Combined effect of drying conditions and starch composition on breadmaking ability of sour cassava starch

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INTRODUCTION

- Cassava starch modified by fermentation and UV irradiation acquires bread making ability.
- Exhaustive works have been performed to try to better understand sour starch breadmaking ability but to date are still not fully elucidated.
- The aim of this work is to contribute to a better understanding of sour cassava properties, and to highlight the effects of varietal, altitude and process parameters on the breadmaking ability.

Manufacturing process of sour starch:

Cassava fecula extraction → Spontaneous Lactic Fermentation (30 – 40 days) → Sun drying or UV → Sour cassava starch

Interest:

- Empirical processing
- Irregular product quality
- Dependence of climatic conditions

- Good breadmaking ability

gluten free

The Problematic:

What produces breadmaking ability?
A mechanism of starch degradation not fully elucidated

2 hypothesis

Molecular scale
- Free radical formation
- Oxidation
- Depolimerisation

Supramolecular scale
- Behavior of starch granule during gelatinisation

Objectif → **Comprehension of determinant factors to predict breadmaking ability of sour cassava starch**

Specific objectif → **Importance of treatment effet Vs varietal effect**

MATERIALS

13 cassava starches (CIAT - Colombie) x 4 treatments

- **3 lowlands (1000 m)**
- **10 highlands (1700 m)**

1) Non fermented oven-dried (NFO)
2) Non fermented sun-dried (NFS)
3) Fermented oven-dried (FO)
4) Fermented sun-dried ¨*Rallanderia*¨ (FSR)

METHODS

a) **Breadmaking test**, recipe with pregelatinization, included lipids. **[1]**
b) **Pasting properties**, performed with a RVA-4 Series (Newport). Protocol according with Sanchez et al. **[2]**
c) **Particular size** performed with a Mastersizer 2000 (Malvern).
d) **Intrinsic viscosity** to determine molecular weight.
e) **Amylose content**, performed with a DSC 7 (Perkin-Elmer) from the energy of amylose–lysophospholipid complex. Protocol according with Mestres et al. **[3]**

RESULTS

Good breadmaking ability after fermentation + sun-drying (FSR) and notably in highland varieties

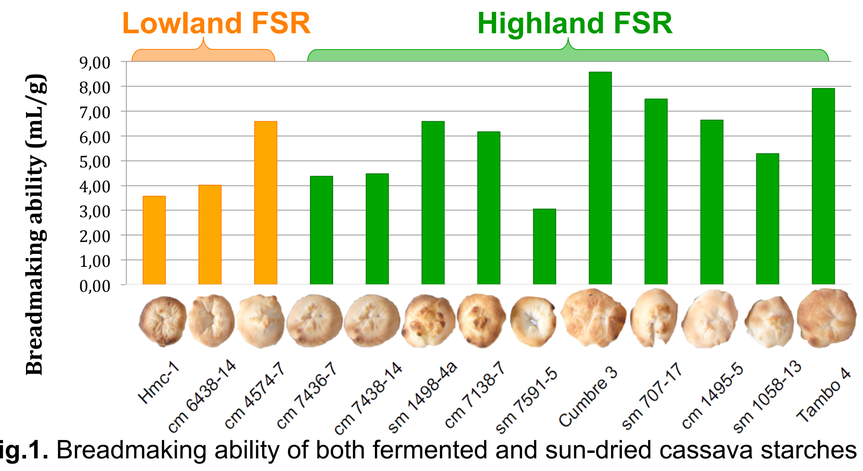


Fig.1. Breadmaking ability of both fermented and sun-dried cassava starches (FSR).

Highland varieties seem to be different to lowland:
- **More marked sensitivy to sun-drying**
- **Different molecular structure, probably**.

Hypothesis established from pasting properties, intrinsic viscosity and granule size.

Amylose influence negatively dough expansion
(possibly amylose-lipid complex formation)

