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Transforming African Agriculture
CGIAR

Rapid field-lab assays for early-stage selections - sensory and textural quality evaluation for boiled and pounded yam

Busie Maziya-Dixon et. al.,

African Yam Annual Meeting, Abuja, Sep 15th - 17th 2022

Contributors: **Alamu E.O, Adesokan M., Fawole S., Otegbayo B. (Bowen University), T. Madu (NRCRI), Okoye, O.O. (NRCRI)**

Outline:

- Background information
- Achievements in the African Yam Project
- Rapid field-lab tools for quality assay at early breeding stages -

  Characterized yam genotypes for biophysical traits: dry matter, protein, starch
  Develop SOP for water absorption
  Develop SOP for instrumental extrusion test for boiled yam
  Develop SOP for sensory characterization of boiled and pounded yam
  Develop NIRS regression model as high throughput techniques

- Instrumental and sensory texture profile of boiled and pounded yam
- Yam pectin effects on texture of boiled and pounded yam
- Future perspective – Hyperspectral Imaging
- Conclusion
- Acknowledgement

Background

- The textural quality of yam is very important because it is one of the factors that influence acceptability by consumers and processors (Otegbayo *et. al*., 2021)

BOILED YAM IITA

Achievements :

Characterized multilocation trials for biophysical traits (Dry matter, protein, starch, color, etc.)

- ❑ 16 clones of fresh yam samples
  - D.rotundata and D.alata
- ❑ Three locations
  - Abuja
  - Ibadan
  - Ubiaja
- ❑ Sample presentations
  - Fresh blended
  - Dried flour
  - Intact tuber
- ❑ Quality Traits
  - Dry matter
  - Starch content
  - Protein

TDr 0900135
TDr 0900295
TDr 1000021
TDr 1100055
TDr 1100128
TDr 1100180
TDr 1400158
TDr 1400359
TDr 1400537
TDr 1400766
TDr 1401161
TDr 1401220
TDr 1401419
TDr 1401593
TDr 8902665
TDr Meccakusa - landrace

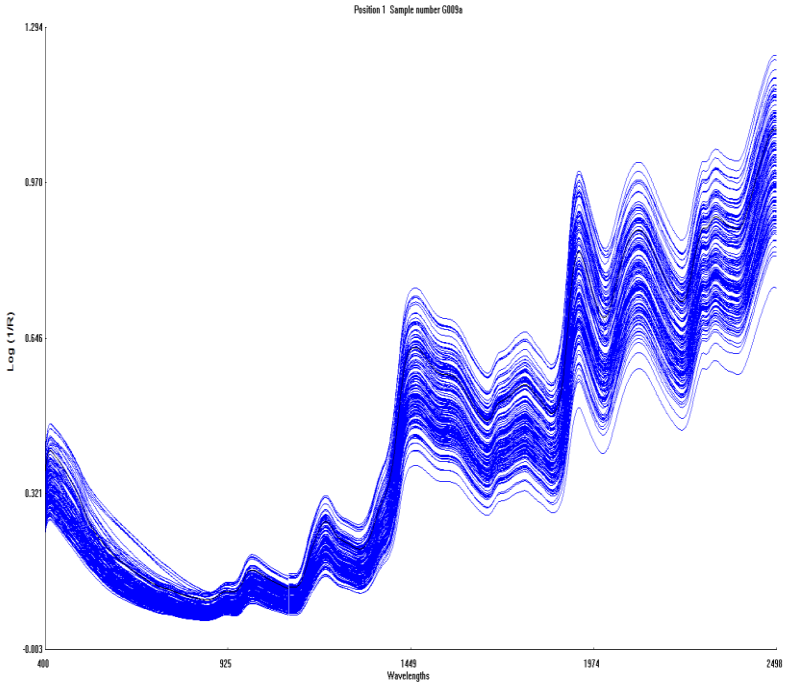
- ❑ Over 5000 NIRS spectra database for African yam germplasm in IITA (fresh, flour, and intact tubers)
- ❑ Standard Operating Procedures

SOP for Colour Measurement in Fresh Yam (Dioscorea Sp.) and Fresh Cassava (Manihot esculenta) using Chromameter

Lusaka, Zambia, July 2020

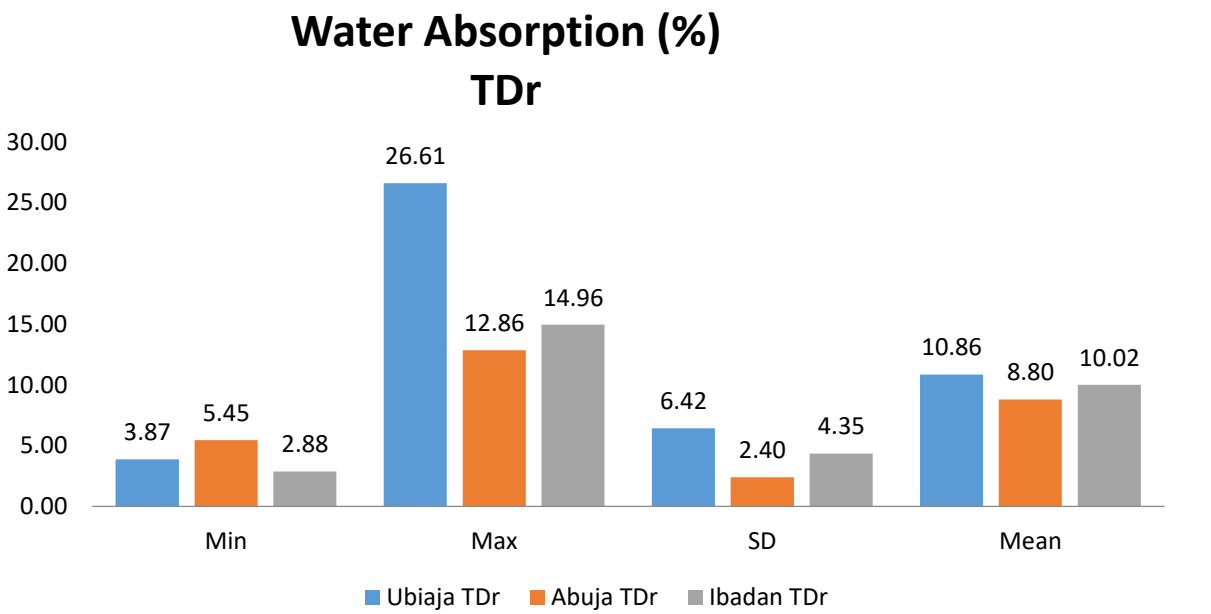
Emmanuel ALAMU, International Institute of Tropical Agriculture (IITA), Lusaka, Zambia
Michael ADESOKAN, IITA, Ibadan, Nigeria

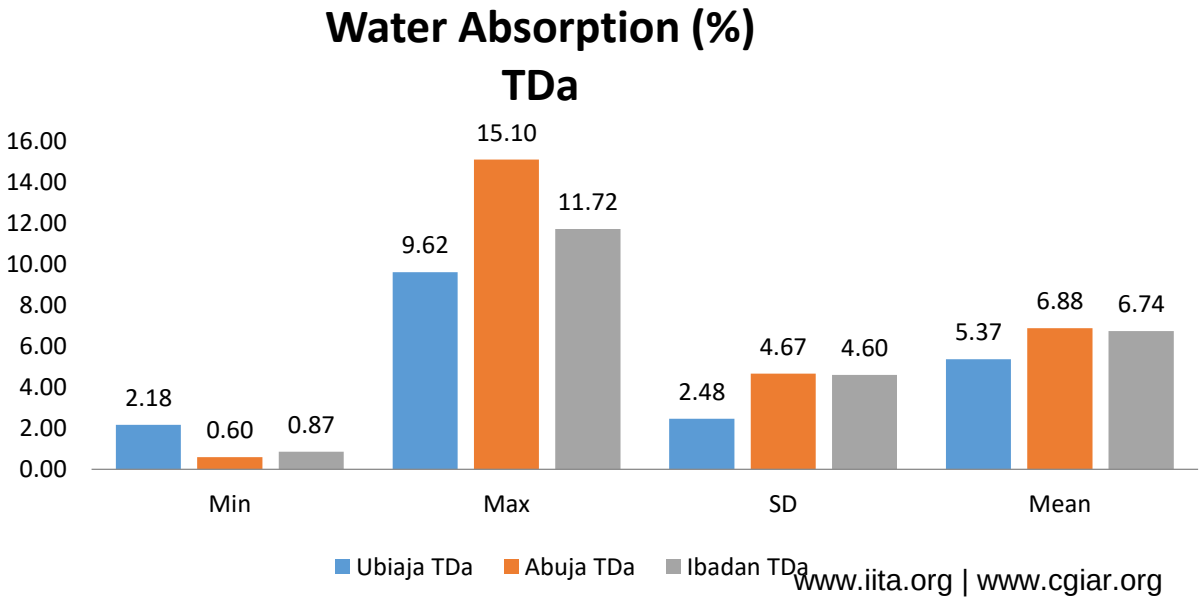
Rapid field-lab tools for quality traits assay at early breeding stages – NIRS, Kitchen tests (Water Absorption)



Develop SOP for water absorption measurements in boiled yam

Water absorption of boiled yam
Adapting RTBfoods SOPs- **RTBfoods_E.5.4_SOP**





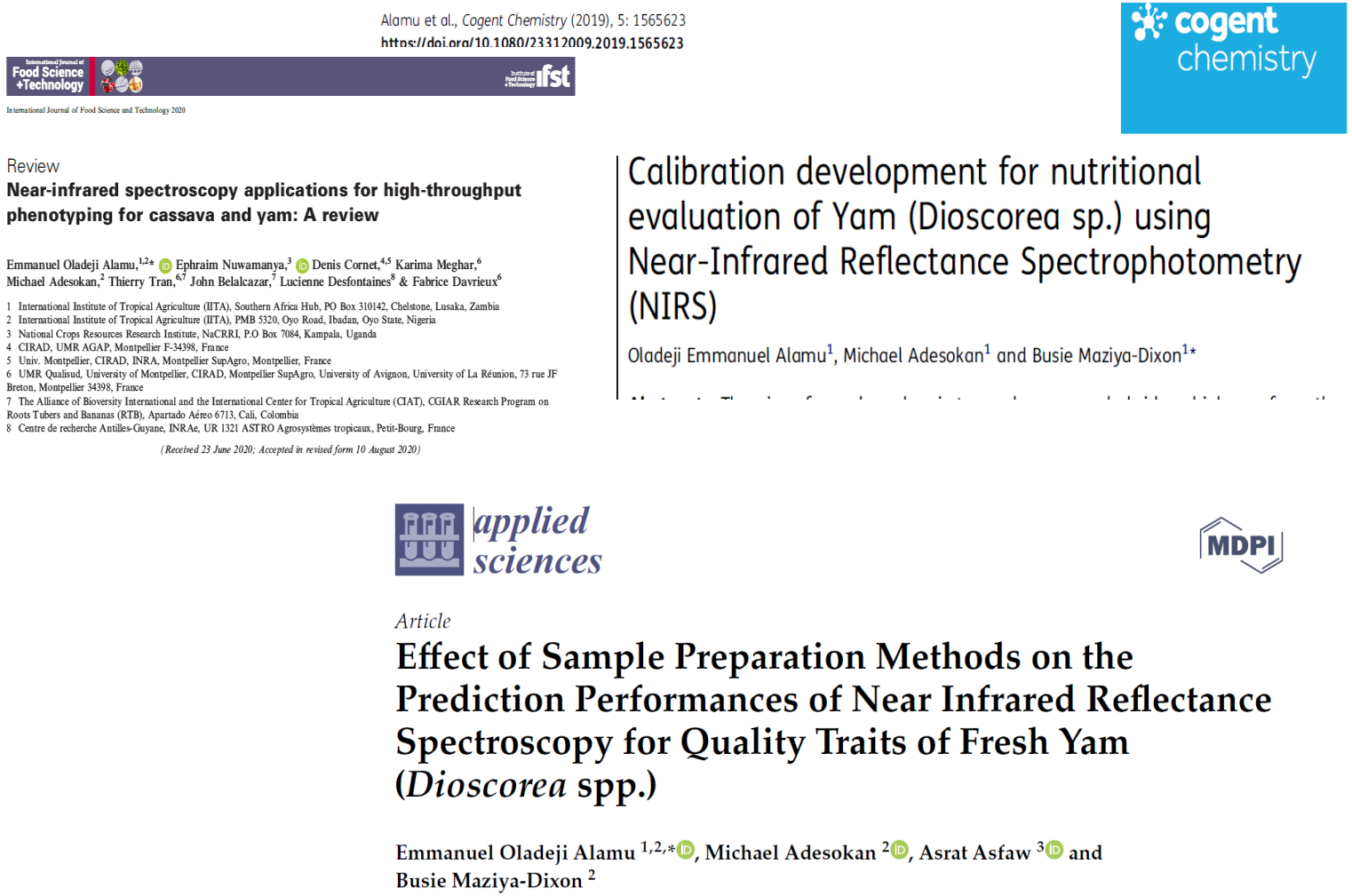
Assessment of biochemical, cooking, sensory and textural properties of the boiled food product of white yam *(D. rotundata)* genotypes grown at different locations.

