

Banana physicochemical & functional differentiation during ripening. A key study for understanding consumer preferences



O. Gibert, D. Dufour, M. Reynes,
A. Giraldo, A. Escobar & A. González



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Introduction

Dessert bananas and cooking bananas :

- Highly diverse source of starch
- Staple food for millions of inhabitants

Rationale & objectives

- Standardization of the methods of evaluation
- Evaluation of physicochemical & functional properties
- Identification & hierarchization of quality traits among consumption subgroups to ensure consumer acceptability

Method

➤ **Socio-economic surveys within communities of stakeholders for identification of consumer preferences**

- (i) Visit and selection of “fincas” with largest diversity
- (ii) Cooking workshops/demonstrations

➤ **Standardization of the methods & germplasm evaluation**

- (i) Selection/isolation of the raw material
- (ii) Physicochemical and functional characterization
- (iii) Chemical characterization during ripening

Banana genotypes & consumption groups

Dessert bananas

- AA – Sucrier, Samba,..
- AAA** – **Cavendish**, Gros Michel,..
- AB – Ney Poovan, Kunnan
- AAB – Silk, Pome, Mysore, ..
- ABB – Pisang Awack

Dessert bananas



Bocadillo (AA)



Primitivo (AA)



Gros Michel (AAA)



Cavendish (AAA)



Rollizo (AAA)



Tafetán morado (AAA)

Banana genotypes & consumption groups

Dessert bananas

AA	– Sucrier, Samba,..
AAA	– Cavendish , Gros Michel,..
AB	– Ney Poovan, Kunnan
AAB	– Silk, Pome, Mysore, ..
ABB	– Pisang Awack
AAAA	– FHIA hybrids, ..
AAAB	– FHIA hybrids

Dessert hybrids



FHIA 25 (AAAB)



FHIA 1 (AAAB)



FHIA 18 (AAAB)



FHIA 17 (AAAA)

Banana genotypes & consumption groups

Dessert bananas

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AAA	– Cavendish , Gros Michel,..
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ABB	– Pisang Awack
AAAA	– FHIA hybrids, ..
AAAB	– FHIA hybrids

Cooking bananas

EA-AAA	– Lujugira
ABB	– Bluggoe, Pelipita, Saba,..
AAT/AT	– Féhis
AAB	– Maia maoli,

Cooking bananas



Cachaco (ABB)



Guineo (EA-AAA)



Hua moa (AAB)



Pelipita (ABB)



Guayabo (AAB)

Banana genotypes & consumption groups

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Cooking bananas

EA-AAA	– Lujugira
ABB	– Bluggoe, Pelipita, Saba,..
AAT/AT	– Féhis
AAB	– Maia maoli, Plantains

Plantains (AAB)



Cubano blanco



Dominico



Hartón



Maqueño



África



Dominico Hartón

Banana genotypes and consumption groups

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Cooking bananas

AAEa	– Lujugira
ABB	– Bluggoe, Pelipita, Saba,..
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AAB	– Maia maoli, Plantains
AAAB	– FHIA hybrids,..

Cooking hybrids (AAAB)

FHIA 20



FHIA 21

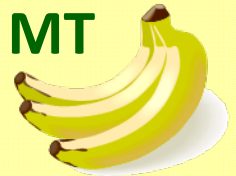


Banana genotypes & consumption groups

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69 MT



Cooking bananas

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AAB	– Maia maoli, Plantains
AAAB	– FHIA hybrids,..

41 MT



Socio-economic survey



Green
(index 1)



Half-ripe
(index 3-4)



Ripe
(index 6)



Overripe
(index 8)



- Identification of the varieties cultivated locally
- Cooking workshops to describe the consumption patterns & for hierarchization of preferences

Few consumption preferences

Process/use	D Harton	Guayabo	Guineo	Gros Michel	Bocadillo
<u>Fried products</u>					



Chips



Tostadas



Moneditas





Patacón pisado



Tostones

Few consumption preferences

Process/use	D Harton	Guayabo	Guineo	Gros Michel	Bocadillo
<u>Fried products</u>					
<u>Product texturization</u>					

Empanadas







Masa precocida



Marranitas

Few consumption preferences

Process/use	D Harton	Guayabo	Guineo	Gros Michel	Bocadillo
<u>Fried products</u>					
<u>Product texturization</u>					
<u>Boiled products</u>					

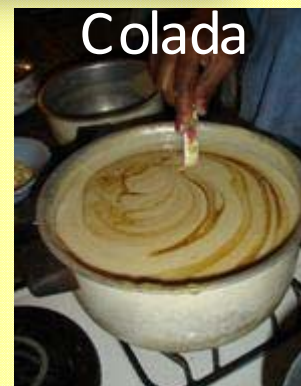


Sancocho



Cooking with peel

©2008 karmafreecothing



Colada

Few consumption preferences

Process/use	D Harton	Guayabo	Guineo	Gros Michel	Bocadillo
<u>Fried products</u>					
<u>Product texturization</u>					
<u>Boiled products</u>					
<u>Intermediate products</u>					



Raw and pre-cooked flour



Few consumption preferences

Process/use	D Harton	Guayabo	Guineo	Gros Michel	Bocadillo
<u>Fried products</u>					
<u>Product texturization</u>					
<u>Boiled products</u>					
<u>Intermediate products</u>					

Adapted from Quintero et al. 2009 in Gibert et al. 2009

Consumption modes/preferences

- great diversity of cultivated varieties identified (> 30) ¹
- various consumption patterns (6 modes) ¹
- preferences based on the selection of varieties at a specific stage of ripeness for a use (4 stages)