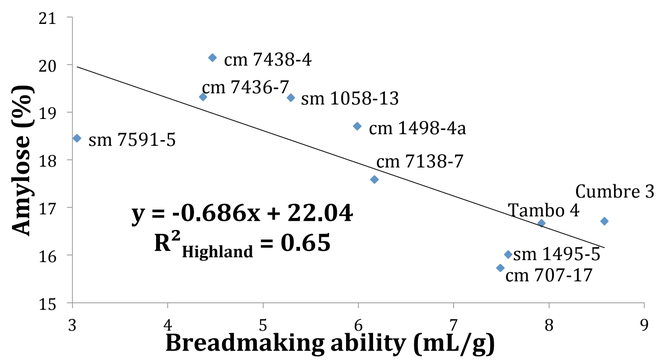
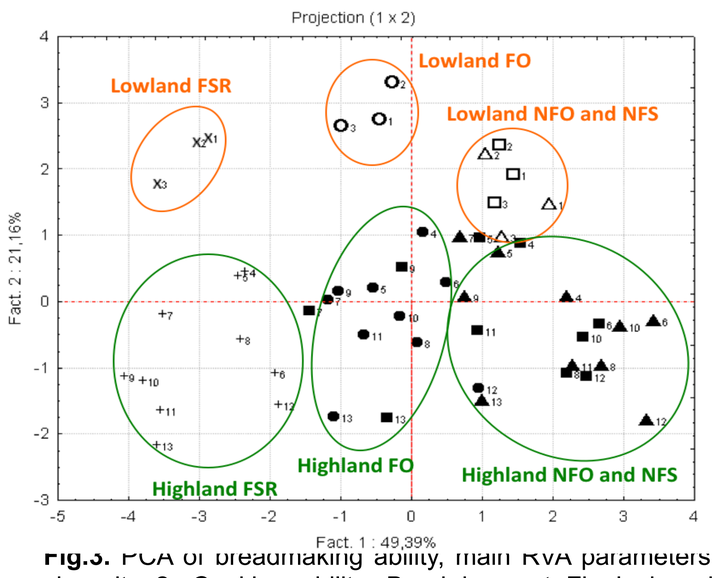


Fig.2. Negative correlation between amylose content and breadmaking ability.

Treatment effect better than varietal effect



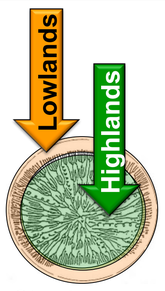
Legend	
NFO	Non fermented oven-dried
NFS	Non fermented sun-dried
FO	Fermented oven-dried
FSR	Fermented sun-dried ¨Rallanderia¨
1	Hmc-1
2	Cm 6438-14
3	Cm 4574-7
4	Cm 7436-7
5	Cm 7438-4
6	Sm1498-4a
7	Cm7138-7
8	Sm7591-5
9	Cumbre 3
10	Cm 707-17
11	Sm 1495-5
12	Sm1058-13
13	Tambo 4

Fig.3. PCA of breadmaking ability, main RVA parameters (Pasting temperature, Peak viscosity 2, Cooking ability, Breakdown et Final viscosity) and granule size of 13 cassava varieties in 4 treatments: NFO (△, ▲), NFS (□, ■), FO (O, ●) and FSR (x, +).

Mechanism of starch damage:

Located at both: at supramolecular level and at molecular level.

1. At **supramolecular level** occurring main during **fermentation.** The site of preferential damage depends of **cultivation altitude** (differences in particle size, RVA and intrinsic viscosity analyses):
   1.1. In **Highland varieties** granules were damaged **throughout their structure**
   1.2. In **lowland varieties** granules were attacked **only on their surface**, only off the outer layers of the granules was shaved, leading to smaller granules with mostly intact cores.
2. At **molecular level, fermentation** and **sun-drying treatments** may also damage structure, i.e. by molecular weight reduction or depolymerization mechanisms.



Varieties	Granule size decrease[1] (%) (NFO Vs FO)	Relative Break Down increase[1] (%)	Intrinsic viscosity decrease[2] (%)
Lowland	9.1	Not signif.[3]	Not signif.[3]
Highland	Not signif.[3]	32.5	26.4

[1]No statistically significant differences, [2]Results of 13 varieties, [3]Results of 7 varieties

Superficial Dammage | **Weakening of internal granular structure**

Fig.4. Altitude effect linked to different location of granule starch damage occurring during fermentation.

CONCLUSION

- Post-harvest treatments were prevailing factors in improving breadmaking ability, while the varietal factor also had some influence.
- Fermentation had a more pronounced effect than sun-drying, but the combination of both treatments improved dough expansion.
- Amylose content influenced negatively dough expansion, possible amylose-lipid complex formation.
- The mechanism of starch degradation was located at supramolecular and molecular level:
  - At supramolecular level it occurs mainly during fermentation. It depends on cultivation altitude: lowland varieties were attacked on their surface whereas highlands throughout their center. In highlands, breadmaking ability was better than lowlands, perhaps due to more extensive granule collapse during gelatinization, consequently better film formation around the bubbles of steam driving dough expansion.
  - At molecular level, fermentation and sun-drying treatments may also damage starch structure,
- Further investigations extend the understanding of the relative influences of molecular and supra-molecular phenomena in determining breadmaking properties of cassava sour starch.

Literature cited:
[1] Laboratorio de calidad de raices 2009 (CIAT), “Protocolo de panificación”
[2] Sanchez et al. 2009, “Screening of Starch Quality Traits in Cassava”
[3] Mestres and Rouau 1997, “Influence of Natural Fermentation and Drying Conditions on the Physicochemical Characteristics of Cassava Starch”