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# Selecting tomato for their ability to react and conserve their quality during the process

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## Abstract

**The quality of tomato based products greatly depends on their color and viscosity, which are influenced by the fruit capacity of modifying their properties according to the processing route. Loss of viscosity due to intrinsic pectin modifying enzymes (also called 'fruit reactivity') is known and used to produce either hot break (HB) purees, more viscous, or cold break (CB) ones, less viscous. Color reactivity, even if less documented, also exists as HB/CB purees differ.**

**This fruit reactivity, although essential for quality purpose, remains almost neglected from breeders. In order to verify if reactivity could be considered as a heritable trait, we measured it through a "quick and dirty" laboratory scaled process and a systematic measurement of the loss of texture and color according to HB or CB process.**

**The results indicated that fruits can be classified according to their capacity of being impacted by the process. For viscosity, some genotypes exhibited a strong capacity for producing highly viscous purees but also exhibited a strong fruit reactivity, indicating that their advantage may be quickly lost during the process if the first break step is not efficient enough, or in case or cold break processing. On other hand, some genotypes exhibited a very low reactivity to process. Reactivity was also greatly reduced by a low irrigation level. And finally, a parallel processing at laboratory or pilot scale indicated that the behavior of a 10-fruits sample in microwaves was correlated to the quality observed in traditional scrapped surface tubular eating system. The color of purees was also influenced by the fruit reactivity, but the enzymatic basis for the color change seemed disconnected from the one controlling viscosity.**

**Those results open the door for a more efficient screening of tomato varieties based not only on the fruit composition, but also on their ability to react to the process.**

**Keywords:** Fruit quality, viscosity, color, tomatoes, processed products

## 1. INTRODUCTION

The quality of tomato products depend on their colour and their consistency, traditionally evaluated through Bostwick measurement. Consistency results from the biochemical as well as the structural properties of purees. The dry matter content is known for long as a major parameter related to consistency. Product concentration performed in industry through water evaporation result indeed in more viscous product. This evaporation is traditionally followed by the measurement of the refraction index (RI) (generally expressed in 'Brix' degree). Therefore, by extension, the 'Brix' value became a reference measurement to measure the fresh tomato quality, in order to predict the processed product quality.

However, 'Brix' is a weak marker of puree quality. Indeed, the consistency of fruit purees is influenced by many other factors than soluble solid content. First of all, the dry matter content (DMC) is also constituted of 'structural' solid, (mainly fruit cell-wall material), which may represent up to 10% of the DMC, and which is not evaluated by IR (Ścibisz et al., 2011). It contains polysaccharides like pectin, highly influent on puree viscosity. As a result, in a large range of varieties, RI and DMC are not fully correlated (Arbex de Castro Vilas Boas et al., 2017). Moreover, many other parameters influence the apparent viscosity. Volume, shape and sizes of particles as well as the viscosity of the serum has been described as influent for the viscosity of apple and tomato purees (Espinosa-Muñoz et al., 2013). Finally, the processing route, depending if time/temperature parameters allow for the activity of fruit pectinolytic enzymes (like in cold break processing route), highly modulate the viscosity (Anthon et al., 2002; Barrett et al., 1998). Fruit enzymatic reactivity, as depending on their enzyme content, may also constitute a valuable genetic parameter to qualify varieties for their ability to produce high quality product.

The objective of this work was to evaluate, on a large range of samples representative of the French tomato, the variability of quality parameters such as viscosity, colour and dry matter content. We also systematically apply a laboratory scale hot break (HB) and cold break (CB) processing, to evaluate the HB/CB difference of viscosity (delta). As being due to pectinolytic enzyme activity, this delta was considered as a marker of the intrinsic reactivity of the fruit. Its variability among samples and their correlation to quality parameters was evaluated.

## 2. MATERIAL AND METHODS

### 2.1. Plant material

In 2015, tomatoes were collected from experimental trials performed by the French professional organisation of industry tomato (SONITO). A large variability of tomato fruits was obtained by collecting fruits of different varieties, from different areas of production (South-East and South-West of France) and harvested as full ripe fruits (according to commercial standard). 88 samples, corresponding to 39 genotypes were collected.

