Discovery of natural waxy cassava starch.
Evaluation of its potential as a new functional ingredient in food.

Sanchez Teresa[1*], Dufour Dominique[1&2*], Morante Nelson[1], Ceballos Hernan[1]

1. CIAT, Cassava Program, AA6713, Cali, Colombia.
2. CIRAD, UMR Qualisud, BP34038, Montpellier, France.

* Corresponding authors: t.sanchez@cgiar.org / dominique.dufour@cirad.fr

Introduction

The lack of amylose in starch means that it gelatinizes easily; yielding clear pastes with higher viscosities. An important property of waxy starches that promotes their use in food products is their improved freeze–thaw stability compared to normal starches. Cassava (*Manihot esculenta* Crantz) is one of the most important sources of commercial production of starch in tropical and subtropical countries (Moorthy, 2004). Average amylose content in a sample of more than 4000 different cassava genotypes was reported to be 20.7%, ranging from 15 to 26% (Sánchez *et al,* 2009). Until recently there was no reported qualitative variation in cassava starch from naturally occurring mutations. An amylose-free transgenic event had been reported earlier (Salehuzzaman *et al.*, 1993). This work reported the discovery of the first natural waxy cassava genotype (AM206-5) in CIAT and further studies on gel behavior and chemical and technological physical stresses. Methodologies used to obtain the results described above were extensively reported (Ceballos *et al.* 2007 ; Sánchez *et al,* 2010).

Screening in search of novel starch in cassava at CIAT.

SDS-PAGE demonstrated abnormality in the GBSS enzyme in the starch of AM206-5. No change in starch granule size or shape was observed in comparison with normal cassava starch. Genotype AM206-5 showed a unique and distinctive staining when treated with an iodine solution **(Figure 1).** Colorimetric and DSC amylose content for starch from AM206-5 was 3.4 and 0%, respectively, in comparison with normal cassava starch (20.7%; 19.0%). Paste clarity in AM206-5 ranged from 57 to 61% compared with normal cassava starch (45.2%). Other comparisons between functional properties of the starch from AM206-5 and normal cassava were as follows: wavelength of maximum absorption (λmax), (535 nm vs. 590 nm); swelling power (54.7% vs. 40%); solubility at 90°C (8.8% vs. 7.3%); pasting properties (RVA 5%): pasting temperature (67.4°C vs. 63.9°C); maximum viscosity (1119 cP vs. 954 cP); and breakdown (631 cP vs. 479 cP).

All analysis reported converge to support the hypothesis that genotype AM206-5 has amylose-free (waxy) starch.

Waxy Cassava Starch under Thermal, Chemical, and Mechanical Stress

The evaluation of gel stress resistance was also compared with other industrial roots, tubers and cereal starches. Stress resistance of waxy cassava starch was similar to normal cassava except for alkaline pH, at which it showed a lower effect.

Syneresis in gels maintained in refrigerated conditions for up to five weeks is illustrated in **Figure 2**. The highest syneresis values were observed in gels from normal maize, rice and potato starches and COLFLO® 67. Gels from waxy potato had much lower syneresis than its normal counterpart, but it was still measurable. Gels from waxy maize, rice and cassava as well as normal rice and cassava starches (CM 523-7 and MPER 183) had negligible levels of syneresis showing a very stable behavior under storage at 4 °C.

Syneresis, evaluated as a parameter for freeze/thaw stability, is illustrated in **Figure 3.** The largest values were observed in normal potato, maize and rice starches and COLFLO® 67, with magnitudes increasing consistently through time. Waxy potato and maize starches had a significantly lower syneresis values compared with their normal counterparts, and had a performance similar to several normal cassava starches. Waxy cassava and rice starches showed a very interesting performance with no syneresis measurable up to five weeks under freezing conditions (Sánchez *et al*, 2010).

This finding agrees with results on transgenic waxy cassava starch already reported and highlights an advantage of using waxy cassava in comparison with other waxy and non-waxy starches. Raemakers *et al.*, 2005 reported that after three freeze/thaw cycles the only starch showing no syneresis was the amylose-free transgenic cassava starch. Gels from normal root and tuber starches (potato, cassava) after refrigeration and freeze/thaw had lower syneresis than cereal starches (maize, rice). Natural waxy cassava starch is, therefore, a promising ingredient to formulate refrigerated or frozen food.

CIAT is producing new waxy genotypes especially for Thailand, and Brazil the biggest world cassava starch producers as well as Colombia and Nigeria (IITA). In a recent evaluation, 25% of large segregating populations (>11,500 genotypes) was waxy. Agronomic evaluation is underway for a release of a waxy starch commercial variety for Thailand.

References

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Figures

Figure 1. Differential staining with iodine of roots of a normal cassava clone (stained blue) and AM206-5 (stained reddish brown).