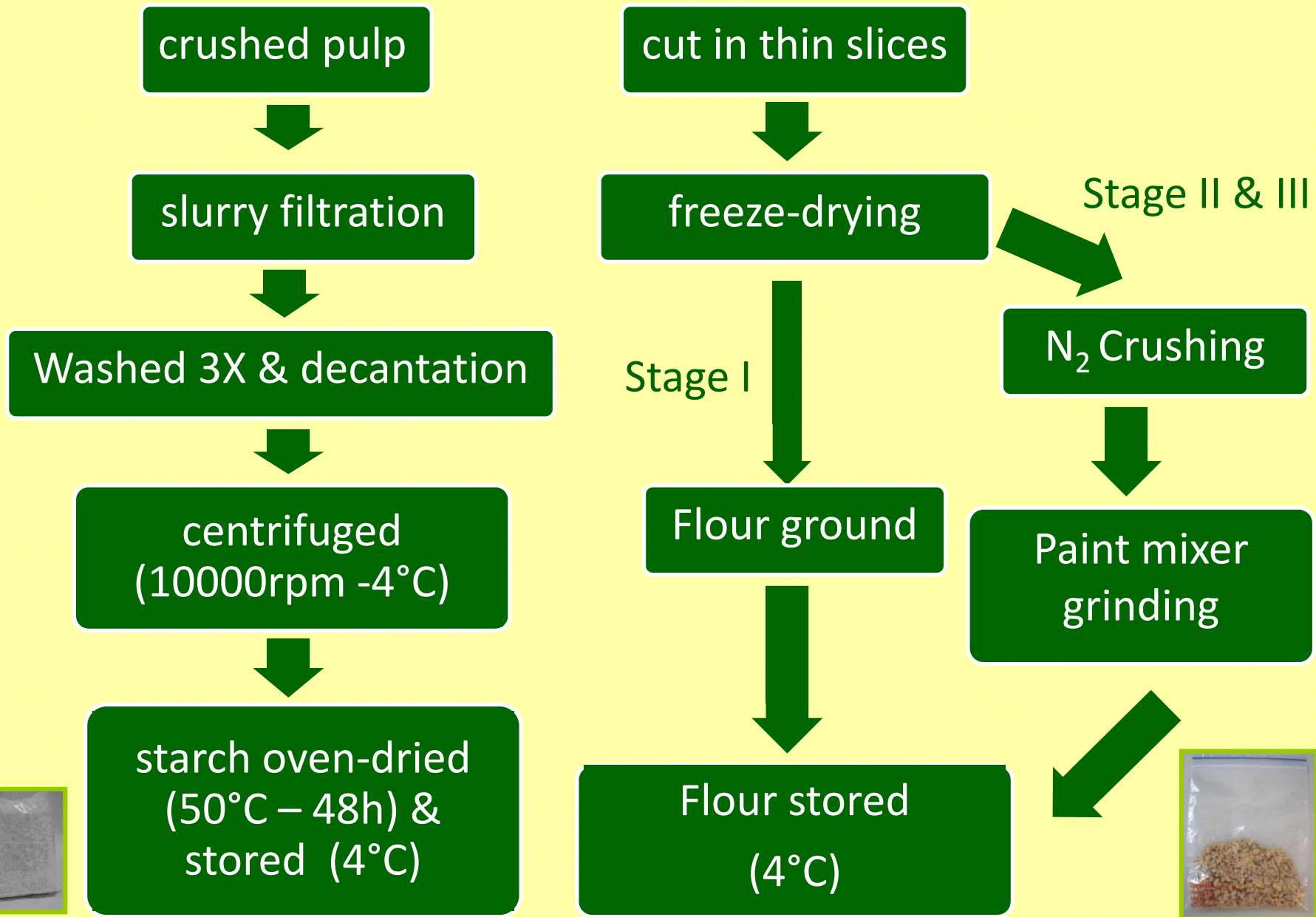


Is it possible to identify some objective quality traits to:



- *differentiate genotypes & banana subgroups?*
- *to justify the consumption patterns/acceptability at various stages of ripeness ?*

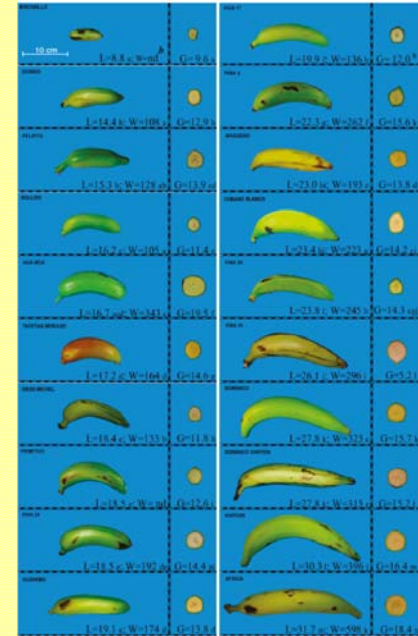
Starch & flour Isolation: an accurate method



Germplasm evaluation

➤ Morphological characterization

Bunch/finger dimension & weight distribution, edible fraction,...



<p>BOCADILLO</p>  <p>L=8.8 a; W=nd^b</p> <p>G= 9.6 a</p>	<p>FHIA 17</p>  <p>L=19.9 f; W=136 b</p> <p>G= 12.0^h</p>
<p>GUINEO</p>  <p>L=14.4 b; W=108 a</p> <p>G=12.9 b</p>	<p>FHIA 1</p>  <p>L=22.3 g; W=262 f</p> <p>G=15.6 k</p>
<p>PELIPITA</p>  <p>L=15.3 b; W=128 ab</p> <p>G=13.9 cd</p>	<p>MAQUEÑO</p>  <p>L=23.0 hi; W=193 e</p> <p>G=13.8 d</p>
<p>ROLLIZO</p>  <p>L=16.2 c; W=105 a</p> <p>G=11.4 e</p>	<p>CUBANO BLANCO</p>  <p>L=23.4 hi; W=223 g</p> <p>G=14.2 cj</p>
<p>HUA MOA</p>  <p>L=16.7 acd; W=343 c</p> <p>G=19.5 f</p>	<p>FHIA 20</p>  <p>L=23.8 i; W=245 h</p> <p>G=14.3 cgj</p>
<p>TAFETAN MORADO</p>  <p>L=17.2 d; W=164 d</p> <p>G=14.6 g</p>	<p>FHIA 21</p>  <p>L=26.1 j; W=296 i</p> <p>G=5.2 l</p>
<p>GROS MICHEL</p> 	<p>DOMINICO</p> 