For each sample, 15 tomatoes were cut into pieces of 2 to 4 cm side, and separated as two identical samples prior to processing.

In 2016, 8 batches of 250kg of tomatoes corresponding to two varieties (H1311 and Terradou) were grown in an experimental field including two irrigation regimes (Arbex de Castro Vilas Boas et al., 2017).

### 2.2. 'lab' scaled processing:

Each sample collected in 2015 were processed alternatively by hot break (HB) or cold break (CB) standard processing (Page et al., 2012). Quickly described: HB treatment consist in first heating the fruits (microwave oven) and then grinding them whereas, in CB treatment, tomatoes were first ground, macerated at room temperature for 30 seconds (allowing for intrinsic enzyme reaction) and then heated as for HB. The two processing routes used the same heating and grinding energy, but the order of operation units changed. After cooking, purees were stored into 400 ml glass jars, pasteurized (100°C, 15 min) and stored at 4 °C until analyses. HB/CB standard processing induce a difference of viscosity due to intrinsic enzymatic activities of fruits, and was, therefore considered as a proper genetic trait, so called 'reactivity of the fruit' in this study.

### 2.3. Pilot plant processing:

Each of the 8 batches batches collected in 2016 were HB/CB processed in a pilot: For HB, break temperature was fixed at 95°C, and then stabilization was for 5 min at 95°C by a scraped-surface heat exchanger. For CB, tomatoes were crushed in the same hammer mill as for HB, but macerated for 10 min at a break temperature of 40°C in an intermediate tank, and then stabilized for 5 min at 95°C. Then both were refined through a 0.8 mm sieve, concentrated until reaching an IR around 7 degree Brix, and product was canned into ¼ liter cans. The same tomatoes were also processed in the 'lab-scaled' methods in order to compare their qualities.

### 2.4 Quality traits analyses

Soluble solids content (SSC) was determined with a digital refractometer (PR-101 ATAGO, Norfolk, VA) and expressed in °Brix at 20°C. The dry matter was measured by drying 3g of samples in air oven (70°C, 96 h). Viscosity was measured at 20°C in a MCR-301 controlled stress rheometer (Anton Paar, Germany) : a steady state measurements were performed with a double ribbon impeller (with an inner radius of 11 mm, a pitch of 45 mm, a length of 45 mm) as described in (Espinosa-Muñoz et al., 2013). The color was measured with a Minolta CR.400 calibrated with a standard background, and result express as the hue angle, ie arc-tangent of the ratio a/b, from the L*, a, b colour values.

## 3. RESULTS AND DISCUSSION

### 3.1 Validation of the laboratory scaled method

As a prerequisite for our studies, we verified that the laboratory scaled method used for the evaluation of a standard enzymatic reactivity of fruits, (consisting in measuring a systematic effect of HB/CB process) was in accordance with what is obtained in industry type methods concerning the reduction of viscosity by a CB processing route as compare to HB route. HB pilot purees exhibited a viscosity varying from 3 to 13 Boswick unit (Bw), while CB purees ranged from 6 to 17 Bw. Purees from H1311 being clearly more viscous than purees from Terradou, but Terradou exhibiting the highest delta of viscosity (HB vs CB) (data not shown). Comparatively, laboratory purees, which did not receive any concentration, ranged from 8 to 22 Bw. However, the two set of data were clearly correlated (p-value< 0,001), indicating that the 'lab-scaled' methods seems an appropriate method not only to classify HB purees according to their potential of producing viscous product, but also to classify tomatoes for their capacity of losing their viscosity when processed in a cold break route. In other words, this method seems appropriate to evaluate the intrinsic enzymatic reactivity to process of tomatoes.

### 3.2 Variability of puree quality of the French tomato production

Tomatoes from 88 samples (representing 39 genotypes) were collected all along the area of production in France. They were systematically HB and CB processed by laboratory scaled method, and classified for their quality (table 1). Their dry matter content varied from 4.6 to 9.4, leading to a large range of viscosity for purees. HB viscosity varied from 0.8 to 5.3 Pa.s. In HB purees, no enzymatic maceration occurred, and therefore, HB viscosity can be considered as the maximum potential of tomatoes to produce viscosity when they are processed into purees. Comparatively, CB viscosity was lower, however, the HB/CB delta of viscosity did not vary in parallel, as it ranged from 0.3 to 2.9, indicating that the enzymatic potential for modifying viscosity differed from one sample to the other. Colours exhibited also a large variability with hues varying from 0.65 to 1.07. The difference was mainly due to the presence of high-pigmented tomatoes like Uno Rosso or H1311. In generally HB/CB purees exhibited a visible difference of colour, as confirmed by the measurements (table 1). HB purees were more ‘orange’ than CB. However, the differences were not systematically the same for all samples.

