particularly firmness (and mealiness to a lesser extent) rated by the panel and instrumental texture parameters and (2) determine the instrumental texture threshold for consumer acceptability of firmness.

1.1 Research questions

Two research questions:

1) Could the associations between instrumental texture and sensory texture be higher with a new set of samples harvested from a different season?
2) Can instrumental texture thresholds be obtained for consumer acceptability evaluations?

1.2 Context

Regarding the first question, there is growing evidence that instrumental texture is correlated with sensory texture of sweetpotato, but there has been low correlation coefficient between instrumental hardness and sensory firmness ($r = 0.63$, $p = 0.03$), and between sensory crumbliness and instrumental cohesiveness ($r = -0.64$, $p = 0.02$) based on data collected during SOP development (https://doi.org/10.18167/agritrop/00749). These correlations need to be improved.

Regarding the second question, it has been shown that the texture of sweetpotato, particularly firmness and mealiness are important drivers for consumer liking in Uganda (Mwanga et al., 2020, Nakitto et al., 2022). Instrumental texture analysis using texture profile analysis (TPA) measures firmness of sweetpotao by imitating the human action of chewing and the TPA protocols developed for the project have been shown to correlate with ratings from descriptive sensory analysis. Therefore, it is expected that instrumental texture particularly firmness will be correlated with consumer hedonic ratings. Also instrumental thresholds need to

be obtained within which breeders may certify that the majority of the consumers are satisfied with consumer desirability of the key traits of firmness and mealiness.

2 METHODS

2.1 Sweetpotato samples

For comparisons between sensory texture and instrumental texture, sweetpotato roots were harvested from Advanced Yield Trials (AYT) planted in season 2023B from Rwebitaba (n=17) and 2023B Elite clones from Namuonge (n=11).

For determining acceptability thresholds of instrumental texture of key traits of sweetpotato, seven genotypes (Beauregard, D20, NASPOT 8, NASPOT 13 O, NAROSPOT 1, UGP20170910-24 and UGP20170902-54) were selected for their contrasting textures, including market leaders for both the white, cream and yellow (NAROSPOT 1) and orange fleshed (NASPOT 8) market segments. A high level of contrast among samples is also important for establishing threshold values that indicate consumer acceptance.

2.2 Instrumental texture analysis

Sample preparation was conducted following previously established procedure detailed in: https://doi.org/10.18167/agritrop/00611. Briefly, three representative roots were selected per sample, and at least three cuboid sample pieces of 30 X30 X 25 mm dimension were cut from each root. To prepare the root portions, about 2 L of water were poured into a steaming pot, and the pieces were placed in a single layer over the base of the pot matted with a piece of banana leaf, then covered with another layer of banana leaf followed by the pan lid. The pieces were cooked for 35 minutes over gas including 25 minutes of actual steaming. After steaming, a layer was scrapped off from both ends of the height of each changing the dimension of the piece to 30 X30 X 20 mm. Instrumental texture analysis was conducted on pieces of cooked root following a double compression Texture Profile Analysis (TPA) procedure (https://doi.org/10.18167/agritrop/00749) where samples were compressed to achieve 25% strain by a plate probe using a TA-XT instrument with 50kg loadcell.

2.3 Descriptive sensory analysis

Descriptive sensory analysis was conducted with a trained panel of 10 -12 persons in Kawanda from March to June 2024. Details about the sample preparation, service, lexicon and scales are detailed in: https://doi.org/10.18167/agritrop/00601.

