Improving the Relationship between Organoleptic/Sensory Attributes and Instrumental Texture Measurements of Gari-Eba

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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

Gari is a significant, versatile and convenient product from cassava roots in the West Africa sub-region. The granular product is popular in West African countries due to its long shelf life and ease of preparation. It can be consumed by soaking in water or turned into Eba, produced by briefly cooking and stirring gari in hot water until homogenous dough is formed. The acceptability of *Eba* by consumers has been reported to be driven by sensory attributes such as appearance, colour, taste, aroma, and other textural parameters such as smoothness, mouldability, hardness, and stretchability. It is essential to establish the relationship between instrumental and quantitative descriptive (QDA) sensory scores for these attributes to present instrumental measurement as a mid-throughput and less costly alternative to the sensory approach. Previous studies have established correlations between the sensory and instrumental measurements for sensory textural attributes of Eba, with a low to medium correlation coefficient. The correlation between the instrumental measurements and the QDA has been improved in the current study using a new set of genetic materials. The instrumental hardness correlated significantly ($p<0.001$) and positively with sensory hardness ($r=0.867$) and mouldability ($r=0.840$) but negatively with sensory stickiness ($r=-0.822$). Sensory stickiness correlated positively and significantly ($p<0.001$) with instrumental springiness ($r=0.695$) and cohesiveness but negatively with instrumental gumminess ($r=-0.678$). The linear regression coefficients have been substantially improved using a new set of diverse cassava genotypes.

Key Words: Gari, Eba, Sensory, Texture, Linear regression coefficient

1 BACKGROUND

Gari is a significant, versatile, granular, and convenient product from cassava roots in the West Africa sub-region. The granular product is dry and crispy, and its popularity in West African Countries is due to its cheapness, ease of storage, long shelf-life, and short preparation time (Irtwange and Achimba, 2009; Udoro et al., 2014). In gari production, the cassava roots are peeled, washed, grated, pressed, sieved, and roasted (Escobar et al., 2018). Gari is also popular because of the various forms by which it can be consumed, one of which is the form of eba. Eba is produced from gari by briefly cooking and stirring gari in hot water until homogenous dough is formed (Adinsi et al., 2019). The acceptability of *Eba* by consumers has been reported to be driven by sensory attributes such as appearance, colour, taste, aroma, and other textural parameters such as smoothness, mouldability, hardness, and stretchability (Ndjouenkeu et al., 2021). The instrumental texture properties related to these vital sensory textural attributes measured by the texture analyzer are hardness, adhesiveness, cohesiveness, springiness, chewiness, gumminess, and resilience. It is important to establish the relationship between instrumental and quantitative descriptive sensory scores for each attribute to present instrumental measurement as a mid-throughput and less costly alternative to the sensory approach, which requires more time to evaluate large number of genotypes

2 MATERIALS AND METHODS

Genetic Material:

Twenty-three (23) cassava genotypes comprising the advanced breeding population and landraces were processed into gari and packaged in plastic containers until laboratory analysis. The production of *Gari* followed the SOP developed by the RTBfoods project (https://mel.cgiar.org/reporting/download/report_file_id/). 50 kg of roots from each variety were peeled, washed, drained, and grated using a mechanical grater. The grated mash was loaded into jute bags and tied with a string. The bagged cassava mashed was left to ferment at ambient temperature before pressing out the juice using a hydraulic press. It was then left to ferment for three days and de-watering for 24 hours. The pressed cake was manually crushed and sieved with a mesh size of 1.50 mm to remove the fibrous materials. The starchy granules obtained were processed into *Gari* (Gamification) by roasting by experienced processors until pre-gelatinised granules were formed. The sensory analysis on Eba was carried out simultaneously with the instrumental measurement using 20 trained panellists. Samples were served to paneliist during two sessions and each samples was presented using separate 3 digits codes. The repeatability of each paneliist was tested using the guidelines provided in the RTBfoods project. https://mel.cgiar.org/reporting/download/report_file_id/25511

Table 1: List of cassava genotypes.