Emmanuel Oladeji Alamu[1,2], Michael Adesokan[2], Wasiu Awoyale[2], Oyedele Hakeem[2], Según Fawole [2], Asrat Amele[3], Busie Maziya-Dixon[2†]

Application of NIRS (High throughput Technique) as a field–lab phenotyping tools

- Developed various Protocols for the application of High throughput methods (NIRS)

- Developed NIRS Calibration models for various traits in fresh and yam flour



Alamu et al., *Cogent Chemistry* (2019), 5: 1565623
https://doi.org/10.1080/23312009.2019.1565623

International Journal of Food Science and Technology 2020

Review

Near-infrared spectroscopy applications for high-throughput phenotyping for cassava and yam: A review

Emmanuel Oladeji Alamu,[1,2*] Ephraim Nuwamanya,[3] Denis Cornet,[4,5] Karima Meghar,[6] Michael Adesokan,[2] Thierry Tran,[6,7] John Belalcazar,[7] Lucienne Desfontaines[8] & Fabrice Davrieux[6]

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7 The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), CGIAR Research Program on Roots Tubers and Bananas (RTB), Apartado Aéreo 6713, Cali, Colombia
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(Received 23 June 2020; Accepted in revised form 10 August 2020)

cogent chemistry

Calibration development for nutritional evaluation of Yam (Dioscorea sp.) using Near-Infrared Reflectance Spectrophotometry (NIRS)

Oladeji Emmanuel Alamu[1], Michael Adesokan[1] and Busie Maziya-Dixon[1]*

applied sciences

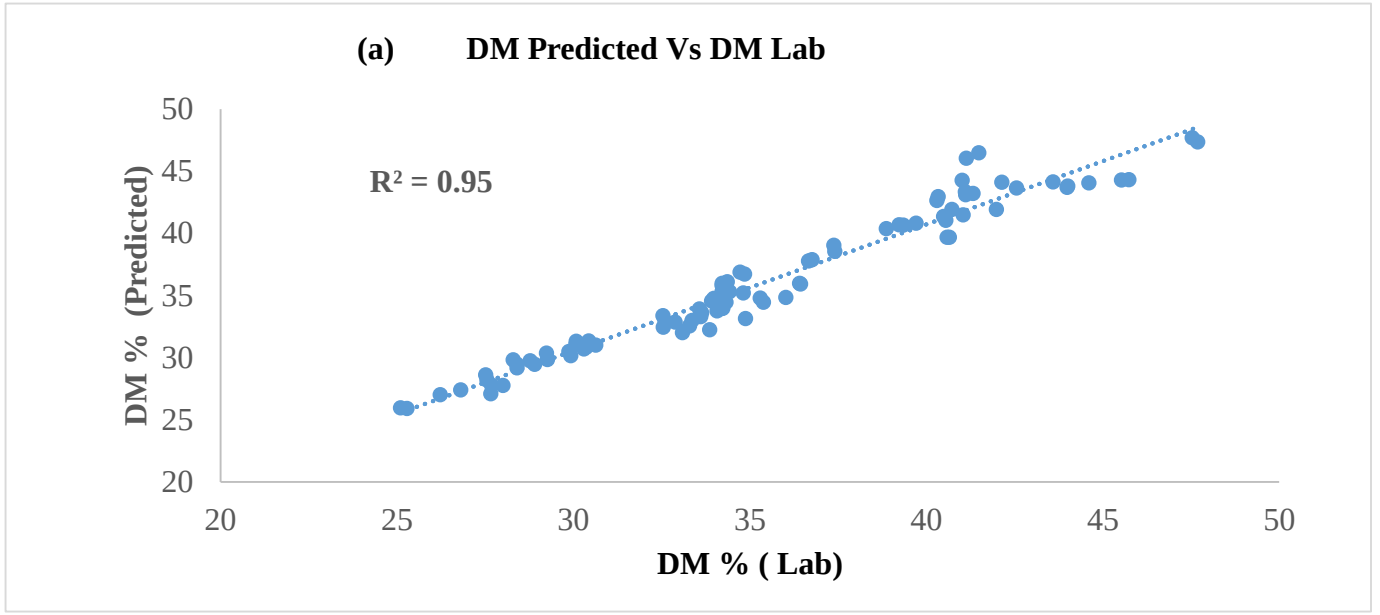
MDPI

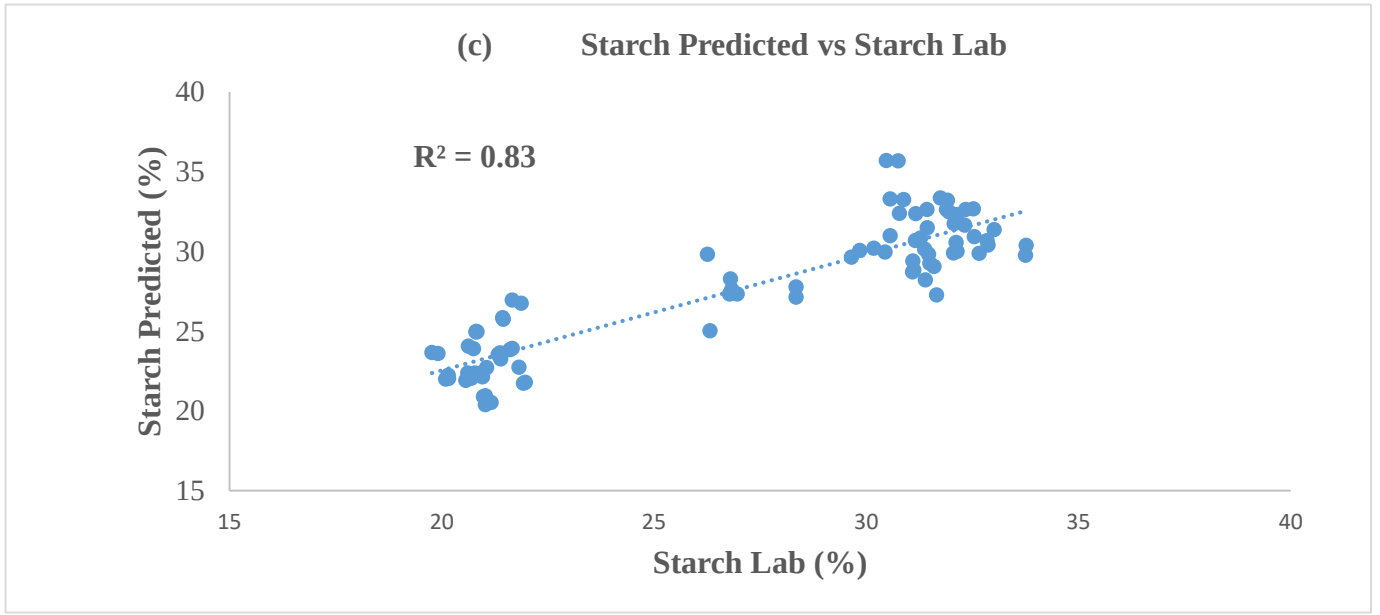
Article

Effect of Sample Preparation Methods on the Prediction Performances of Near Infrared Reflectance Spectroscopy for Quality Traits of Fresh Yam (*Dioscorea* spp.)

Emmanuel Oladeji Alamu [1,2,*], Michael Adesokan [2], Asrat Asfaw [3] and Busie Maziya-Dixon [2]

Prediction Performance of the Developed NIRS Calibration Models (Blended)