### 3.3 Variability of the reactivity to tomato processing

The correlations between data within the set of quality parameters measured for the 88 samples confirmed that viscosity cannot be only explained by the dry matter content of tomatoes. DMC exhibited a low correlation with HB viscosity as well as with CB viscosity. This result was already observed with tomato harvested in one area but varying for their irrigation (Arbex de Castro Vilas Boas et al., 2017). But the most interesting findings of this set of data came for the correlation between the delta of viscosity and either HB or CB viscosity. Indeed, if delta was clearly correlated to HB viscosity, the correlation drop to a low level with CB viscosity. This result indicated, not only that genotypes varied for their capacity of losing viscosity but also that this reactivity is not related to the intrinsic potential of viscosity as measured with HB viscosity. When enzymatic reaction occurred as it happen with CB, the correlation was weaker. Despite this difference of reactivity, correlation between CB and HB viscosity remained high, as genotypes producing a low HB viscosity remain low when CB processed. However, points were more dispersed for high HB viscosity. Some samples exhibiting an equivalent high HB viscosity either remained high or dropped to a low value. This result clearly indicated that tomatoes do not exhibit an equivalent reactivity to the process. We do not obtain such a clear result with the differences of colour between HB and CB. It is not surprising, because, the differences of colour may result from very complex physical reasons, which are not as straightforward as the relation of pectinolytic enzymes with the digestion of pectin within cell-wall, which, in turn, as been already described as a major factor for the loss of puree viscosity (Sánchez et al., 2002).

## CONCLUSIONS

One major finding of our study is that tomatoes exhibit a variable reactivity to the process depending of their variety and their area of production. This reactivity, depending of the intrinsic enzymatic content of fruits, is, to a certain limit, independent of the potential properties of the varieties to produce high viscous product. Those last are indeed more dependent of the structure of fruit tissues, and their capacity to resist to processing steps. However, our experimental design did not allow for quantifying the heritability of the reactivity, and this remains a perspective to this work. And additionally we indicate that a 'quick and dirty' laboratory scaled processing using microwave seemed appropriate for classifying tomatoes according to their intrinsic potential to produce high/low viscus product (HB viscosity) and also their potential reactivity to the process (delta). However, the validation of the methods in an industrial context need to be achieved.

## Literature cited

Anthon G.E., Sekine Y., Watanabe N., Barrett D.M. (2002) Thermal inactivation of pectin methylesterase, polygalacturonase, and peroxidase in tomato juice. Journal of Agricultural and Food Chemistry 50:6153-6159. DOI: 10.1021/jf020462r.

Arbex de Castro Vilas Boas A., Page D., Giovinazzo R., Bertin N., Fanciullino A.-L. (2017) Combined Effects of Irrigation Regime, Genotype, and Harvest Stage Determine Tomato Fruit Quality and Aptitude for Processing into Puree. Frontiers in Plant Science 8. DOI: 10.3389/fpls.2017.01725.

Barrett D.M., Garcia E., Wayne J.E. (1998) Textural modification of processing tomatoes. Critical Reviews in Food Science and Nutrition 38:173-258.

Espinosa-Muñoz L., Renard C.M.G.C., Symoneaux R., Biau N., Cuvelier G. (2013) Structural parameters that determine the rheological properties of apple puree. Journal of Food Engineering 119:619-626. DOI: http://dx.doi.org/10.1016/j.jfoodeng.2013.06.014.

Sánchez M.C., Valencia C., Gallegos C., Ciruelos A., Latorre A. (2002) Influence of processing on the rheological properties of tomato paste. Journal of the Science of Food and Agriculture 82:990-997. DOI: 10.1002/jsfa.1141.