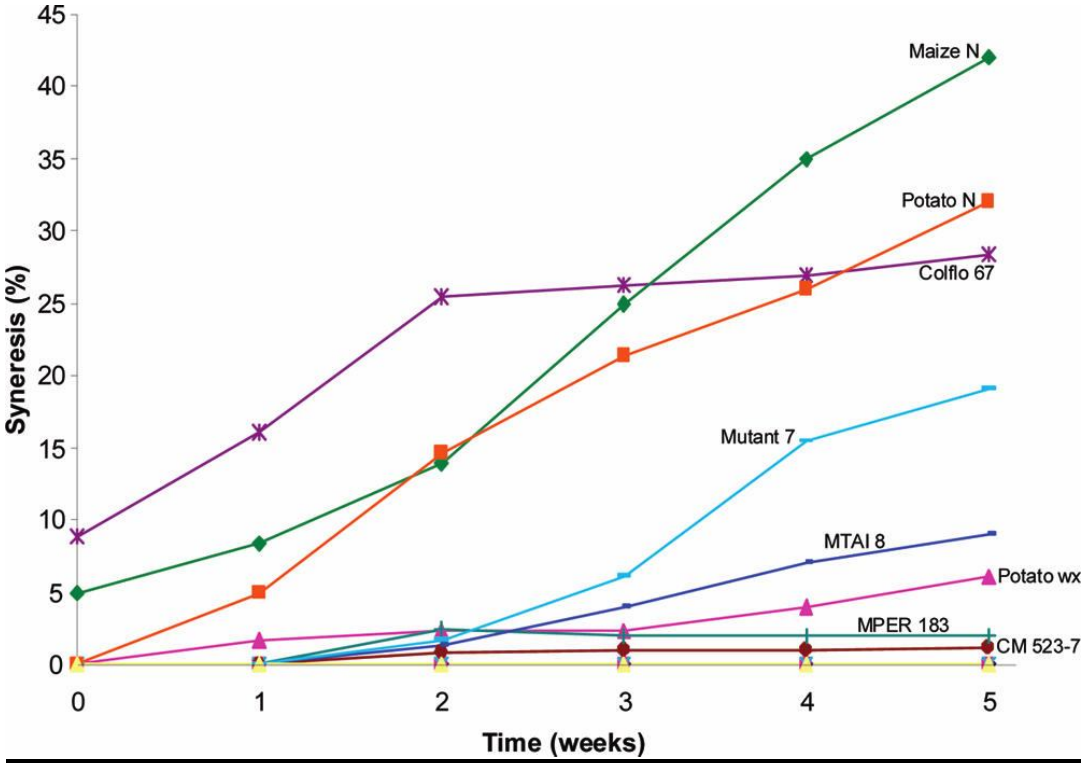

Figure 2. Refrigeration stability for up to 5 weeks of gels from different types (normal, waxy, or modified: colflo67) of starches from different crops (maize, potato, rice, and cassava: Mutant7, MTAI8, MPER183, CM523-7).

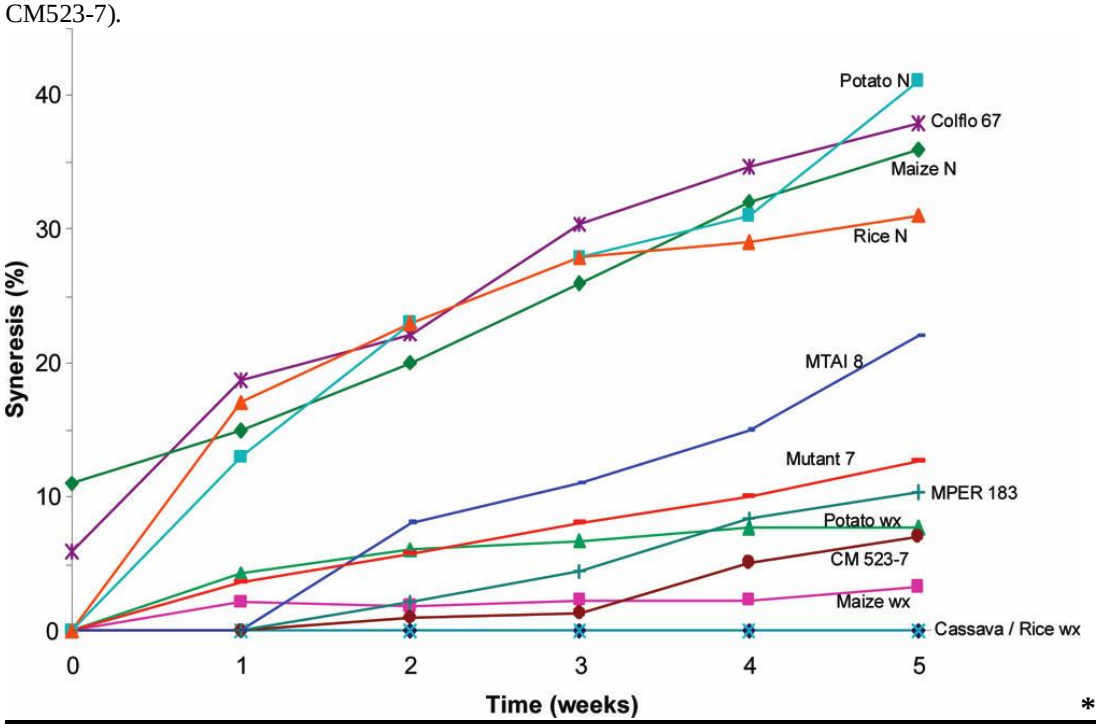

Figure 3. Freeze/thaw stability for up to 5 weeks of gels from different types (normal, waxy, or modified: Colflo67) of starches from different crops (maize, potato, rice, and cassava: Mutant7, MTAI8, MPER183, CM523-7).