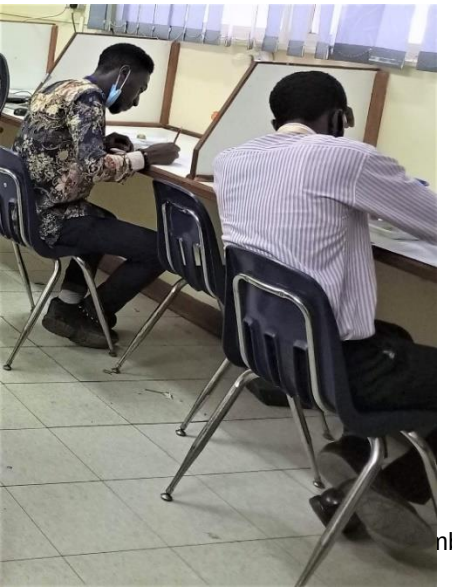


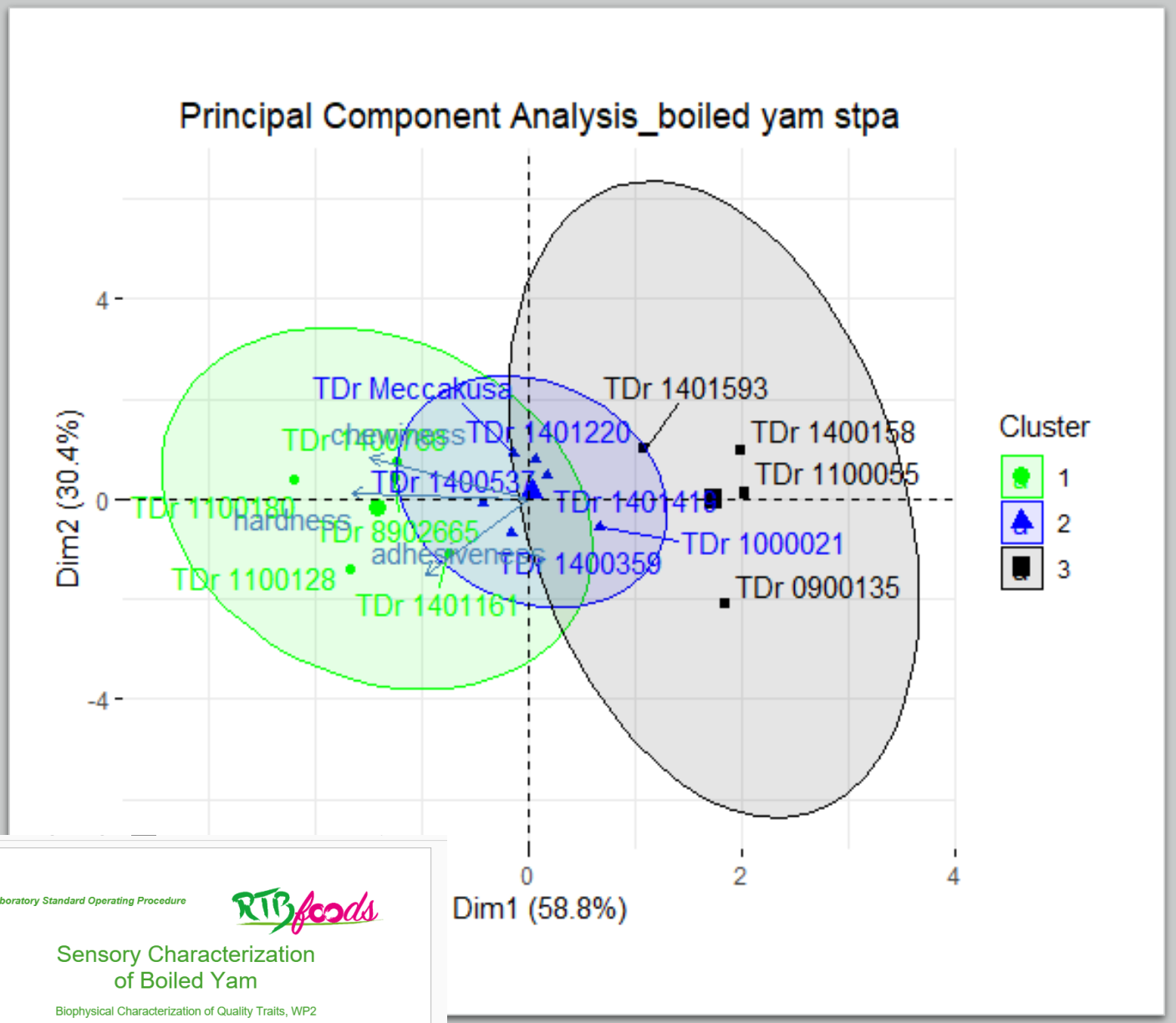


Quantitative Descriptive Analysis (QDA)- Boiled yam

- 16 trained sensory panellists
- 0-10 points scoring scale
- Attributes: hardness | ease of chewing| |stickiness to the hand |
- Data cleaning and testing of panelist performance:

RTBfoods_E6.3_SOP





Laboratory Standard Operating Procedure

RTBfoods

Sensory Characterization of Boiled Yam

Biophysical Characterization of Quality Traits, WP2

Cotonou, Benin, January 2020

Laurent ADINSI, Université d'Abomey-Calavi, Faculté des Sciences Agronomiques (UAC-FSA), Cotonou, Benin

Noël AKISSOE, UAC-FSA, Cotonou, Benin

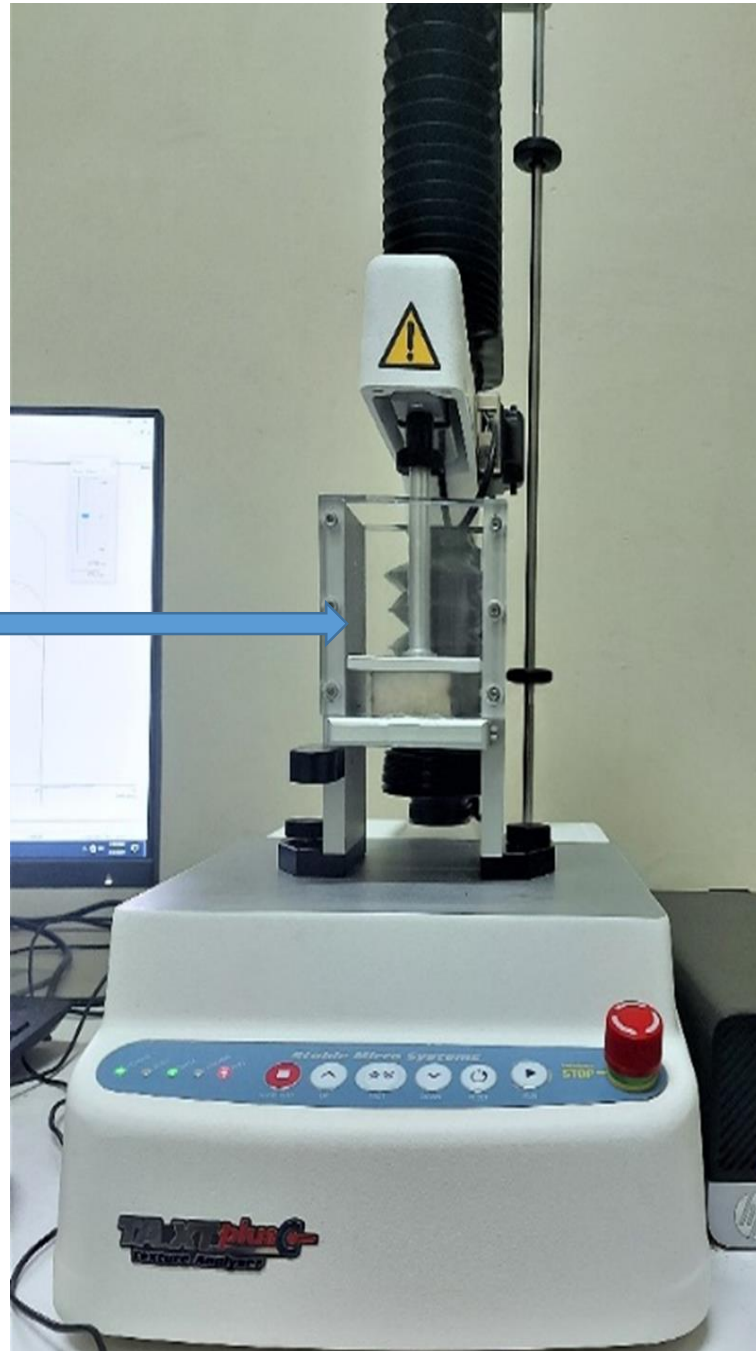
Instrumental Extrusion Analysis

Hardness (By variety)

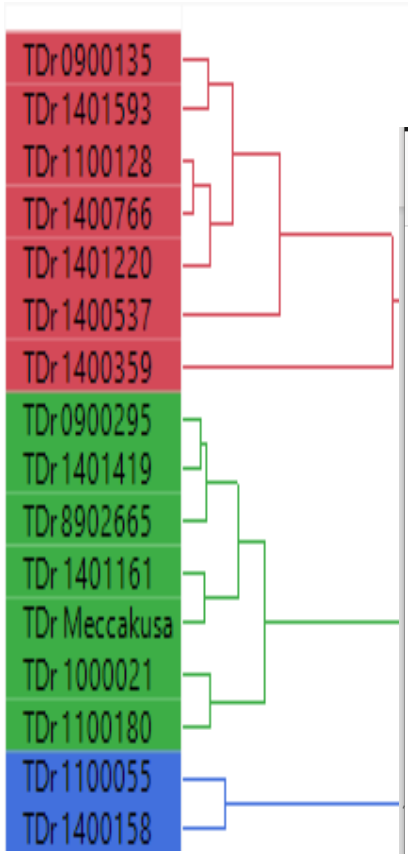
One-way Analysis of Variance

Source	N	DF	Sum of Squares	F Ratio	Prob > F
variety	15	15	104881828	7.1516	<.0001*
replicate	1	1	9721822.67	0.9944	0.3262
variety*replicate	15	15	89294692.6	0.6089	0.8458

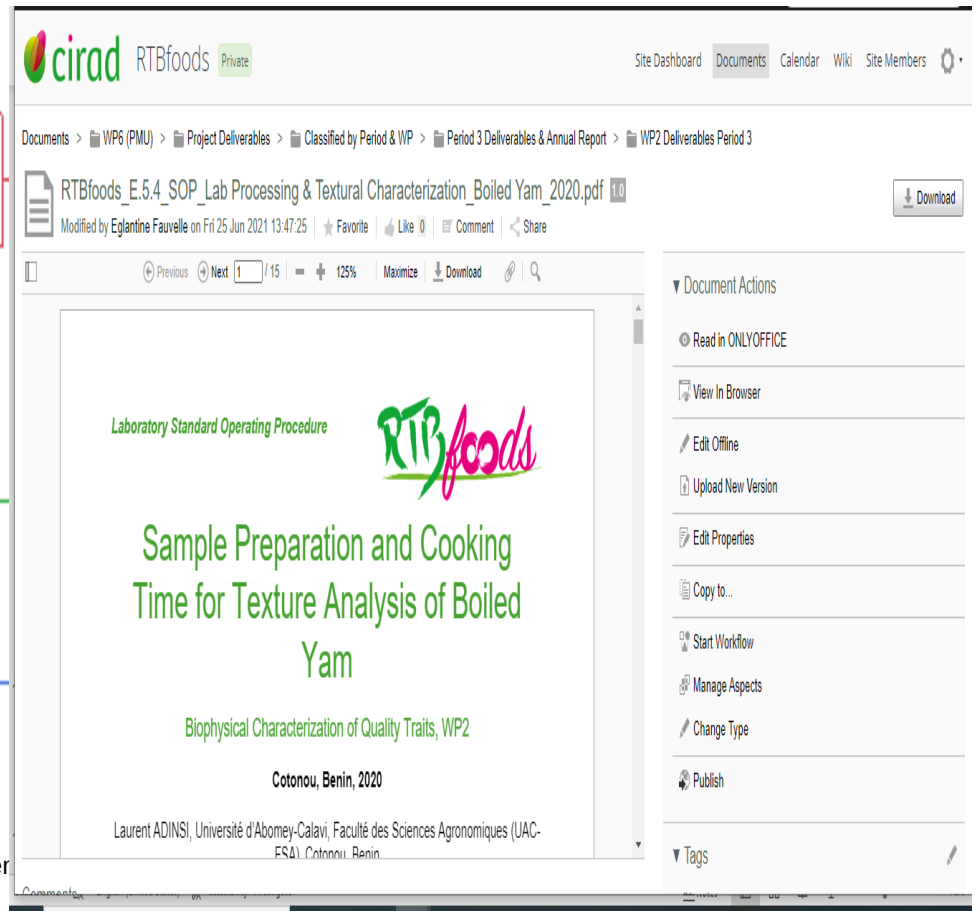
Pre-test speed	2 mm/s
Test speed	1 mm/s
Trigger force (when the probe touches the surface of the sample)	1,000g
Distance	20mm
Temperature of test	45 °C