Ścibisz I., Reich M., Bureau S., Gouble B., Causse M., Bertrand D., Renard C.M.G.C. (2011) Mid-infrared spectroscopy as a tool for rapid determination of internal quality parameters in tomato. Food Chemistry 125:1390-1397. DOI: http://dx.doi.org/10.1016/j.foodchem.2010.10.012.

Table:

**Table 1. Variability of quality parameters of purees obtained from tomatoes from two areas of production in France in 2015, and processed by laboratory scaled method**

| | **DMC** | **HB Viscosity** | **CB Viscosity** | **Reactivity** | **HB Hue** | **CB Hue** |
|---|---|---|---|---|---|---|
| | *(%)* | | *(Pa.s)* | | *(L*.a.b units)* | |
| Min | 4,6 | 0.8 | 0.1 | 0.3 | 0.65 | 0.78 |
| Median | 6,7 | 2.0 | 0.8 | 1.3 | 0.88 | 0.94 |
| Max | 9,4 | 5.3 | 2.6 | 2.9 | 1.07 | 1.04 |

Figures:

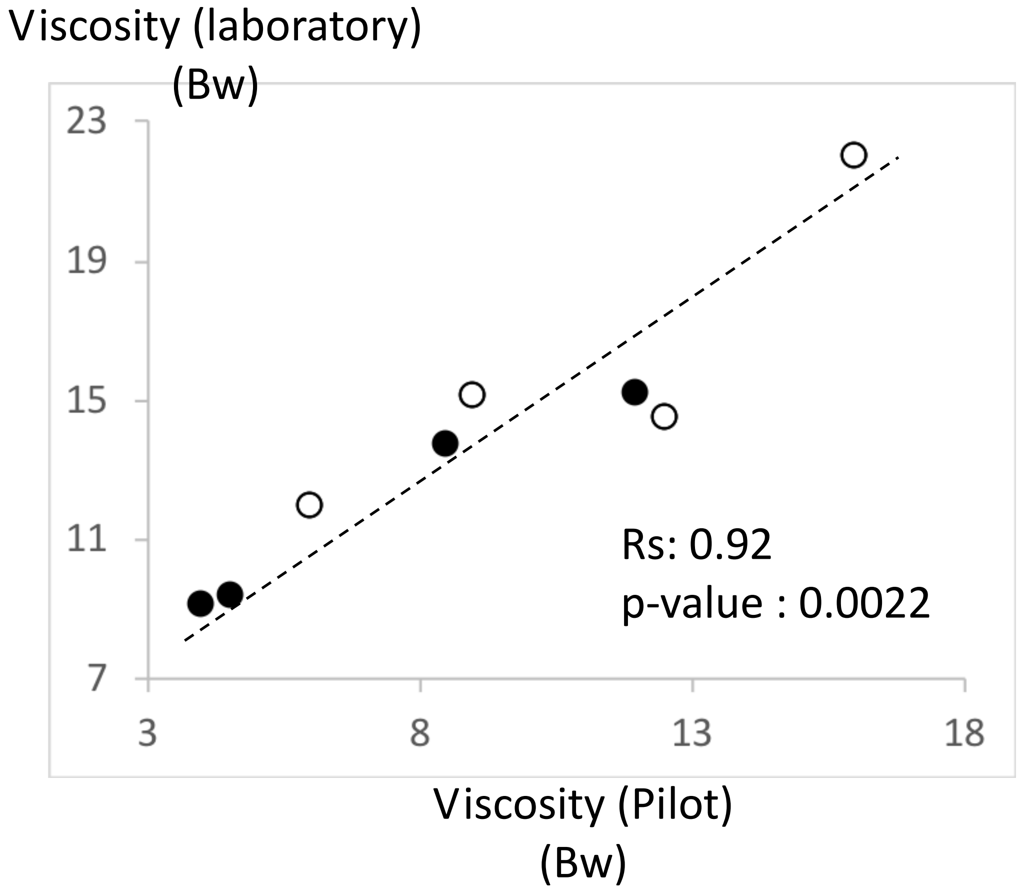

**Figure 1. Correlation between viscosities of purees obtained either laboratory or pilot scaled methods.** Open circles are hot break processed purees, and black circles are cold break. Rs is the Spearman correlation coefficient, and p-Value is the associates probability of correlation (Spearman rank test correlation)