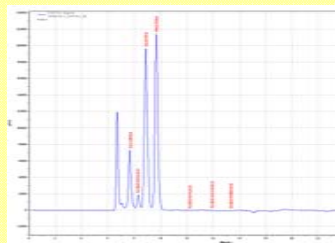
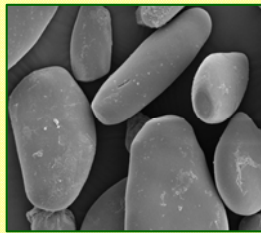
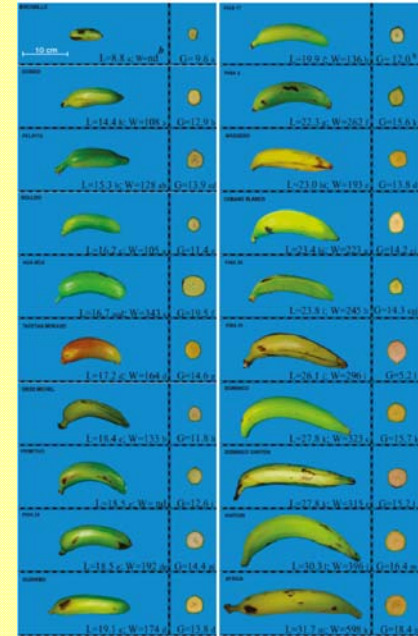
Germplasm evaluation

➤ Morphological characterization

Bunch/finger dimension & weight distribution, edible fraction,...

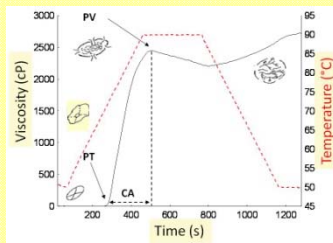
➤ Physicochemical characterization

pH, TA, DM, specific gravity, ash, TSS, soluble sugars, organic acids, proteins, starch content, crude fiber, minerals, texture