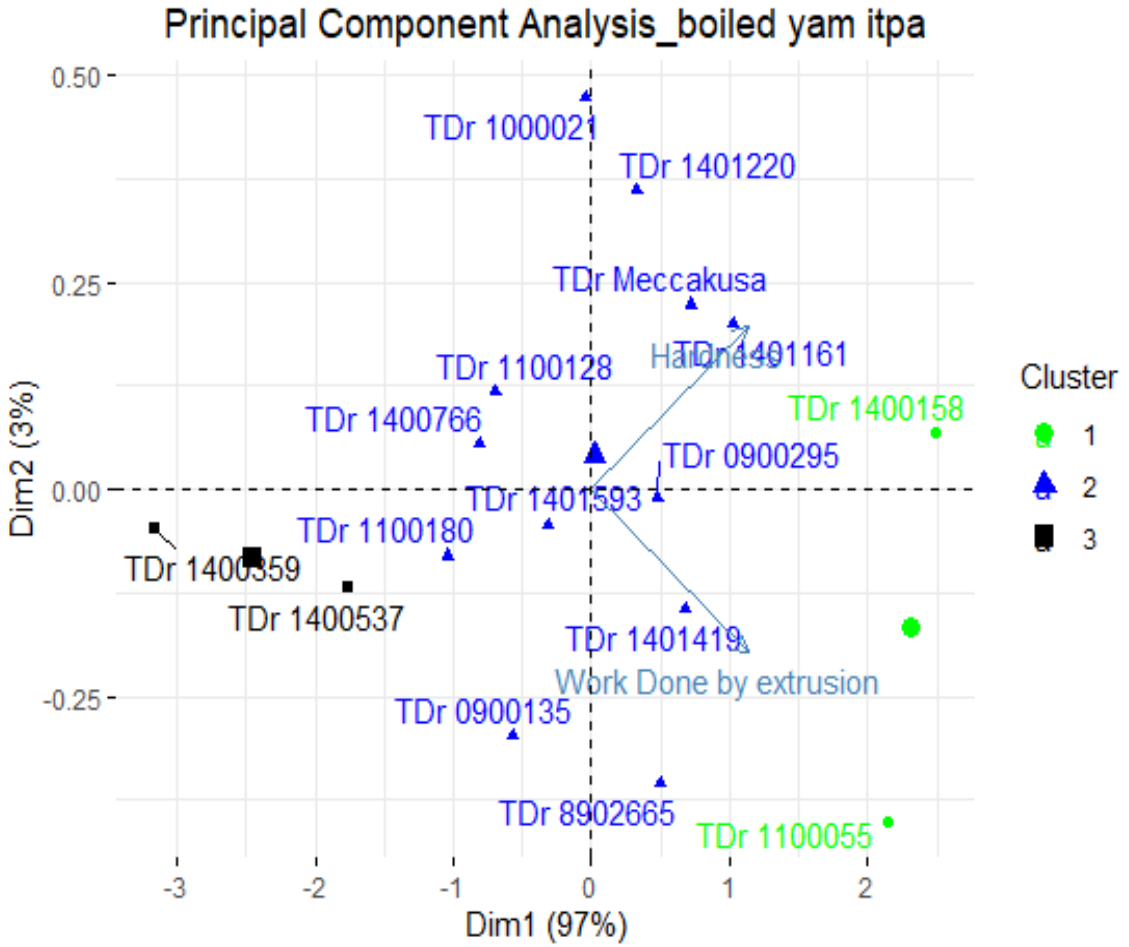


Data Exploration for Boiled Yam Extrusion



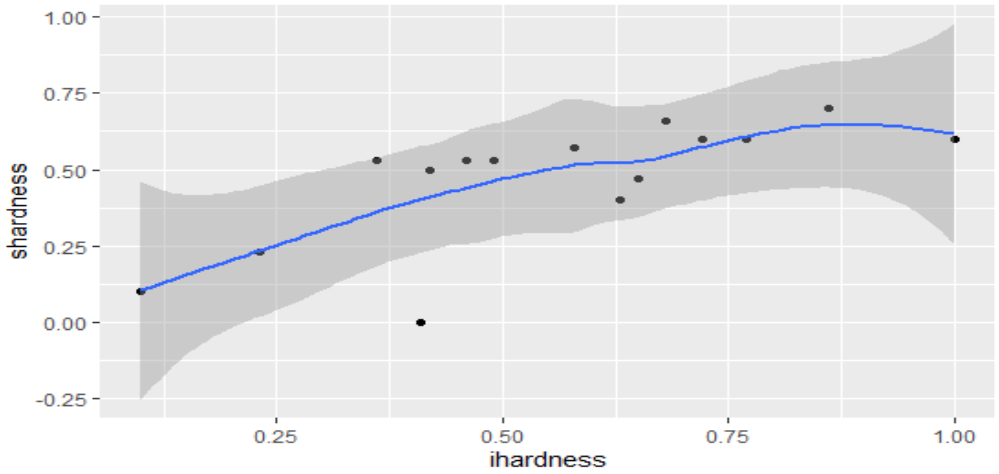
RTBFoods_E 6.3_SOP



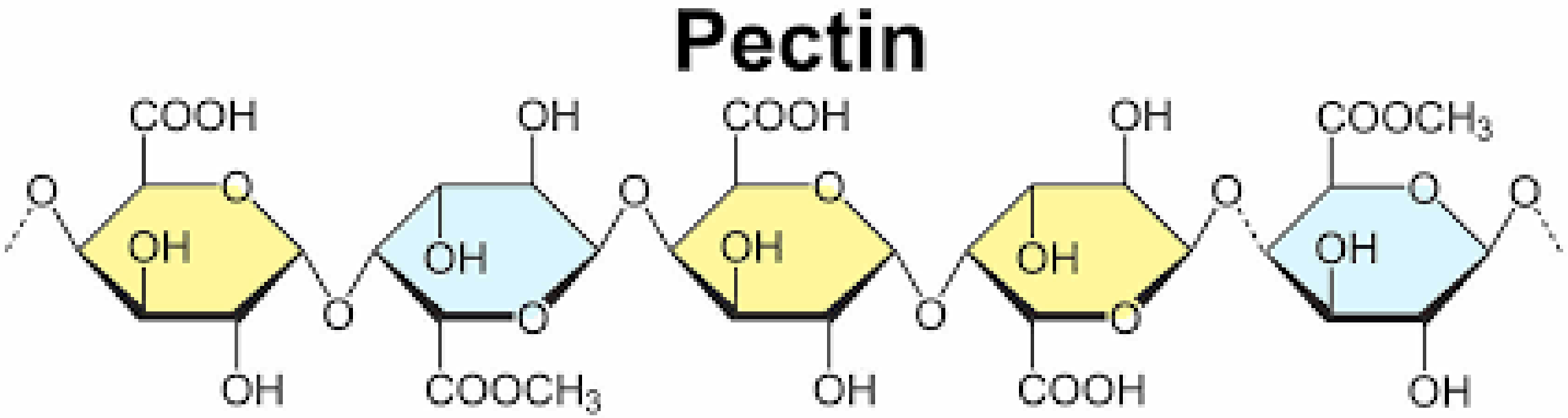


Pearson Correlation of QDA and Extrusion Texture Analysis for boiled yam

	I-Hardness	*Extrusion Work*	*S-hardness*	*Stickiness*	*Ease of chew*
I-Hardness					
Extrusion Work	0.93				
S-hardness	**0.71****	0.63			
Stickiness	**-0.50 ns**	-0.50	-0.42		
Ease of chew	0.52	**0.55**	0.59	-0.15	1



- Further work to improve the correlation between the Sensory and instrumental measurements



YAM PECTIN AND EFFECTS ON TEXTURE OF BOILED AND POUNDED YAM

Liticia et al., 2020

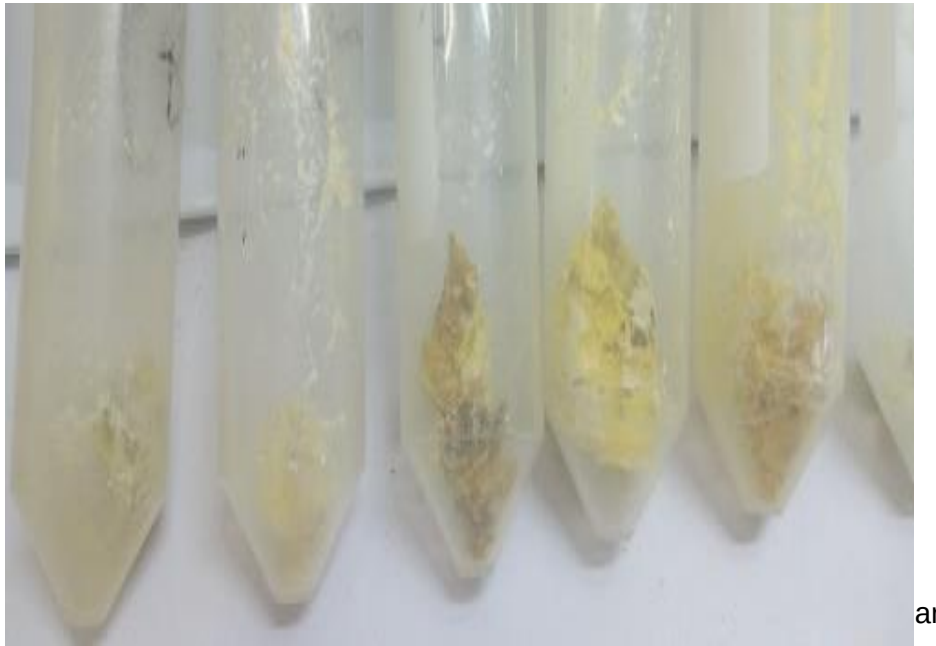
Yam Pectin and Textural Characteristics

- Pectin consists of a chain of galacturonic acid units linked by α-(1,4) glycosidic bonds.
- The study aimed to investigate how the texture of boiled and pounded yam is affected by pectin and its degree of esterification.
- Genetic Materials:

  Seven (7) newly developed yam varieties, (3 *D. rotundata* and 4 *D. alata*) were obtained from the Crops Research Institute (CRI), Fumesua, Ghana.

Methods:

- **Cell Wall Extraction**
- **Degree of Esterification**
- **Texture Profile Analysis of yam and pounded yam**



Preliminary Results of Yam Pectin and Textural Characteristics

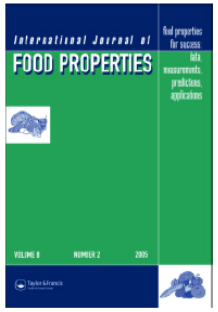
Key research findings:

- ❑ High methoxy pectin (DE >50) ⟷ ❑ Low methoxy pectin (DE<50)

❖ The degree of esterification in this study ranges from 22.5% to 51%

Low methoxy

❖ Positive correlations existed between the textural parameters and pectin content as well as the DE but were not significant (p > 05)



International Journal of Food Properties

Taylor & Francis
Taylor & Francis Group

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ljfp20

Yam pectin and textural characteristics: a preliminary study

Liticia Effah-Manu, Bussie Maziya-Dixon, Faustina D. Wireko-Manu, Jacob K. Agbenorhevi & Ibok Oduro

Correlation of pectin and DE with the textural parameters of boiled and pounded yam

	Pectin		DE	
Textural attribute	Correlation coefficient	p-values	Correlation coefficient	p-values
Boiled yam				
Hardness	-0.263	0.435	0.287	0.392
Fractuability	-0.145	0.670	0.332	0.318
Cohesiveness	-0.139	0.683	0.416	0.203
Chewiness	-0.137	0.689	0.387	0.240
Gumminess	-0.208	0.539	0.283	0.399
Pounded yam				
Firmness	0.204	0.547	0.217	0.521
Consistency	-0.27	0.938	-0.029	0.933