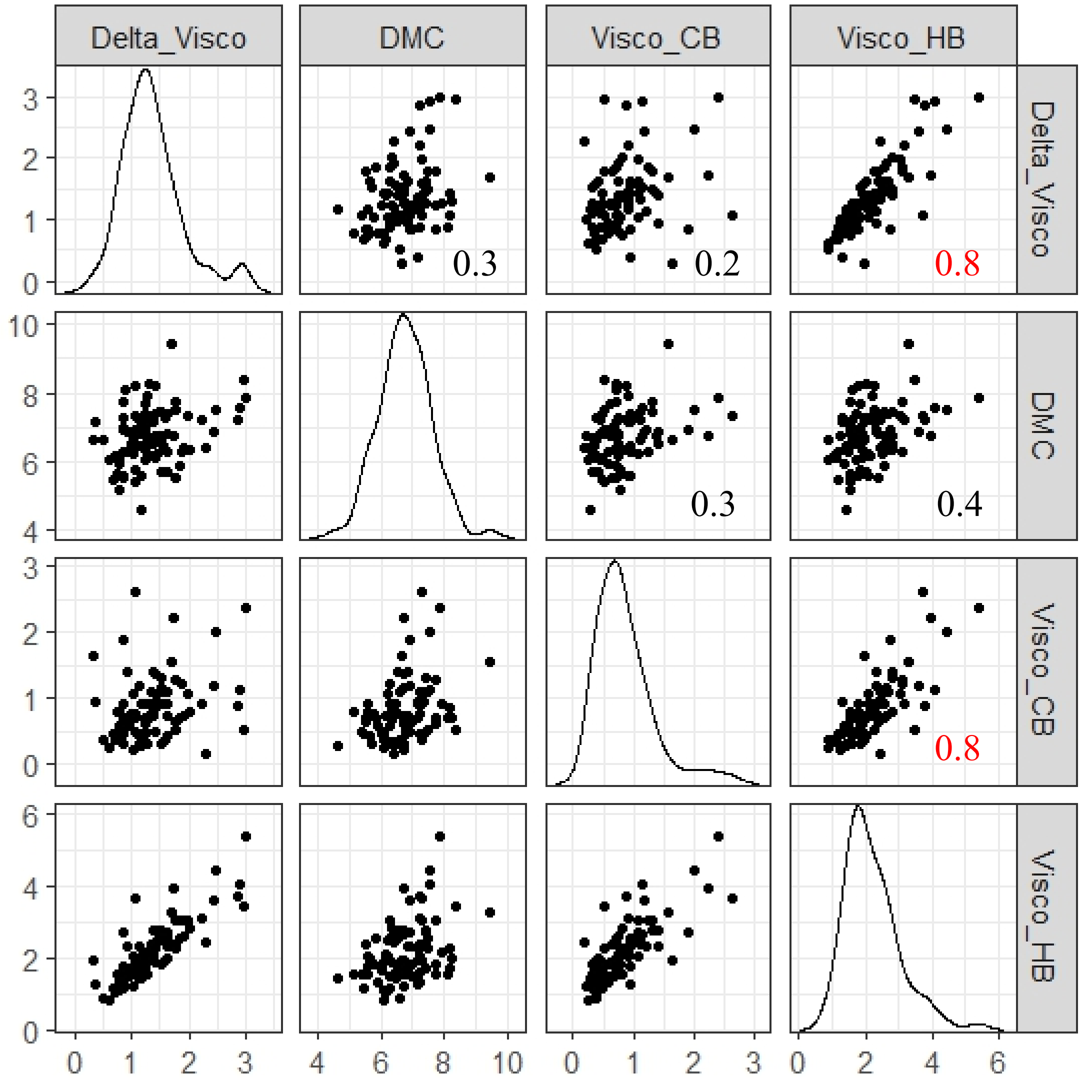

**Figure 2. Scatter plot matrix of dry matter content (DMC), Viscosity (hot break: HB and cold break CB), and the difference of viscosity between HB and CB purees (delta_visco).** Pearson correlation coefficient are indicated for each pair of data, and only highly correlated (according to t-test, p-values <0.0001) are indicated in red