2.4 Consumer Testing

Consumer testing was conducted with consumers of sweetpotato in Kawempe, a division of Kampala district located northward of the city on two consecutive days. Consumers identified from lists provided by local leaders were randomly selected and invited to participate. Among the invited participants 100 individuals participated on the first day and 95 on the second. On each day, participants evaluated 5 genotypes each day with UGP20170910-24 and NASPOT 8 repeated on both days. To prepare samples, the roots were washed, peeled and wrapped in banana leaves separately. Then, each bundle was placed over banana stalk matting in separate locally fabricated aluminum saucepans and covered with additional layers of banana leaves then steamed over stoves filled with red hot charcoal to cook following local community practice (Nakitto et al., 2022). When steam emitted above the heap of banana leaves covering the saucepan, material was carefully and slightly uncovered to press some roots and check if they had become soft enough and

ready. Once ready, sweetpotato samples were put of fire and out of the saucepans to serve. Each root was wrapped separately in aluminum foil with a unique random code assigned to the sample.

Trained enumerators helped to administer the questionnaire to participants and translated to the local language, mostly Luganda where appropriate. Samples were served one by one for evaluation and participants rated the overall-liking for each sample on a nine-point hedonic scale ranging from 1 ("dislike extremely") to 9 ("like extremely") and, firmness and mealiness on five-point just-about-right (JAR) scale ranging from 1 to 5, anchored at 3 (just-about-right). All data was entered in compusense. Upon completing the interview, respondents were given a small token amounting to about 5000 on average.

2.5 Data Analysis

Texture profile analysis curves were curated using MACROS to obtain several texture parameters including hardness (N), springiness, cohesiveness, resilience, adhesiveness, gumminess and chewiness. Attribute means were calculated from the individual panel scores of each sample. For consumer testing, the 5 JAR groups were collapsed into three by combining the two groups scoring less than 3 into "Too soft", the two groups scoring higher than three into "Too hard", separately form the third group that scores JAR equal to 3 ("Just about right firm". The frequencies of consumers for each group were calculated and expressed as a percentage of all consumers. Correlations between the average QDA scores for the various texture attributes evaluated by mouth and in hand and instrumental texture parameters were derived using XLSTAT (Adinsoft). Curves of instrumental hardness (N) against frequency JAR "Too Soft" and "JAR firm" were graphed in MS Excel and their intersection was extrapolated to indicate the optimum acceptable value for instrumental hardness (threshold).

RESULTS AND DISCUSSION

Pearson correlation indicated that there was good correlations between various instrumental texture parameters and sensory texture (Table 1). Specifically, the instrumental texture hardness was correlated with hardness by hand (r = 0.809) and in mouth (r=0.758) as well as mealiness by hand (r=0.768) and in mouth (r=0.746). Generally, instrumental hardness and gumminess correlated significantly with sensory hardness and mealiness. Instrumental gumminess also had good correlations between hardness by hand and in mouth as well as crumbliness / mealiness.

There was a relationship between consumer preference and instrumental hardness (Figure 1). The lower the instrumental hardness the more people perceived sweetpotato genotypes to be softer than they would like (JAR <3, "Too soft"). Also, the higher the instrumental hardness the higher the number of consumers who perceived the genotype to meet their preference for firmness (JAR = 3, "Just-About-Right). These observations indicate a relationship between instrumental texture and consumer preferences. The intersection of the curves corresponds to an instrumental hardness of 28N which is the proposed minimum threshold for firmness. Considering an ideal target level for consumer acceptability at 70%, the ideal range for instrumental hardness is 52-120N.There was a similar relationship between consumer preference and hardness (Figure 2) but the regression coefficient was lower.

These results confirm the validity of the established instrumental texture method for evaluating quality of boiled sweetpotato. Instrumental texture analysis of sweetpotato would be useful for evaluating sweetpotato at mid-stages where there are more samples that the sensory panel can manage to complete, particularly Preliminary Yield Trials. We therefore recommend this stage as its point of integration in sweetpotato breeding cycle.