Sample Number	Genotypes
1	IITA-TMS-IBA051601
2	IITA-TMS-IBA000070
3	IITA-TMS-ZAR010116
4	IITA-TMS-IBA090485
5	IITA-TMS-IBA030006A
6	TME B693
7	IITA-TMS-IBA950925
8	IITA-TMS-IBA090576
9	IITA-TMS-IBA980581
10	IITA-TMS-MM-99O302
11	124KALESO
12	IITA-TMS-IBA071313
13	IITA-TMS-IBA30572
14	IITA-TMS-IBA990304
15	IITA-TMS-IBA982101
16	SIMONYE
17	IITA-TMS-IBA083580
18	TMS13F1053PO015
19	TMS13F1053P0010
20	TMS13F1343P0022
21	TMS13F1088P007
22	151TMS13F1153P0002
23	TMS13F1343P0002

3 Laboratory Analysis: Sensory and Texture Profile Analysis (STPA and ITPA):

Eba was prepared by sprinkling the gari samples into boiled water at a ratio of 1g to 3 mL as specified in the standardized protocols developed within the RTBfoods project (Maziya-Dixon et al., 2022a). The dough formed is allowed to stay for 1 minute before stirring to homogenize for another 1 minute in an electric dough mixer. The formed eba samples were then packed into aluminium foil and kept in a Styrofoam box to minimize temperature loss before analysis. Instrumental texture profile analysis (ITPA) and sensory texture profile analysis (STPA) of the Eba samples were carried out using the standardized protocol developed within the RTB foods project (Maziya-Dixon et al., 2022b). Both experiments were carried out simultaneously to eliminate bias, and the samples were analyzed at temperatures of 40^{0}C. The TA-XTplus Stable Micro Systems texture analyzer was used to conduct the ITPA experiments, while STPA was carried out in two sessions by 18 trained panellists.

4 Results

4.1 Instrumental Texture Parameters of Gari/Eba

Figure 1 shows the principal component analysis (PCA) of instrumental texture parameters of Gari/Eba, where PC 1 and PC 2 explain 80.2% of the variation within the cassava genotypes with respect to their textural attributes. The PCA associate the Gari/Eba samples into various groups depending on the similarity in thier textural characteristics, showing discriminance among the cassava genotypes. Hardness and adhesiveness occupied opposite quadrants, showing a negative association, and adhesiveness is associated with cohesiveness. This is like the preliminary results obtained in 2022, where different discriminant cassava genotypes were studied. TMS-IBA990304, TMS-IBA0990485 and TMS-IBA30572 were grouped together based on similarity in their hardness, whereas TMS 13F1053P0010, TMS IBA090576 were clustered by cohesiveness and springiness and occupying an opposite section of the quadrant to hardness and gumminess. The new study affirmed that the SOP for texture measurement has proven relevant for discriminating cassava genotypes based on their contrasting textural attributes. This serves as a remarkable contribution to cassava breeding programs.