➤ Functional characterization

Pasting & thermal properties

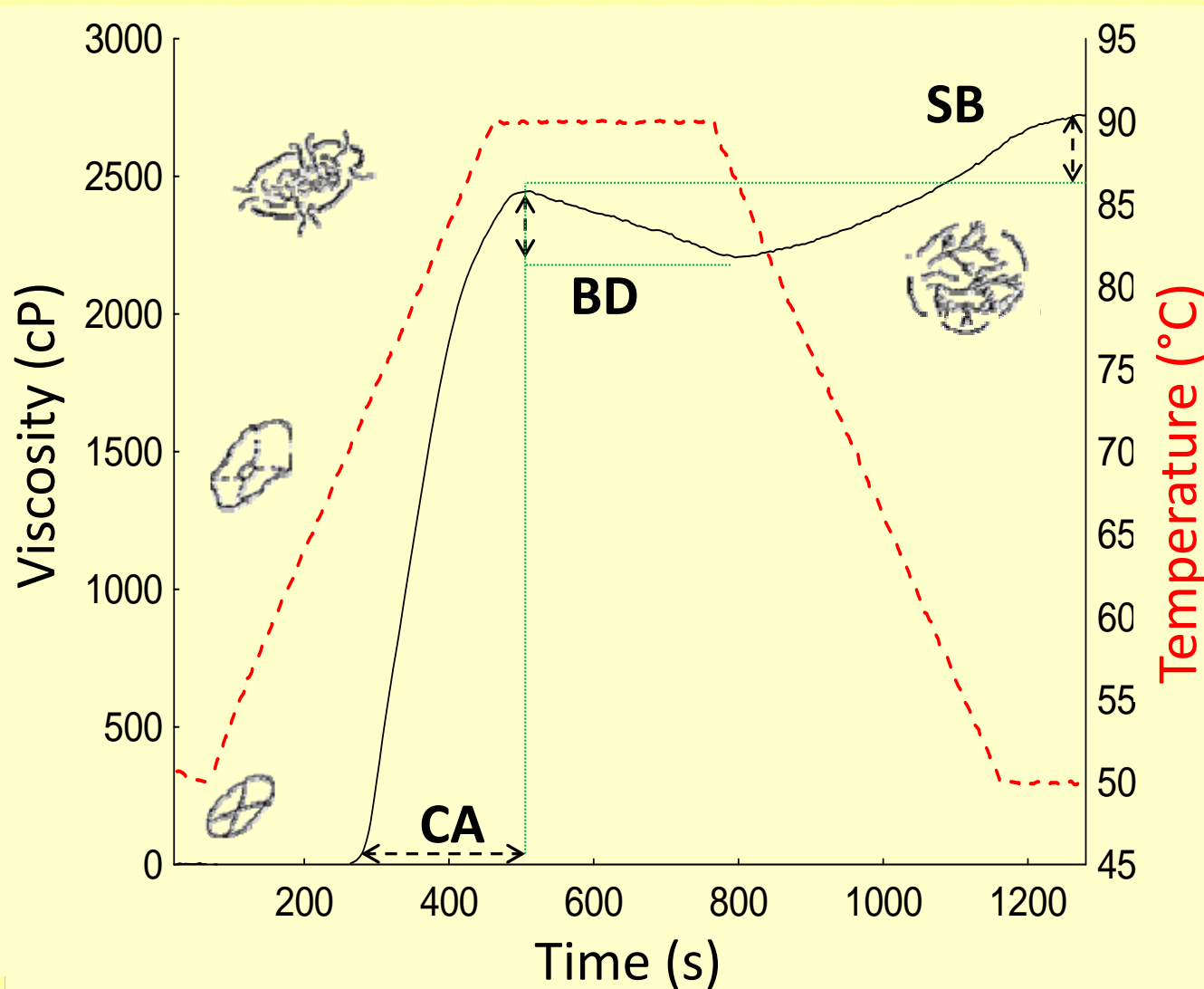


Gibert et al., JAFC 57, 2009, err. 58, 2010

Dufour et al., JAFC 57, 2009

Gibert et al., JFE, 2010

Pasting properties by RVA



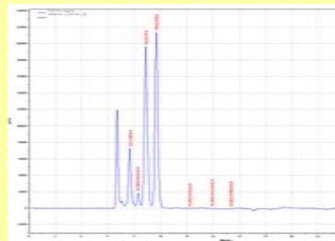
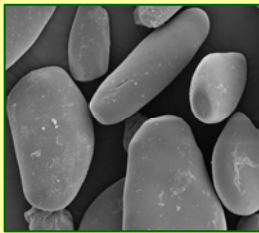
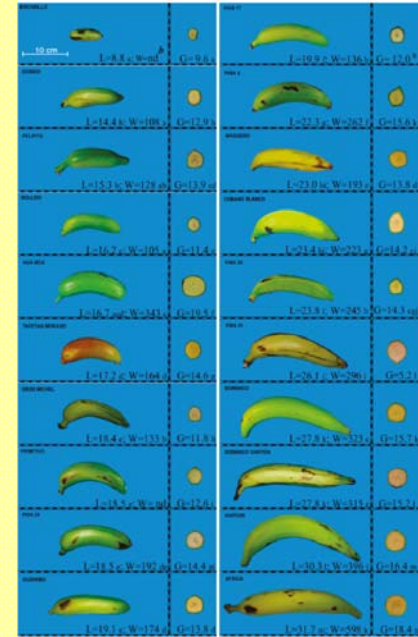
Germplasm evaluation

➤ Morphological characterization

Bunch/finger dimension & weight distribution, edible fraction,...

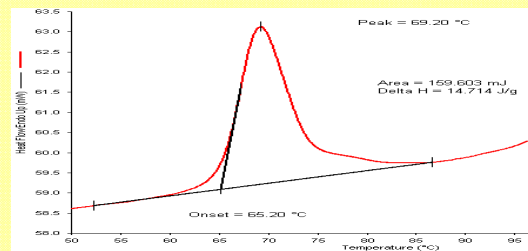
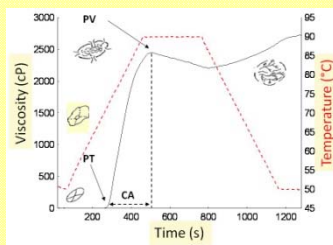
➤ Physicochemical characterization

pH, TA, DM, specific gravity, ash, TSS, soluble sugars, organic acids, proteins, starch content, crude fiber, minerals, texture