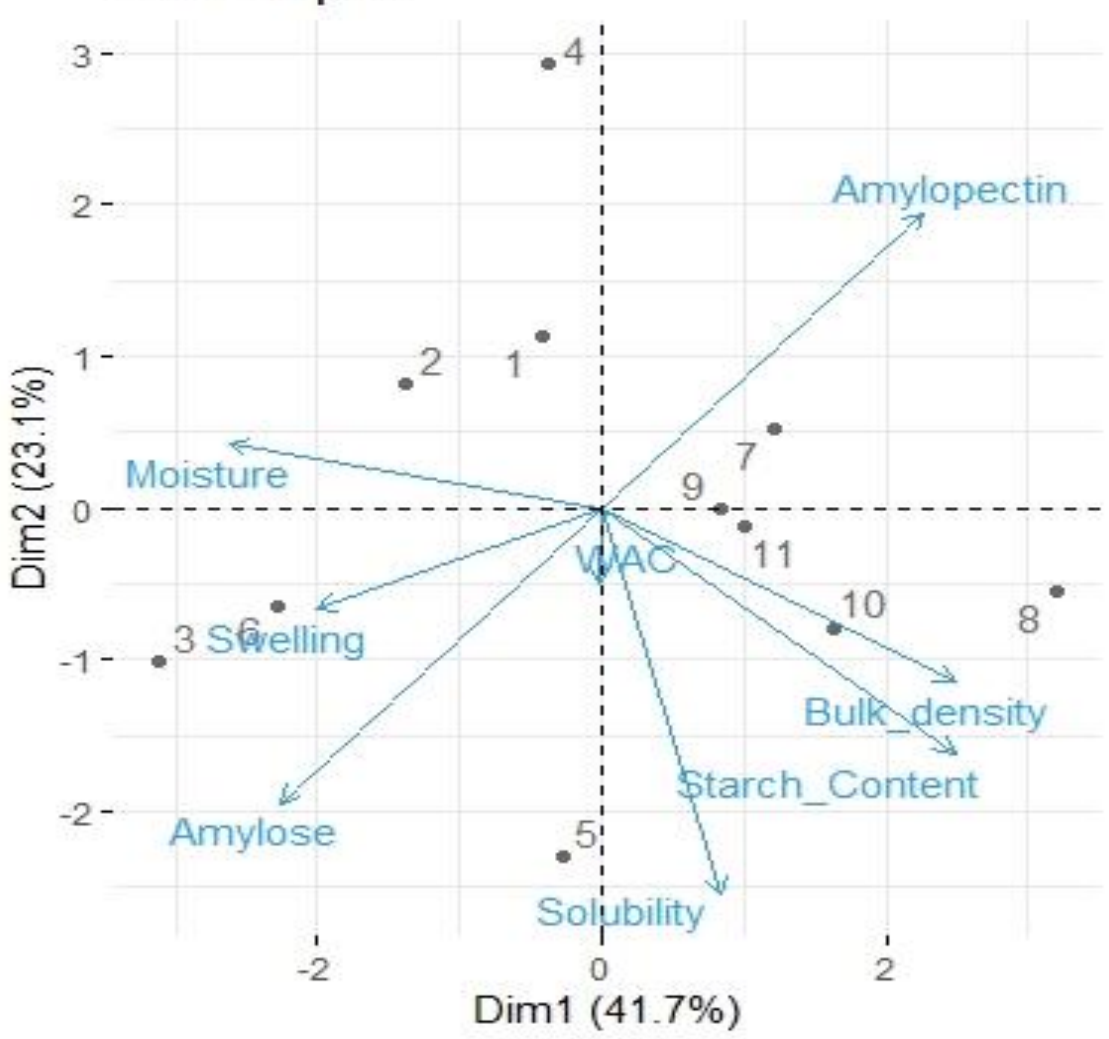
Loading plot of chemical and functional properties

CyTA - Journal of Food

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tcyt20

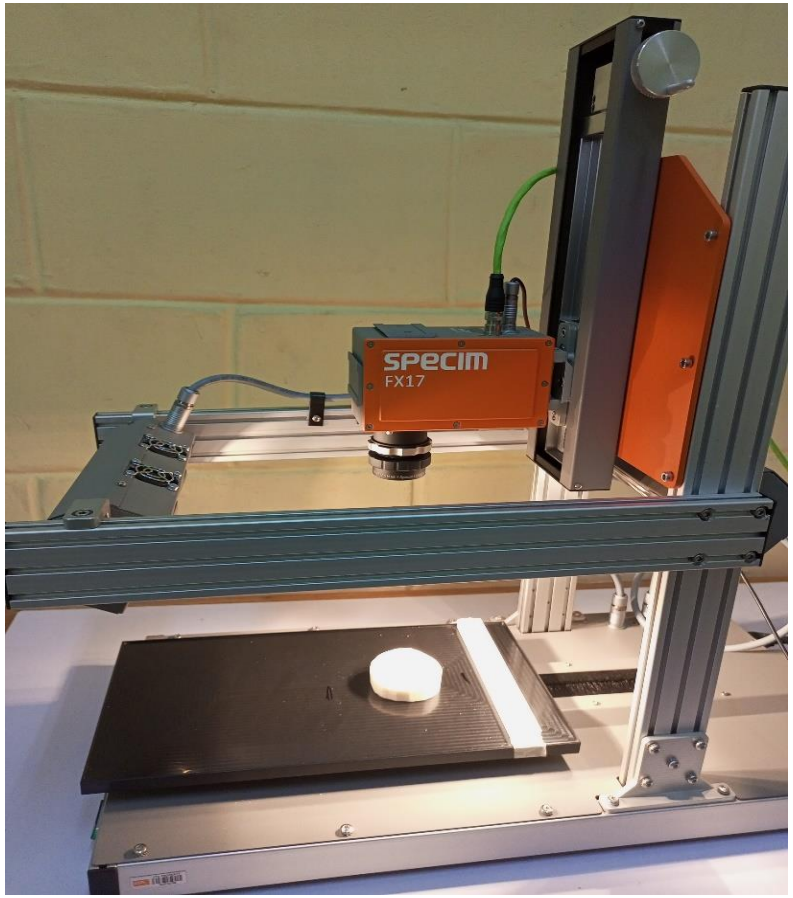
Chemical, functional and pasting properties of starches and flours from new yam compared to local varieties

Liticia Effah-Manu, Faustina D. Wireko-Manu, Jacob K. Agbenorhevi, Bussie Maziya-Dixon & Ibok Oduro

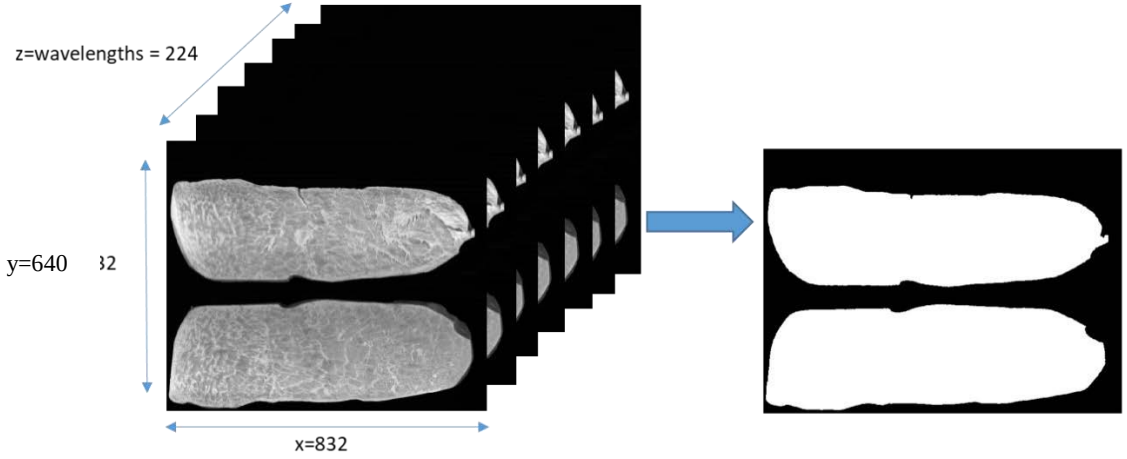


Future: Hyperspectral Imaging

- We hope to explore NIR-HSI which combines spectroscopy with imaging to characterize physical and biochemical traits in RTBs



Karimah's visit to IITA

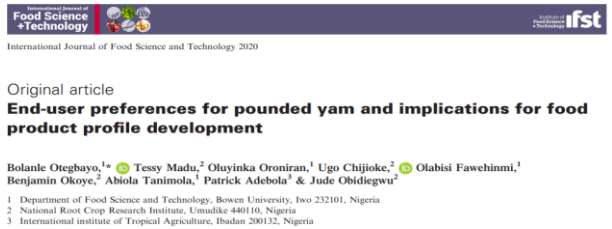


POUNDED YAM BOWEN

Key findings on pounded yam in RTBfoods project

Gender mapping and consumer testing

Food quality profile and key quality traits preferences by consumers has been identified as color and textural quality


International Journal of Food Science and Technology 2020

Original article

End-user preferences for pounded yam and implications for food product profile development

Bolanle Otegbayo,[1]* Tessy Madu,[2] Oluyinka Oroniran,[1] Ugo Chijioke,[2] Olabisi Fawehinmi,[1] Benjamin Okoye,[2] Abiola Tanimola,[1] Patrick Adebola[3] & Jude Obidiegwu[2]

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2 National Root Crop Research Institute, Umudike 440110, Nigeria
3 International institute of Tropical Agriculture, Ibadan 200132, Nigeria

Key intrinsic qualities in yam that can indicate the textural quality and colour of pounded yam to be passed to breeders

Otegbayo et al., 2021; RTBfoods report, 2022

MTTP method to determine the key preferred traits (color & textural quality)

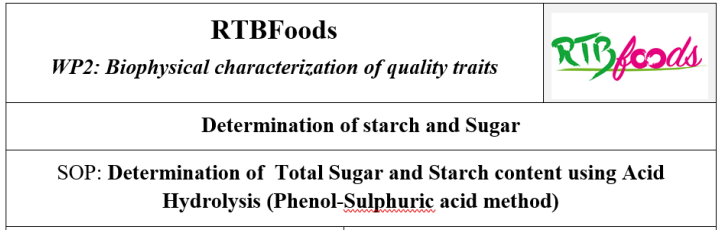
Established Correlations between Instrumental and Sensory textural quality measurement

Development of Standard operating procedures (SOP)

Developed SOP for Starch and Sugar analysis by acid hydrolysis

Developed SOP for Preparation and Sensory descriptive analysis of Pounded yam

Developed SOP for Instrumental measurement of Textural quality in Pounded yam

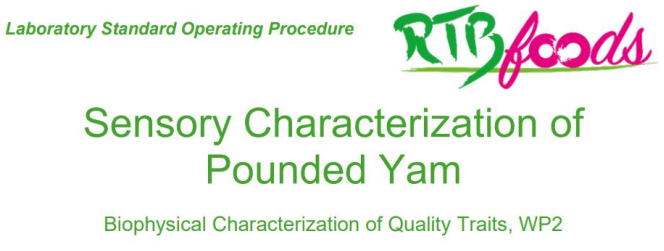


RTBFoods

WP2: Biophysical characterization of quality traits

Determination of starch and Sugar

SOP: **Determination of Total Sugar and Starch content using Acid Hydrolysis (Phenol-Sulphuric acid method)**