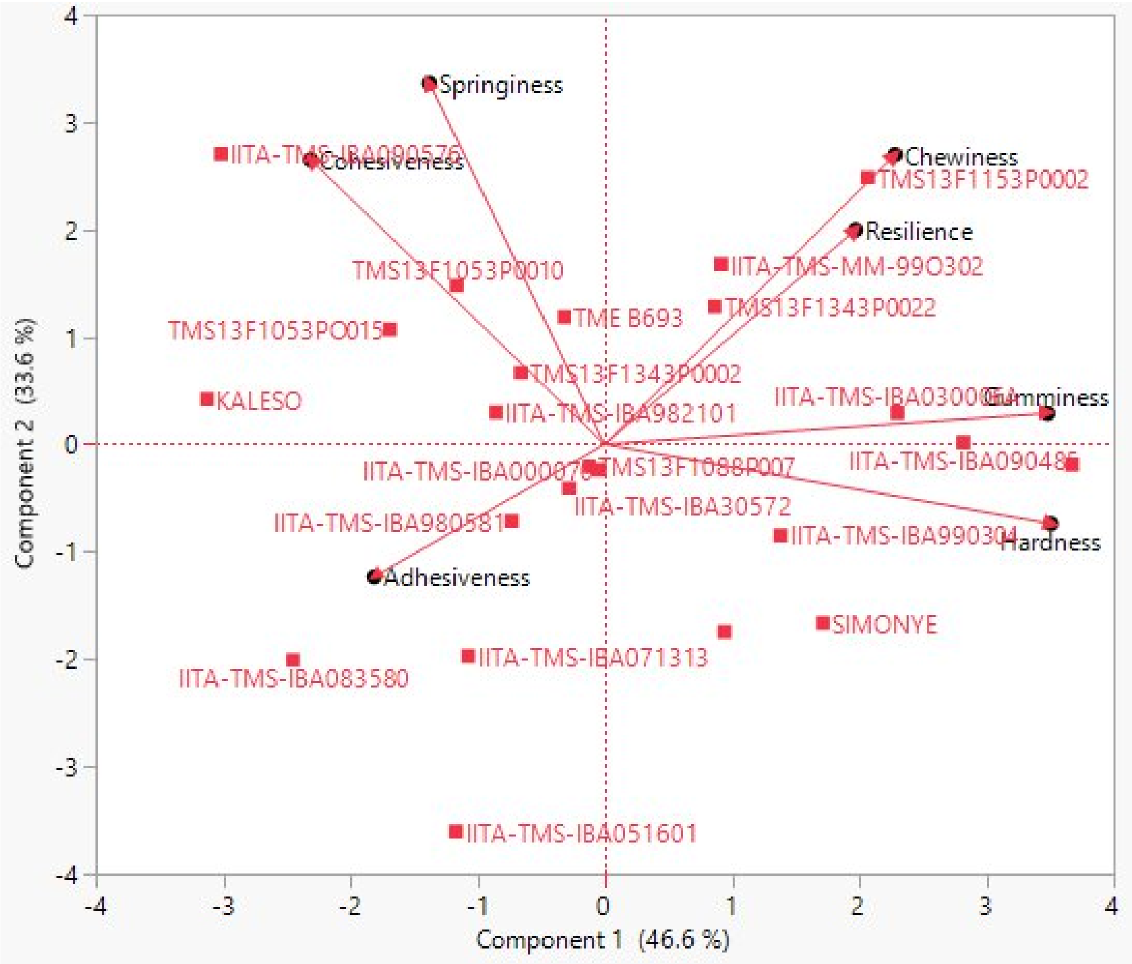

Figure 1: PCA of Instrumental Texture Analysis of Gari/Eba

4.2 Correlations between the instrumental and sensory texture attributes of Eba.

Table 2 shows the correlation statistics between the instrumental and sensory texture profiles of Gari/Eba. Instrumental hardness correlated significantly ($p<0.001$) and positively with sensory hardness ($R=0.867$) and mouldability (R=0.840) but negatively with sensory stickiness (r=-0.822). Sensory stickiness correlated positively and significantly (p<0.001) with instrumental springiness (r=0.695) and cohesiveness but negatively with instrumental gumminess (r=-0.678). A highly significant (p<0.001) and negative correlation was observed between instrumental cohesiveness, sensory hardness, and mouldability, while the correlation with sensory stickiness is significantly negative.

Table 2: Correlation between Instrumental Texture Parameters and Sensory Parameters

Header	I-Hardness	I-Resilience	I-Springiness	I-Cohesiveness	I-Gumminess
S-Hardness	**0.867*****	0.109^{ns}	**-0.593****	**-0.696*****	**0.764*****
S-Stretchabilty	0.033^{ns}	**0.629****	0.299^{ns}	0.130^{ns}	0.146^{ns}
S-Stickiness	**-0.822*****	0.073^{ns}	**0.695*****	**0.735*****	**-0.678*****
S-Mouldabilty	**0.840*****	0.075^{ns}	**-0.623****	**-0.715*****	**0.730*****

** P<0.05, *** P<0.001

5 Conclusion

Consumers and processors identified the texture and appearance of Gari/Eba as important criteria for adopting new cassava varieties. The relevance of the SOPs developed for the characterization of the textural attributes of Eba, such as hardness, stretchability, adhesiveness, and cohesiveness, has been proven by establishing a positive significant correlation between the quantitative descriptive analysis by trained panellists and the results generated from the instrumental measurements. Incorporating instrumental screening protocols in cassava breeding may allow the identification of a broader phenotypic variability in breeding populations. Instrumental measurements are an objective, cost-effective, and rapid alternative to measuring Eba's textural quality attributes.