Table 1 : Correlations between instrumental texture and sensory analysis of boiled sweetpotato using data from 2023B AYT harvest (n=28)

		INSTRUMENTAL TEXTURE PARAMETERS						
	Variables	Hardness	Springiness	Cohesiveness	Resilience	Adhesiveness	Gumminess	Chewiness
SENSORY TEXTURE	Hardness_by_hand	**0.809**	**0.607**	0.308	**0.543**	0.184	**0.729**	**0.695**
	Moisture_release	**-0.407**	-0.308	-0.001	-0.191	0.082	-0.342	-0.337
	Cohesiveness	**-0.793**	**-0.620**	-0.238	**-0.529**	-0.113	**-0.719**	**-0.720**
	Crumbliness/Mealiness_by_hand	**0.768**	**0.622**	0.218	**0.486**	0.081	**0.681**	**0.670**
	Firmness/_Hardness in mouth	**0.758**	**0.613**	0.303	**0.519**	0.151	**0.678**	**0.650**
	Crunchiness in mouth	0.227	0.365	**0.412**	**0.376**	0.279	0.249	0.234
	Crumbliness in mouth	**0.746**	**0.621**	0.215	**0.470**	0.079	**0.659**	**0.649**
	Fibrousness in mouth	-0.054	-0.005	-0.002	-0.011	0.143	-0.072	-0.080
	Smoothness in mouth	**-0.751**	**-0.548**	-0.207	**-0.452**	-0.231	**-0.656**	**-0.625**