Laboratory Standard Operating Procedure

Sensory Characterization of Pounded Yam

Biophysical Characterization of Quality Traits, WP2

Laboratory Standard Operating Procedure

SOP: Instrumental Texture Evaluation of Pounded Yam

Biophysical Characterisation of Quality Traits, WP 2

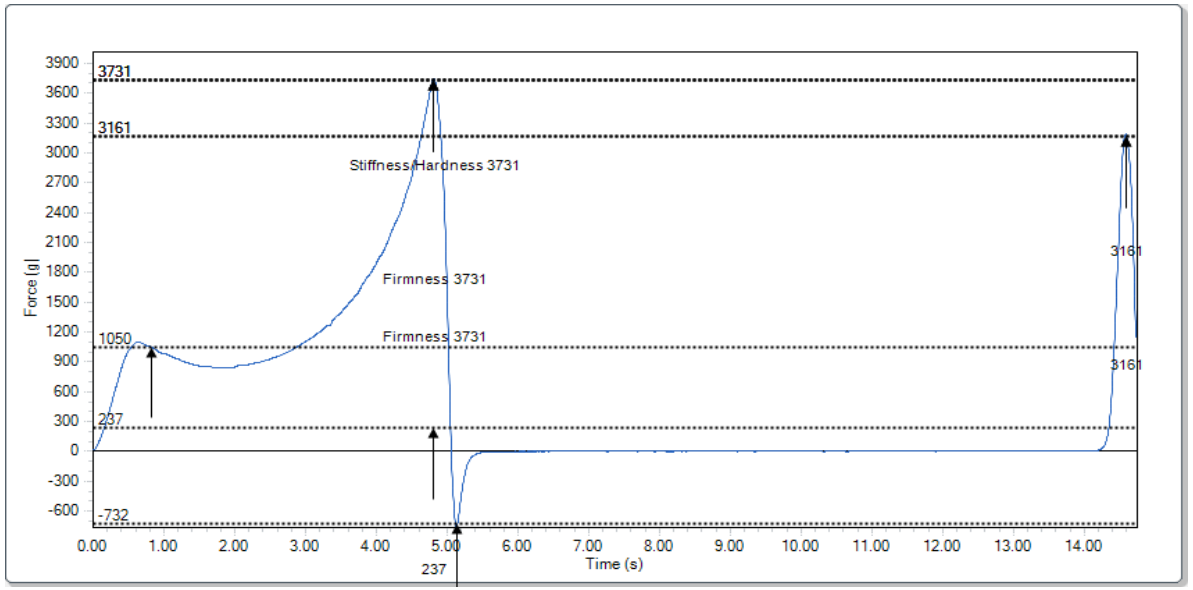
Key findings on pounded yam in RTBfoods project

- Through Texture Profile Analysis (TPA) we have been able to:
  - Establish promising correlation between sensory hardness, mouldability and adhesiveness and instrumental hardness, cohesiveness and adhesiveness
  - Discriminate between textural quality of Pounded yam from yam genotypes
  - Develop a TPA profile for pounded yam with preferred and non-preferred textural quality
- Hence TPA can be a MTTP to characterize textural quality of Pounded yam in place of sensory descriptive analysis

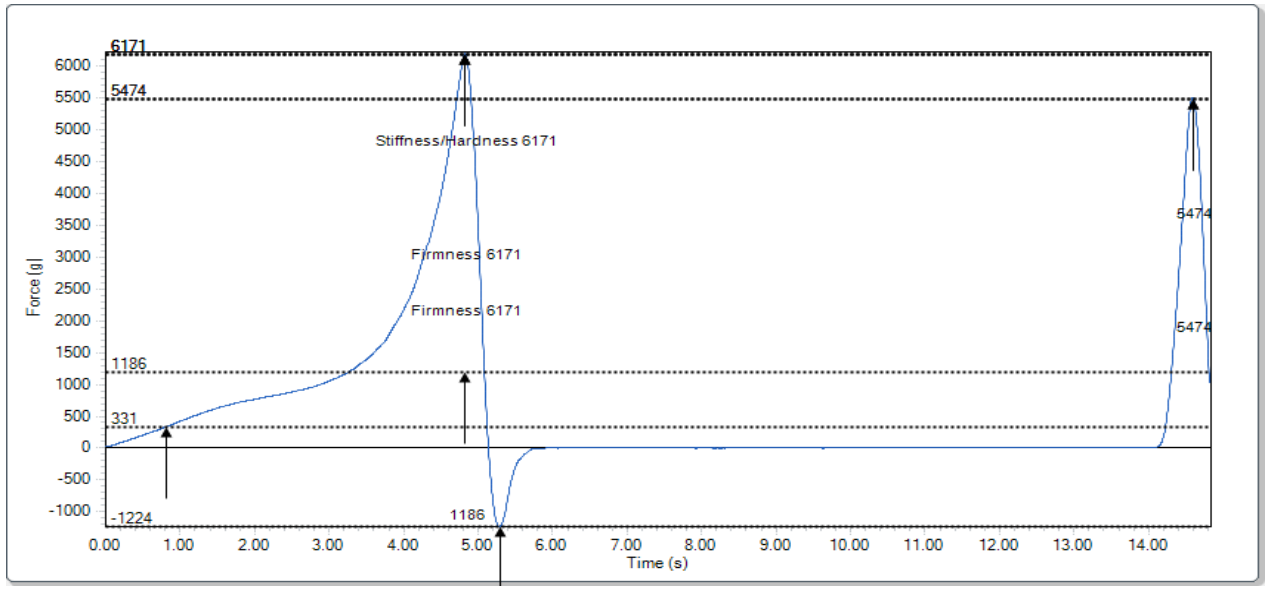
Correlation between Instrumental texture parameters and Descriptive sensory evaluation parameters for Pounded yam made *D. rotundata and D.alata* varieties

		Instrumental texture parameters					
Sensory parameters	***D. alata***	Stickiness	Cohesiveness	Stiffness/hardness	Springiness	Stringiness	Resilience
	Adhesiveness	**0.76**	-0.11	-0.68	-0.14	-0.14	0.27
	Mouldability/ Cohesiveness	0.00	**0.60**	0.01	-0.13	0.12	-0.13
	Hardness/ softness	-0.78	0.09	**0.63**	0.25	0.25	0.30
	Stretchability	-0.03	0.70	0.09	-0.92	0.51	0.70
Sensory parameters	***D. rotundata***	Stickiness	Cohesiveness	Stiffness/hardness	Springiness	Stringiness	Resilience
	Adhesiveness	-0.11	0.29	-0.54	-0.67	-0.67	-0.36
	Mouldability/ Cohesiveness	-0.25	**0.81**	0.12	-0.006	-0.06	-0.29
	Hardness/ softness	0.11	-0.45	**0.64**	0.58	0.58	0.44
	Stretchability	-0.42	0.92	-0.35	-0.36	-0.35	-0.66

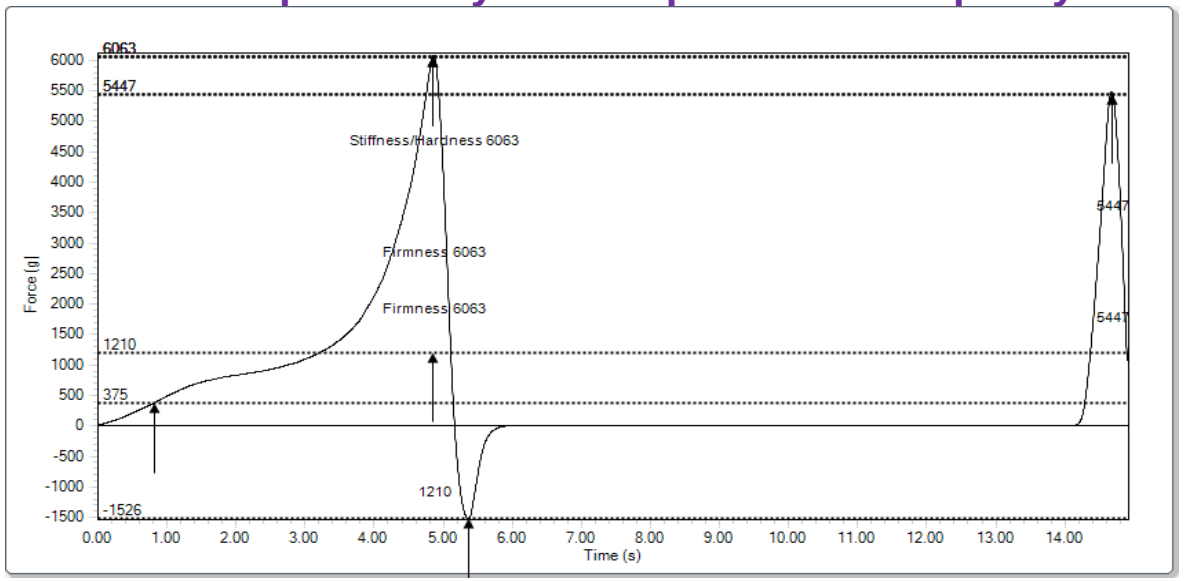
- Correlation between ITP and STP established hence, TPA can be used to measure – hardness, cohesiveness and adhesiveness in pounded yam in place of sensory panelist as a MTTP method



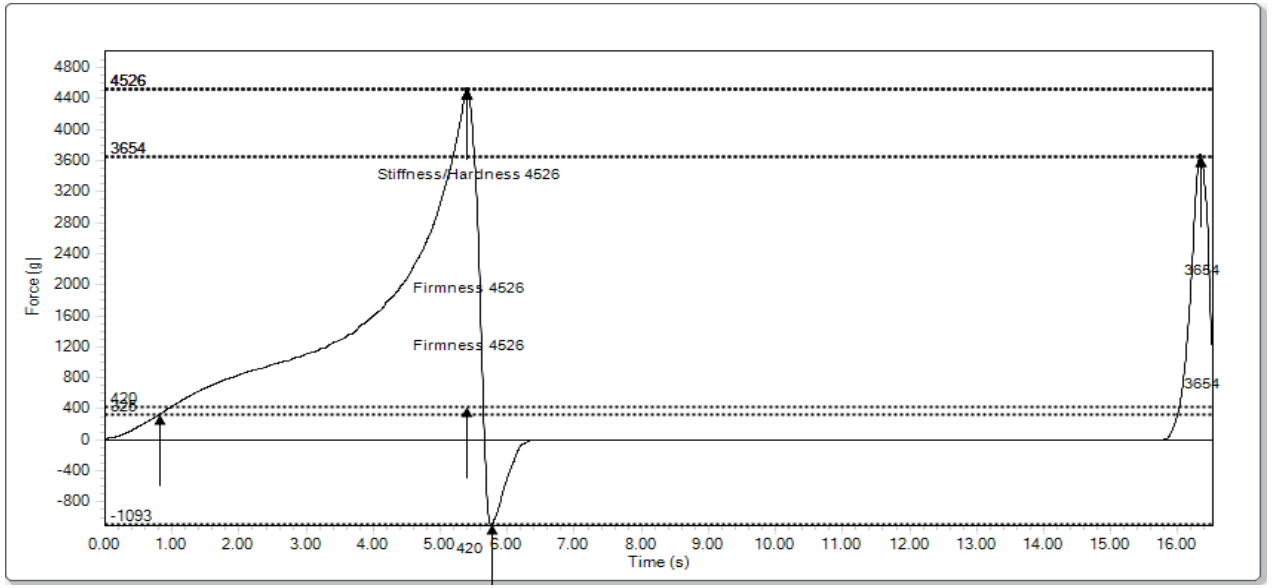
TPA curve of pounded yam with poor textural quality