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7 APPENDICES

7.1 Annex 1: Supplementary Table

Supple Table 1: Results of Instrumental Texture Profile Analysis of Gari/Eba

Genotypes	Hardness	Resilience	Springiness	Adhesiveness	Cohesiveness	Gumminess	Chewiness
IITA-TMS-IBA051601	330.698	3.504	17.262	-148.947	0.244	80.888	14.963
IITA-TMS-IBA000070	338.304	4.417	28.193	-602.792	0.286	96.068	27.791
IITA-TMS-ZAR010116	637.571	4.368	24.484	-574.369	0.267	170.086	41.808
IITA-TMS-IBA090485	524.732	5.513	24.393	-731.427	0.267	139.897	34.174
IITA-TMS-IBA030006A	471.361	5.778	25.634	-739.187	0.273	128.509	32.987
TME B693	312.703	4.731	31.462	-444.440	0.341	106.584	34.957
IITA-TMS-IBA950925	440.762	3.996	22.406	-623.199	0.247	108.808	24.427
IITA-TMS-IBA090576	171.961	4.281	41.329	-466.861	0.418	71.777	29.708
IITA-TMS-IBA980581	281.481	4.154	26.643	-755.013	0.286	80.165	21.358
IITA-TMS-MM-99O302	376.714	4.627	33.236	-688.889	0.320	120.382	40.304
KALESO	179.905	3.909	34.013	-257.879	0.361	64.452	22.711
IITA-TMS-IBA071313	307.589	4.174	23.534	-269.142	0.266	81.844	19.339
IITA-TMS-IBA30572	327.427	4.068	27.470	-621.720	0.294	96.095	26.587
IITA-TMS-IBA990304	480.051	4.580	24.787	-324.477	0.270	129.416	32.101
IITA-TMS-IBA982101	275.479	3.818	30.814	-774.321	0.314	86.549	26.773
SIMONYE	489.331	3.905	21.405	-802.079	0.245	119.816	25.652
IITA-TMS-IBA083580	211.606	3.761	22.353	-271.577	0.305	64.611	15.350
TMS13F1053PO015	212.620	4.351	34.369	-549.385	0.330	71.753	30.020
TMS13F1053P0010	258.872	4.329	34.852	-568.796	0.350	90.852	32.156
TMS13F1343P0022	372.267	5.965	30.556	-424.033	0.313	116.710	36.177
TMS13F1088P007	313.359	4.643	27.871	-752.959	0.284	88.808	24.820
TMS13F1153P0002	385.048	7.404	33.314	-719.192	0.287	112.140	40.940
TMS13F1343P0002	296.591	4.006	31.458	-620.165	0.327	96.775	30.758

Supple Table 2: Results of mean quantitative descriptive analysis of Gari/Eba for 20 trainined panellists.

Accession_name	Hardness	Stretchabilty	Stickiness	Mouldabilty
IITA-TMS-IBA051601	4.22	3.47	3.94	6.50
IITA-TMS-IBA000070	3.38	4.59	6.17	5.53
IITA-TMS-ZAR010116	5.20	4.20	4.23	7.08
IITA-TMS-IBA090485	6.50	4.41	4.73	7.97
IITA-TMS-IBA030006A	5.03	4.16	4.24	7.49
TME B693	4.06	4.92	5.21	5.78
IITA-TMS-IBA950925	5.90	4.55	3.24	7.64
IITA-TMS-IBA090576	2.03	4.58	6.53	4.15
IITA-TMS-IBA980581	3.27	4.51	6.06	5.00
IITA-TMS-MM-99O302	3.74	4.34	5.54	5.62
KALESO	1.55	3.06	7.42	2.52
IITA-TMS-IBA071313	4.03	3.62	5.91	6.27
IITA-TMS-IBA30572	5.63	4.00	4.43	7.85
IITA-TMS-IBA990304	4.97	4.29	5.27	7.19
IITA-TMS-IBA982101	3.64	4.35	5.67	5.45
SIMONYE	6.76	3.21	3.08	7.80
IITA-TMS-IBA083580	1.76	4.60	7.07	3.81
TMS13F1053PO015	1.85	3.84	7.75	3.31
TMS13F1053P0010	2.97	4.54	6.37	4.56
TMS13F1343P0022	3.19	5.23	6.41	5.04
TMS13F1088P007	3.70	4.76	6.35	5.60
TMS13F1153P0002	4.06	5.06	6.00	5.45
TMS13F1343P0002	2.97	3.57	6.43	4.35

See raw data attached in excel table.