The bolded coefficients are significant at 5% level

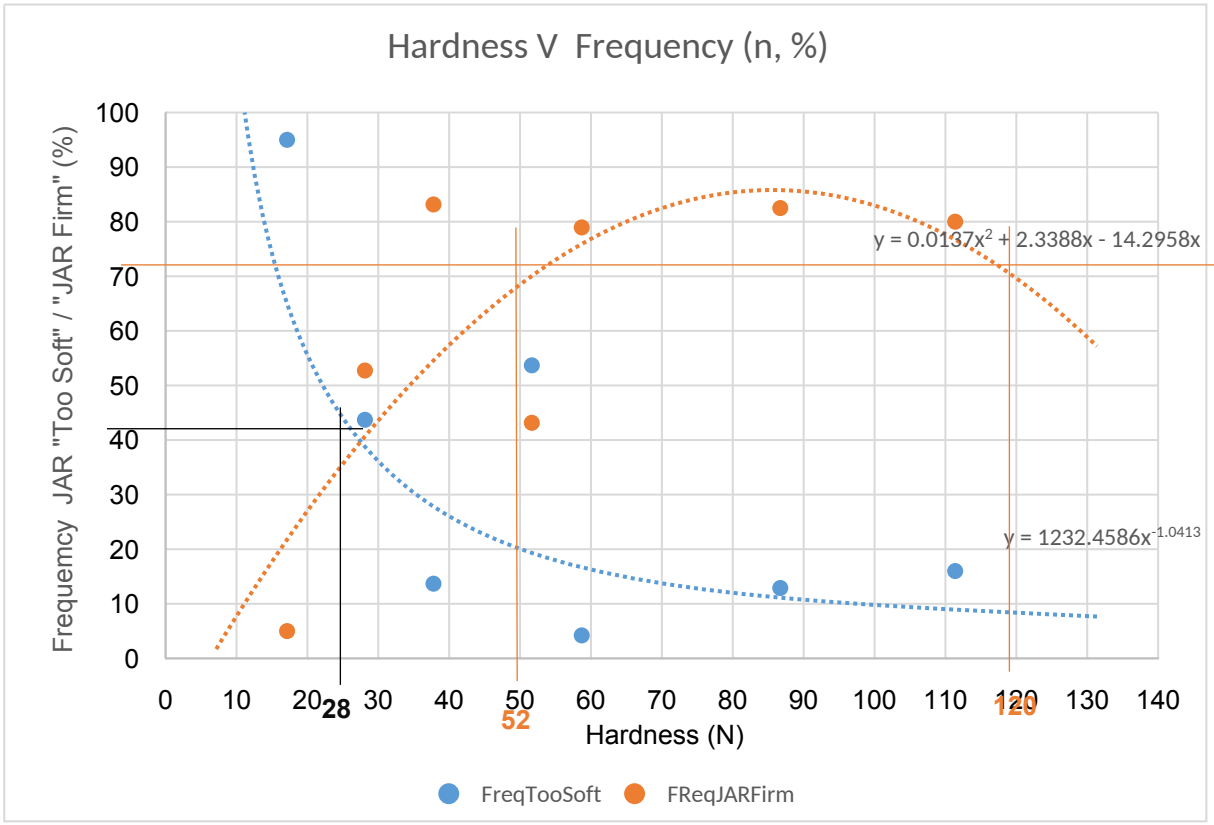

Figure 1. Frequency JAR "Too soft" and "JAR firm" against instrumental hardness

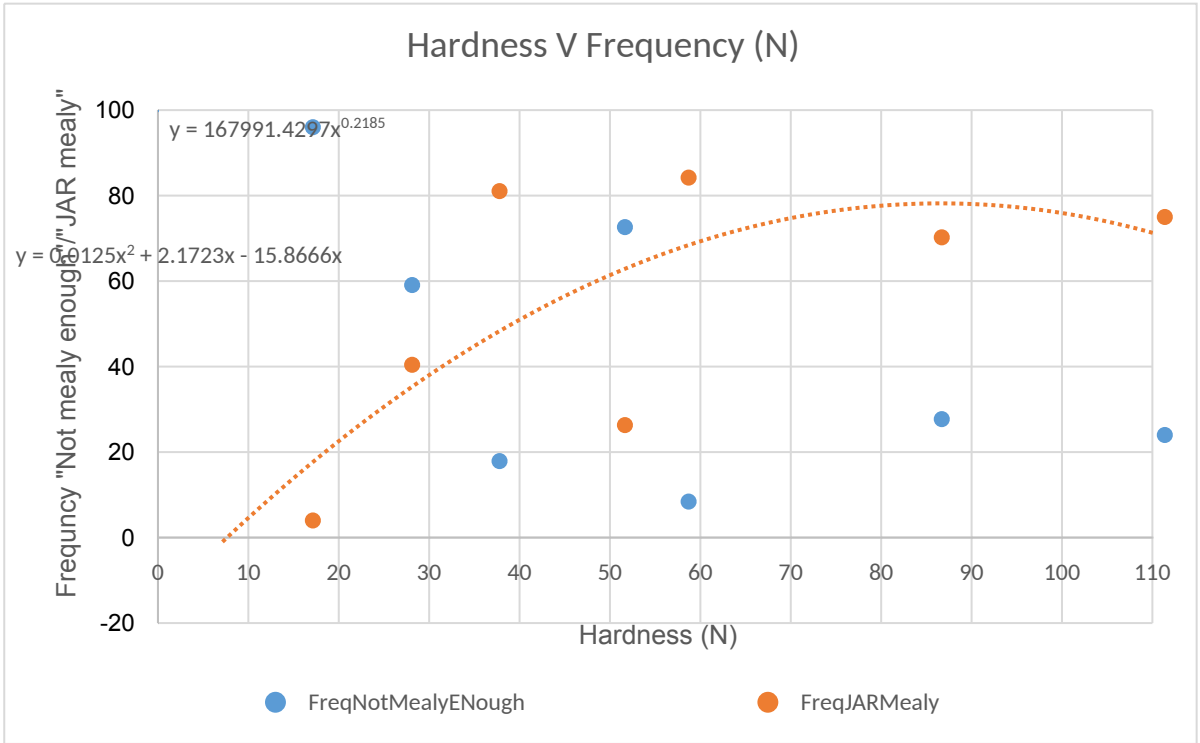

Figure 2. Frequency JAR "Not mealy enough" and "JAR mealy" against instrumental hardness

APPENDICES

2.6 Annex 1: Title

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2.7 Annex 2: Title

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