➤ Functional characterization

Thermal & pasting properties

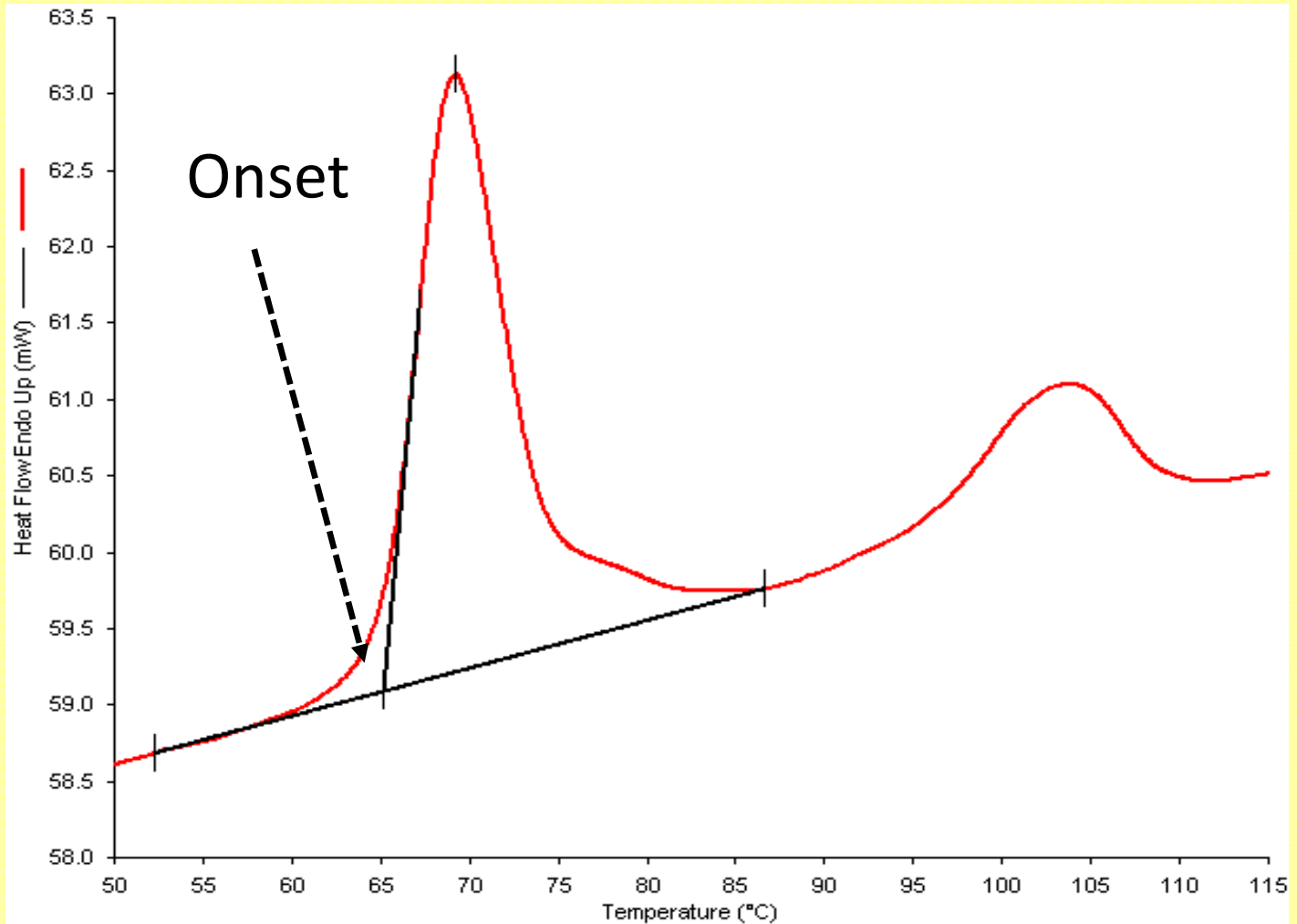


Gibert et al., JAFS 57, 2009, err. 58, 2010

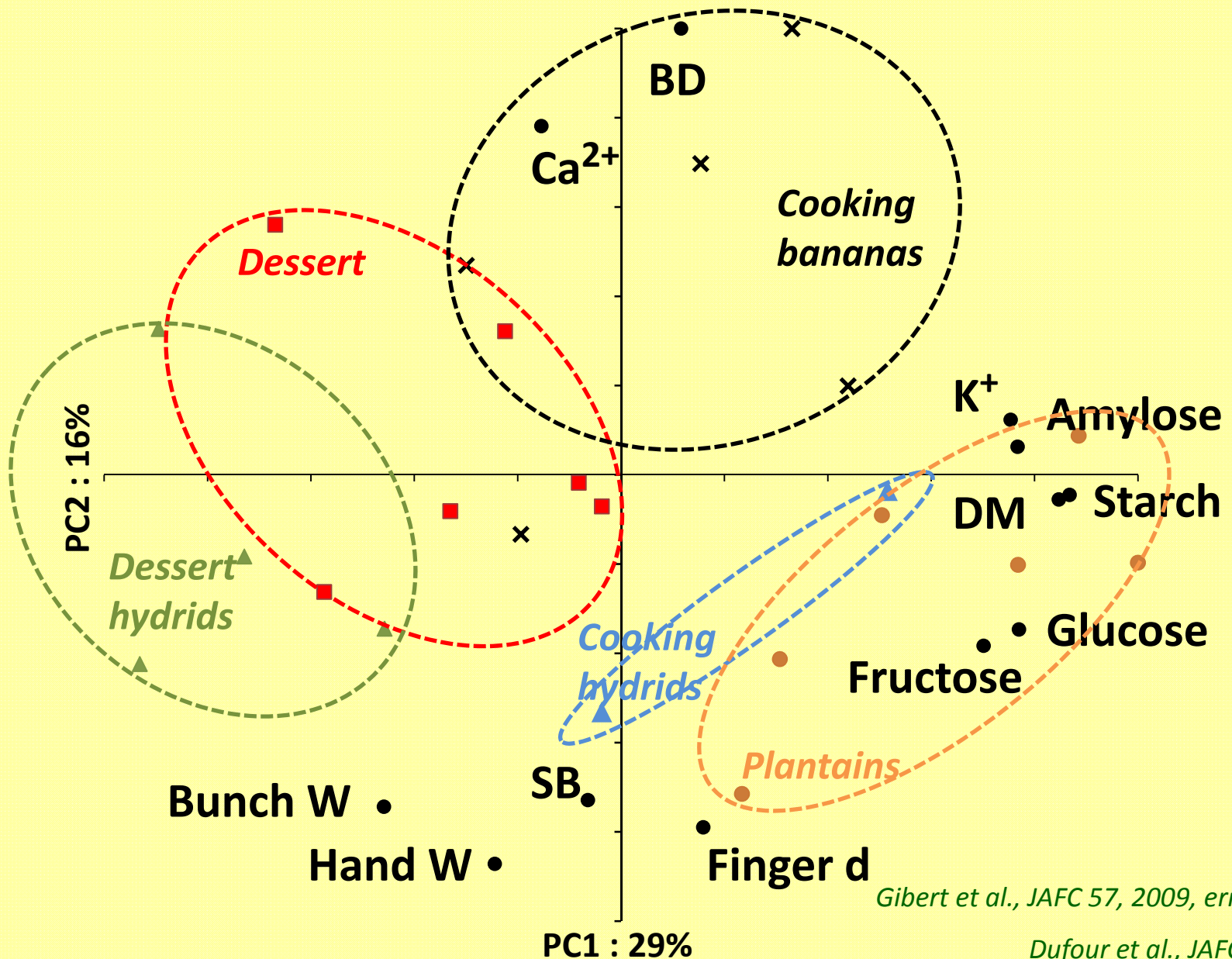
Dufour et al., JAFS 57, 2009

Gibert et al., JFE, 2010

Functional properties by DSC



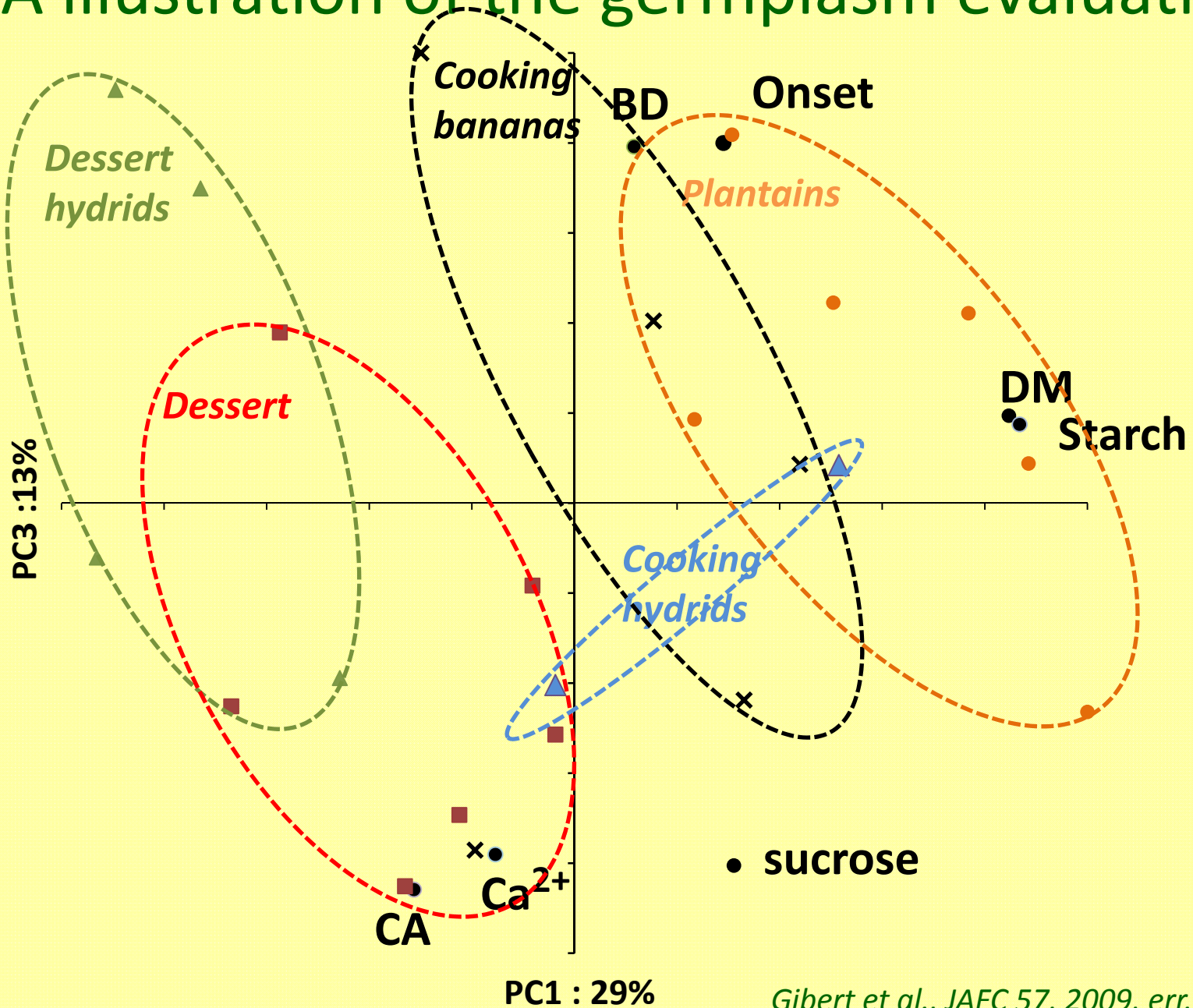
PCA illustration of the germplasm evaluation



Gibert et al., JAF 57, 2009, err. 58, 2010

Dufour et al., JAF 57, 2009

PCA illustration of the germplasm evaluation



Gibert et al., JAF 57, 2009, err. 58, 2010

Dufour et al., JAF 57, 2009

How to guaranty consumer acceptability ?

➤ A specific firmness ^{1,2}

➤ A specific appearance ³

➤ A « flavor profile » ¹ :

- volatile compounds ⁴

- taste  Presence of starch ⁵

 Sweetness : glu, fru, suc ⁶

 Sourness : malic, citric & TA ^{1,7}

 Astringency : oxalic ⁸



*Ripening influence on OA & soluble sugars ?
Any differences among genotypes?*

¹ Veirmer et al. 2009;

² Gibert et al. 2010;

³ Garutti et al. 2010;

⁴ Aurore et al. 2011;

⁵ Soares et al. 2011;

⁶ Kyamuhangire et al. 2002;

⁷ Bugaud et al. 2011;