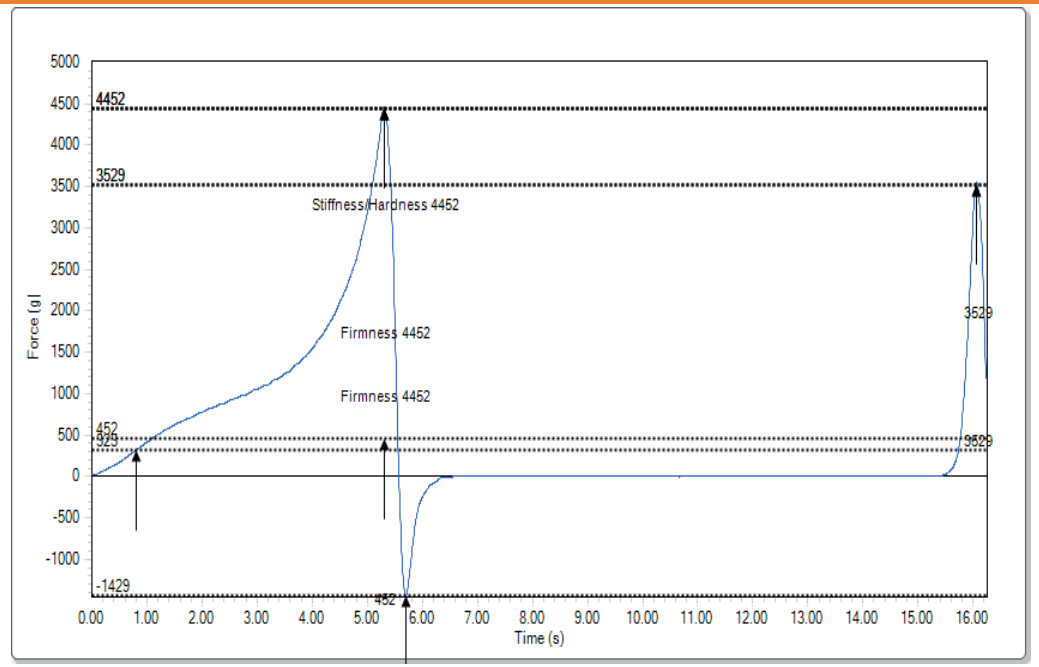
TPA curve of pounded yam with good textural quality



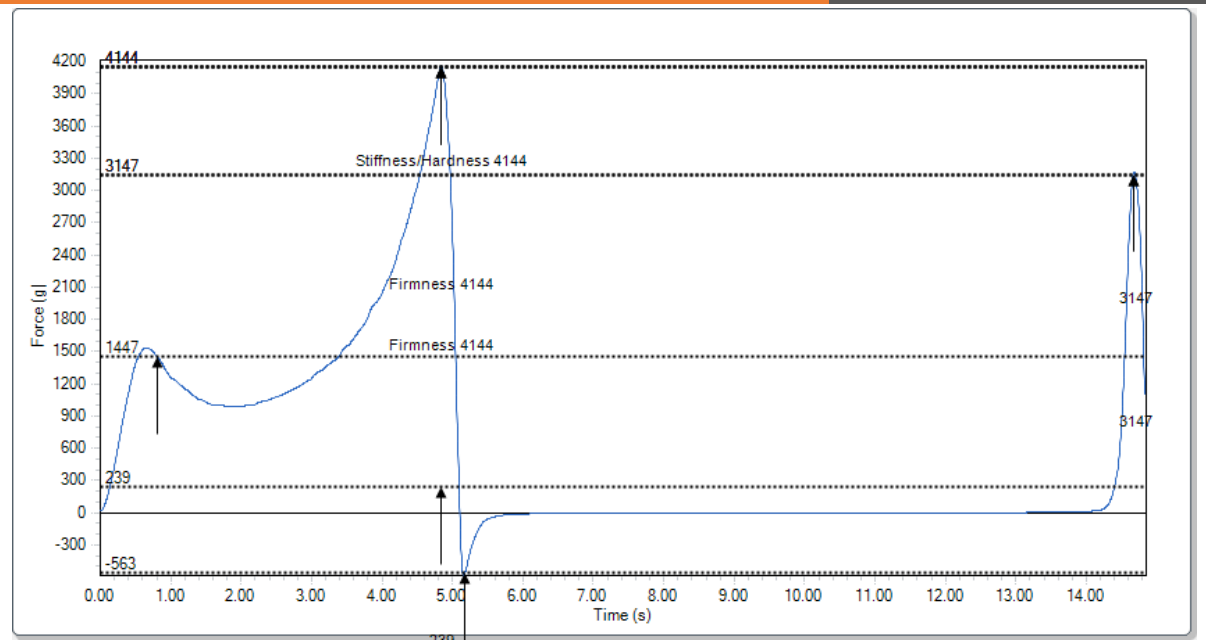
Typical instrumental texture profile of pounded yam from *D. rotundata* (TDr IGN)



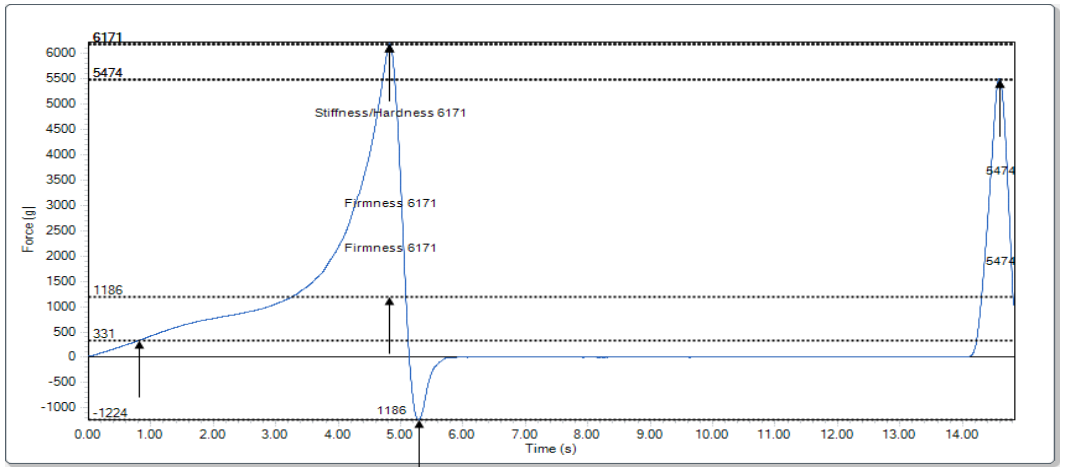
Typical instrumental texture profile graphs of pounded yam from *D. alata* (TDa1100316)



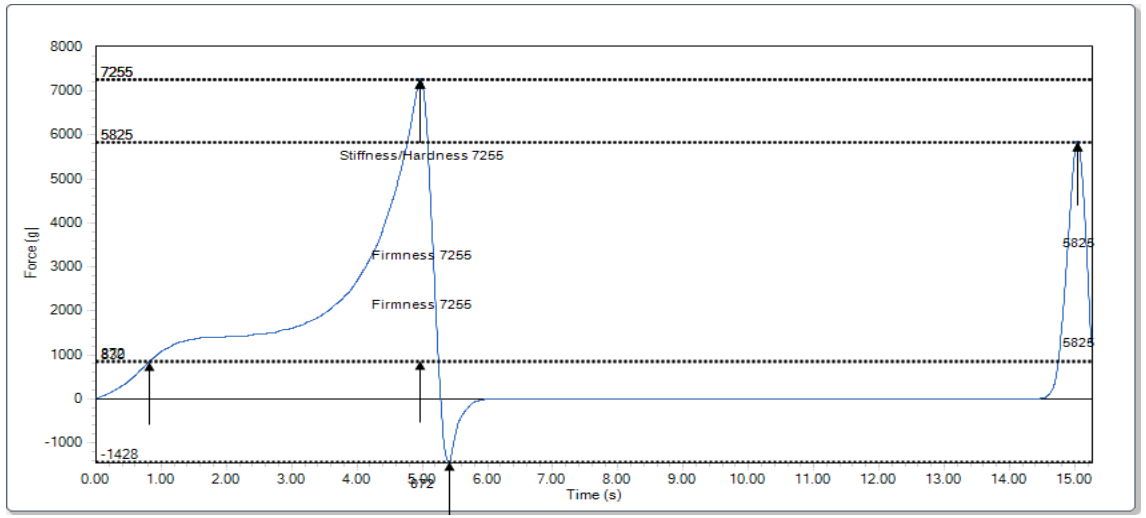
TPA curve of pounded yam from *D. alata* with good textural quality



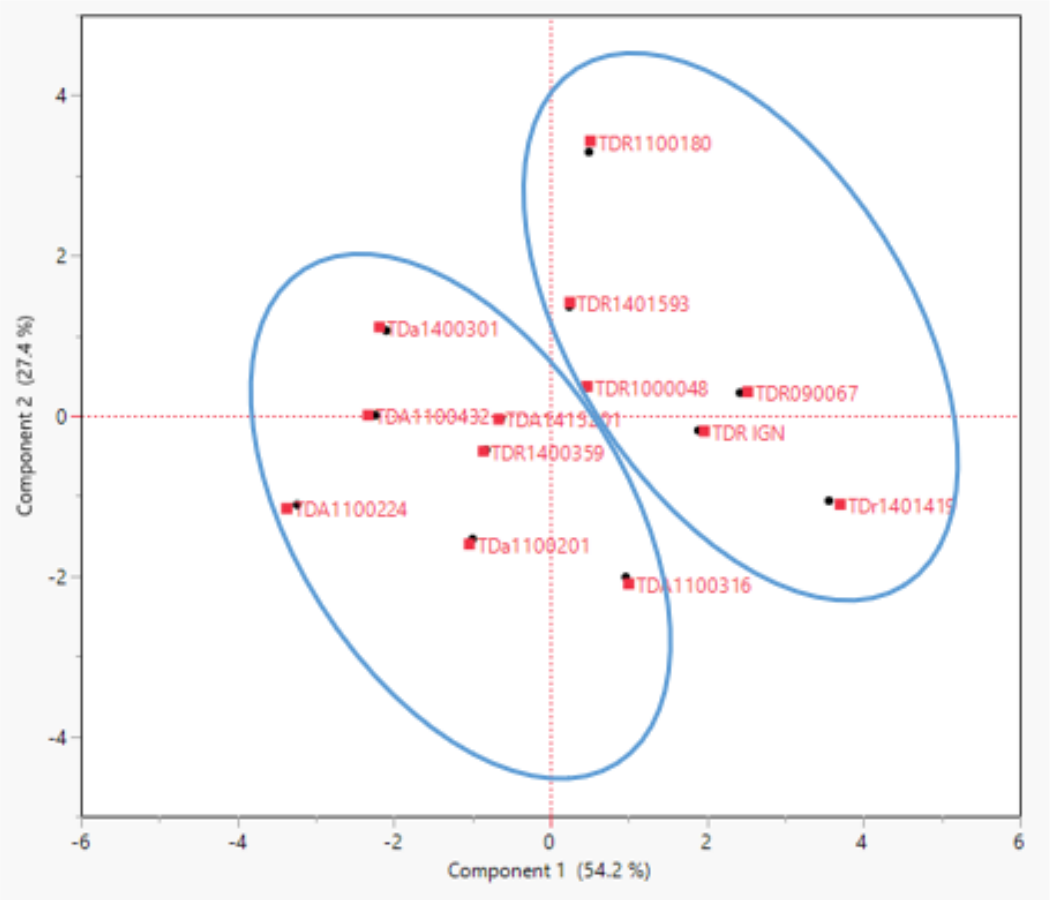
TPA of pounded yam from *D. alata* with poor textural quality



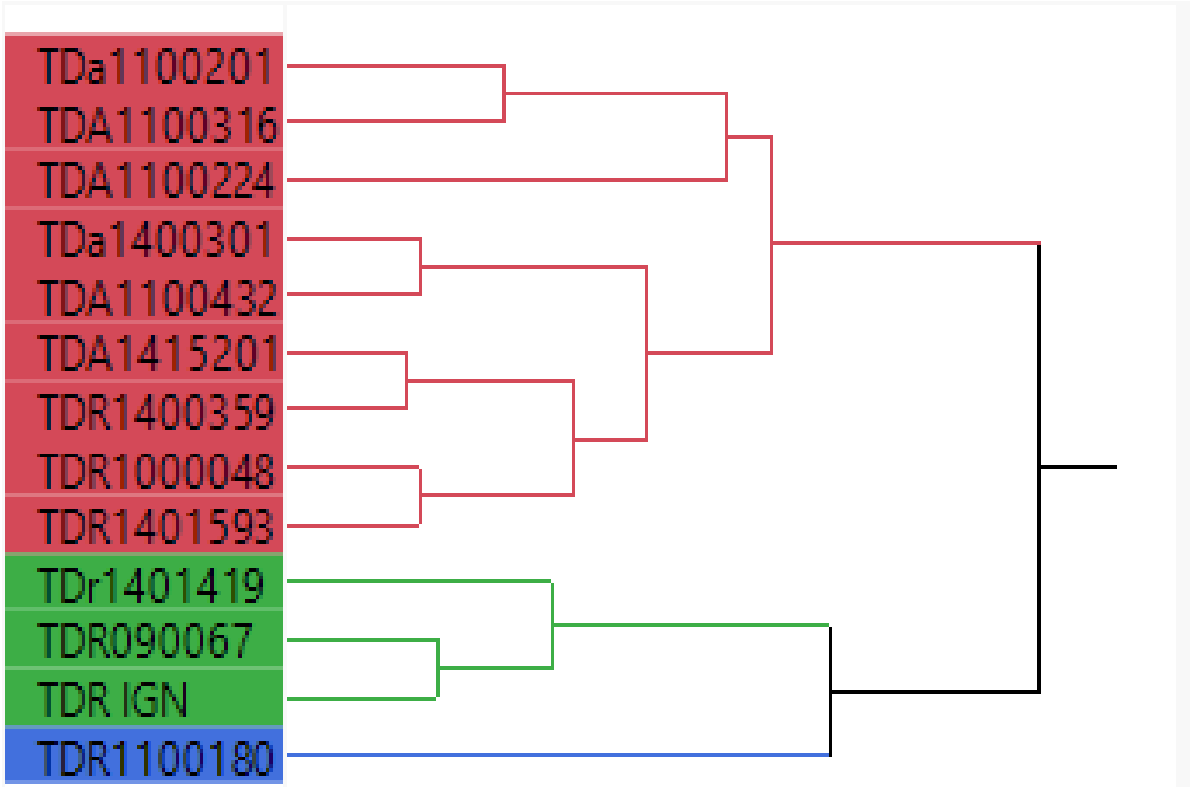
TPA curve of pounded yam from *D. rotundata* with good textural quality



TPA of pounded yam from *D.rotundata* with poor textural quality



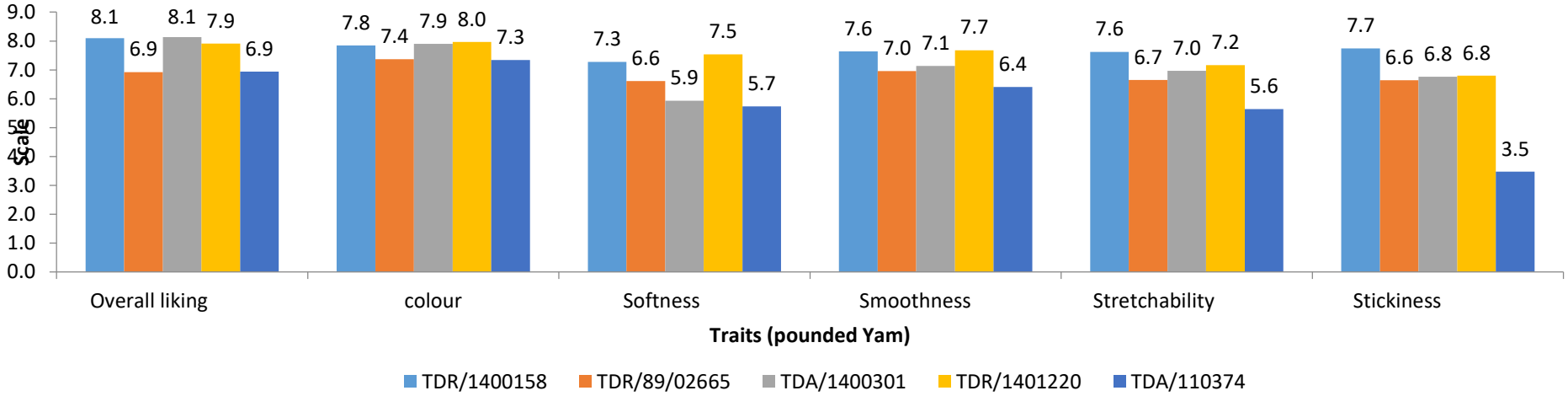
PCA of 13 genotypes of yam for pounded yam texture



Hierarchical clusters of textural quality of Pounded yam made from 13 genotypes of yam

POUNDED YAM NRCRI

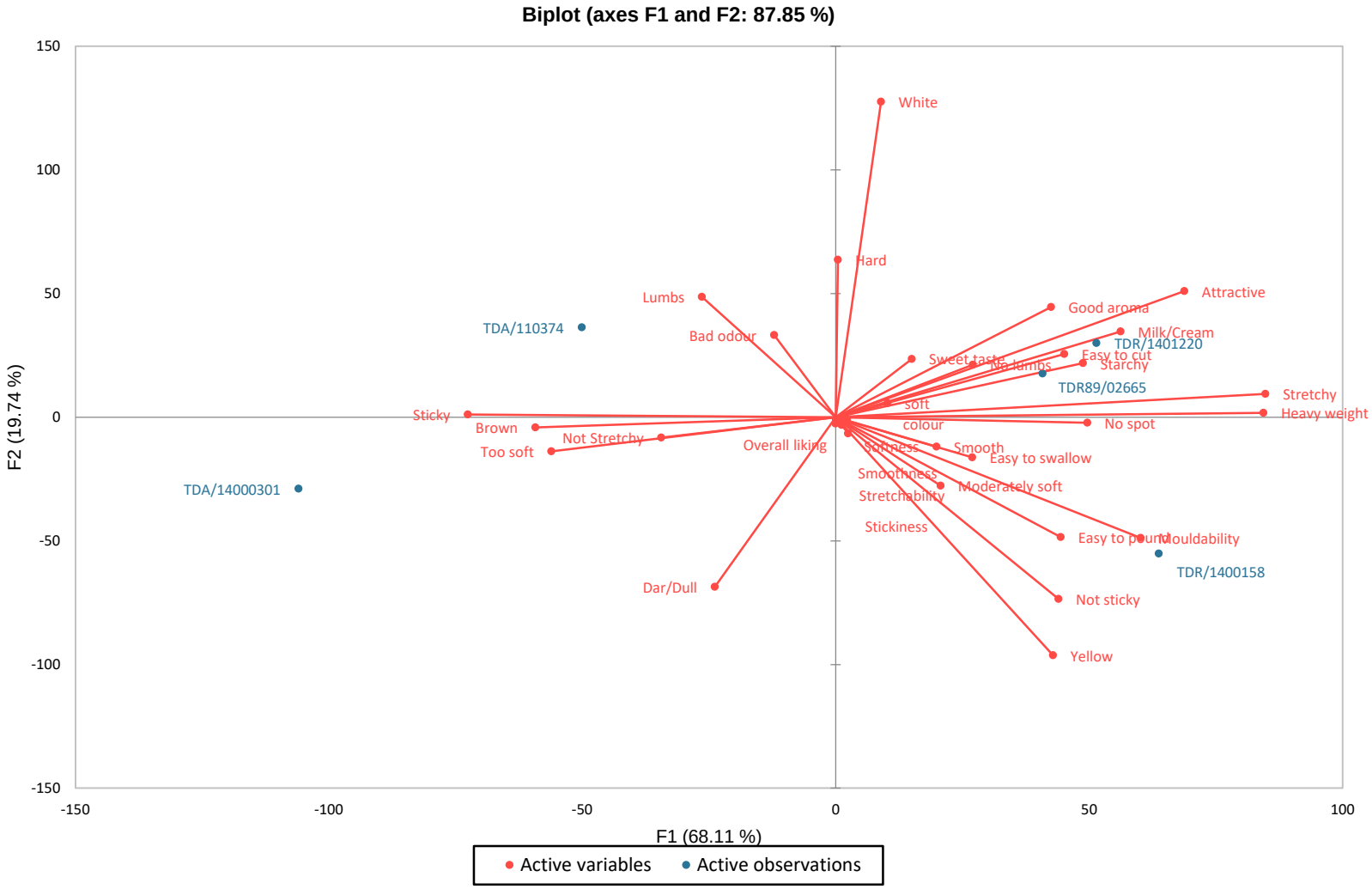
Consumer Acceptability- Traits (Pounded Yam) Study location, Sampling, Hedonic Scaling, PCA, ANOVA (N=100) – Location-Umudike and Ubakala



- Results show significant variations in the level of acceptability among the 5 Yam varieties
- TDA/1400301 compared favorably with TDR/1400158 for all the traits
- The least preferred was TDA/110374

Variety	Pounded yam
TDA/1400301	5.34a
TDR/1400158	**8.10b**
TDA/110374	6.94ab
TDR/89/02665	**7.82b**
TDR/1401220	**7.91b**

- There were significant differences in overall acceptability of the 5 yam varieties
- TDR/1400158 ranked highest in overall acceptability, followed by TDR98/89/02665 and TDR/140122 (which were not significantly different)
- The least liked was TDA/1400301
- This indicates significant variations in the level of acceptability among the varieties



Mapping of the sensory characteristics and the overall liking of the product samples (Pounded yam)

The PCA shows the clustering of Positive traits around the TDr varieties and the negative traits around TDAs.

CAPACITY BUILDING

- **2 students have successfully completed their Post-graduate degree programs in IITA on the African Yam project**
  - Liticia Efa-Manu (Ghana) (Ph.D
  - Helen Ufondu (Nigeria) (Ph.D)
- **1 M.Sc Student in Bowen University on RTBfoods proect**
  - Ayomide Alamu

CONCLUSION

- Quality has been identified in most breeding programs as the driver for variety adoption by farmers, market demand identification and consumer product acceptability

- RTBfoods project has done well in the past five years to identify the Key Priority Traits (KPT) for Yam, in which Color and Texture ranked high

- Food scientists have established the Proof of Concepts for these traits and developed SOPs for their determination, including the HTTP (Credits to RTBfoods project) which breeders are now using

- The outlook for the future is the perfection of the prediction tools and the integration of these traits into breeding selection metrics

- Validation of HTTP for assessing quality traits in Pounded yam

- All yam genotypes used by Institutes were supplied by Breeders from AfricaYam
- Dr. Amele Asrat (IITA)
- Dr. Jude Obidiegwu (NRCRI)

IITA Transforming African Agriculture

CGIAR

AfricaYam

BILL & MELINDA GATES foundation

BOWEN UNIVERSITY
(of the Nigerian Baptist Convention)

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Thank you