⁸ Shimokawa 1972

Ripening stage definition

13 varieties harvested at optimal green stage



Stage I

13 varieties let to ripen until being fully-ripe



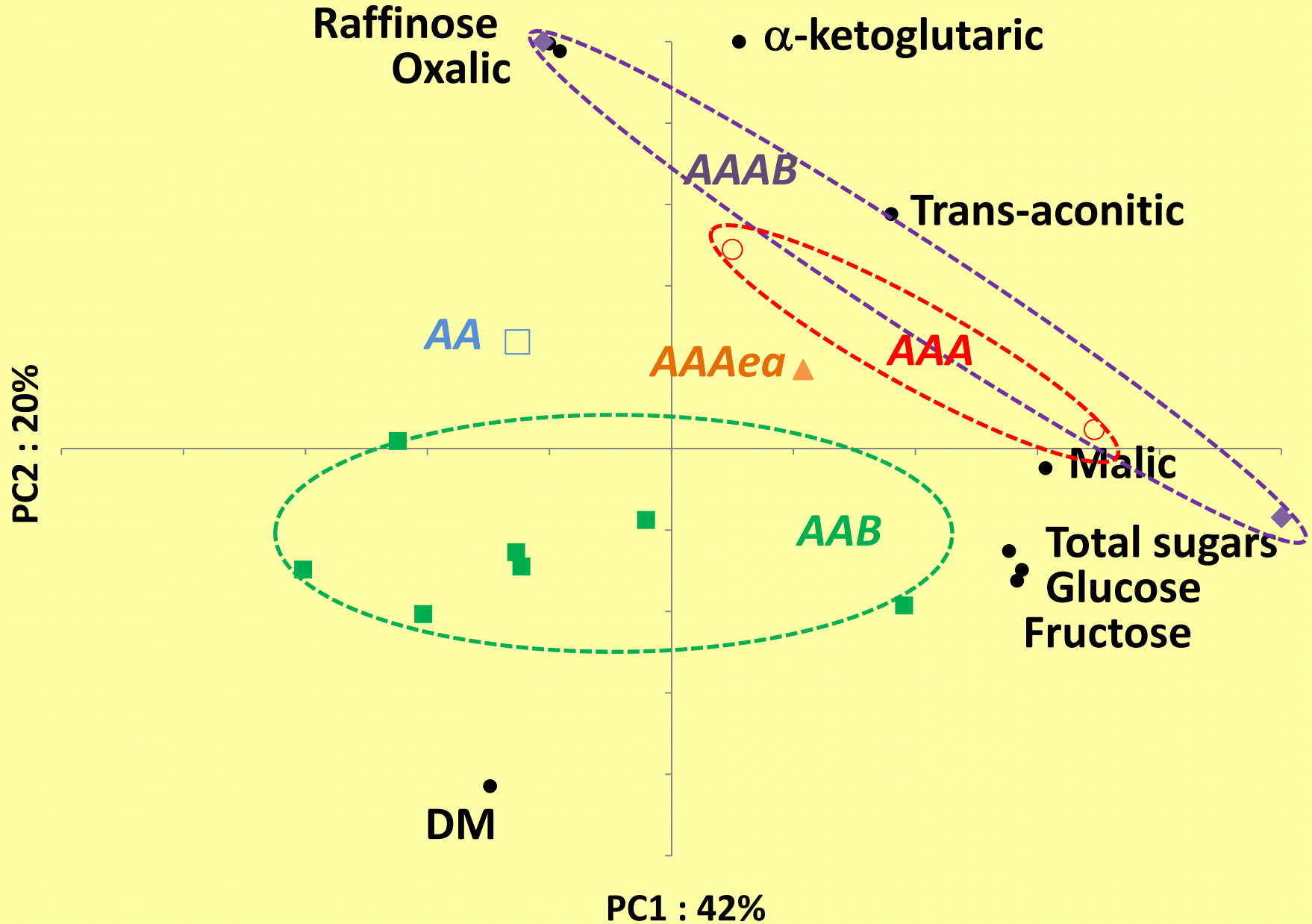
Stage II

13 varieties let to ripen until being over-ripe

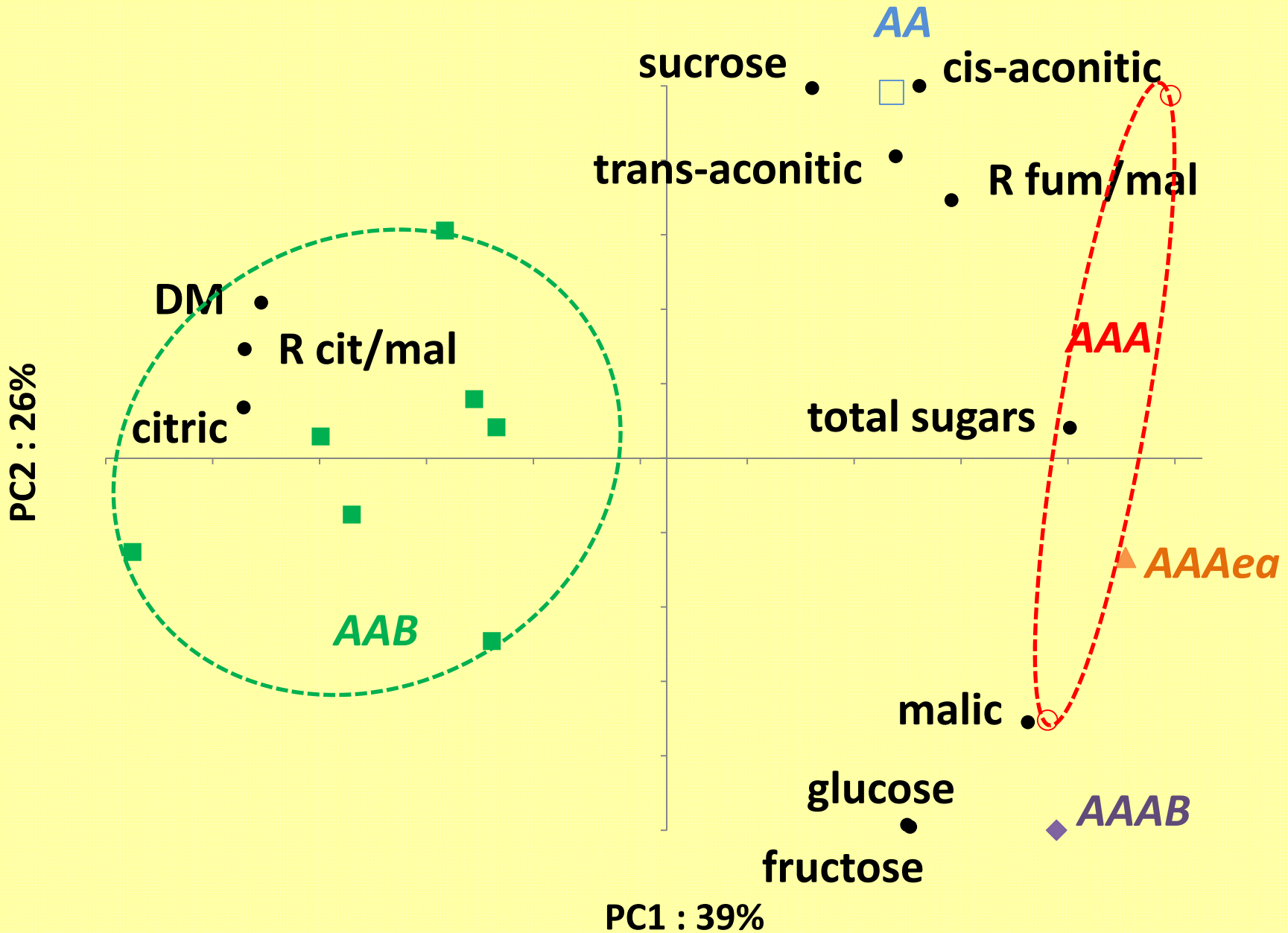


Stage III

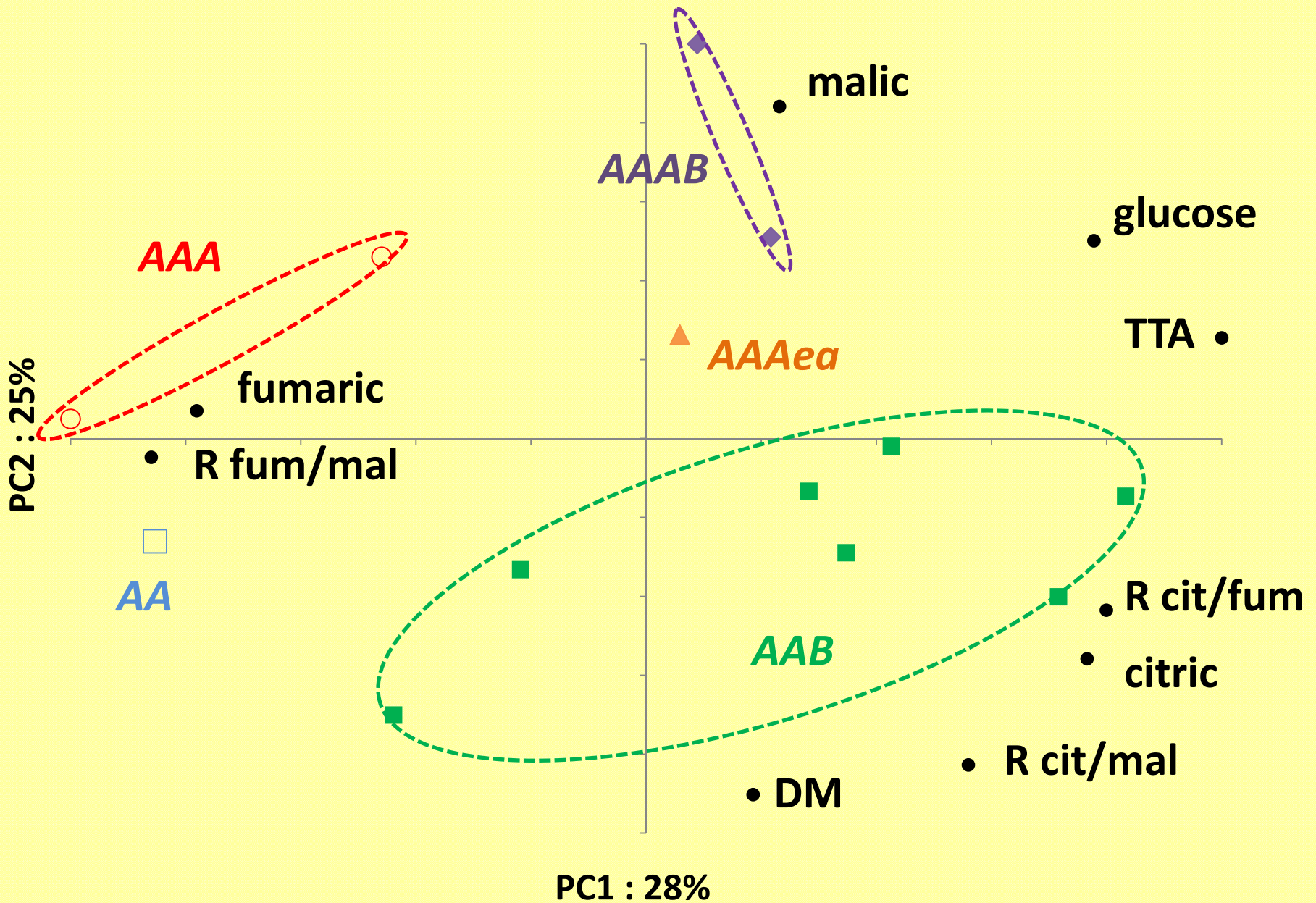
Soluble sugars & organic acids : *stage I*



Soluble sugars & organic acids : *stage II*



Soluble sugars & organic acids : *stage III*



Quality traits: a hierarchization trial & limits

	Attribute	Issue	Limitations
Morphological	•Hand w-finger w Finger d	•Differentiation pl-cook. des. hyb.	•Cooking behavior? Sensorial acceptability?
	•Edible food fraction	•Yield & productivity	
	•Spatial dimensions	•Intra bunch variability (sampling strategy) Potential for industrial application	•Edaphoclimatic conditions
Functional	•Onset temp. Breakdown (BD) Setback (SB) Cooking ability (CA)	•Sensorial acceptability Prediction of cooking behavior Industrial formulation & neglected var. valorization	•Environmental contribution & interaction with genetic origin

Quality traits: a hierarchization trial & limits

	Attribute	Issue	Limitations
Physicochemical	•DM- Starch Amylose	•Differentiation between subgroups at stages I, II, III Potential for processing	•Environmental contribut. & interaction with genetic origin
	•Ca ²⁺ , K ⁺	•Subgroup differentiation	•Farming practices
	•Pulp firmness	•Sensorial acceptability Differentiation on consumption mode	•Dependence on stage of ripeness
	•Soluble sugars	•Genotype differentiation Fermentation ability	•Dependence on stage of ripeness
	•Organic acids	•pH or TA prediction	•Relationship with sensorial acceptability to established

Prospects..

- Validation of prioritized traits
- Environmental contribution to hierarchized traits
- Taste prediction (sweetness, taste & aroma dynamics) based on chemical attributes, with genotype/ripening stage
- *“Full use of genetic diversity through consumer-oriented evaluation”* :
 - adding value to neglected varieties
 - contributing to breeding strategy improvement
 - ensuring consumer acceptability



**Thank you for
your attention**

**Obrigado pela
sua atenção**

olivier.gibert@cirad.fr