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Effect of a commercial pectinmethylesterase on tomato paste consistency

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Abstract

Background: Consistency is one of the main traits that define commercial quality and price of tomato paste. Pectins are partially responsible for consistency in tomato paste, therefore enzymatic pectin modification could be used to increase paste consistency. **Results:** This work reports the effects of a commercial enzymatic preparation of pectin-methyl-esterase (PME) (NovoShape™) on tomato paste consistency taking into account variables as enzyme/substrate ratio (0,1% w/w - 1% w/w), reaction time (0 hr - 3 hrs) and reaction temperature (40ºC-60ºC). The results indicate that NovoShape™ increased consistency when reaction temperature ranged from 40 to 50ºC with an enzyme/substrate ratio of 0.5 to 1 (l PME solution/g tomato paste on dry base). On the other hand, enzymatic treatment was not effective at 60ºC with an enzyme/substrate ratio of 0.1%. **Conclusions:** Based on these results, addition of NovoShape™ is a good technological approach to increase tomato paste consistency.

Keywords: pectin methyl esterase, tomato paste, viscosity

INTRODUCTION

Tomato paste is obtained by concentrating tomato juice after removal of skin and seeds. Its commercial quality is associated with colour, lycopene concentration and consistency, therefore, improvement of any of these traits determines a better competitiveness and commercial value in the market (Haley and Smith, 2003; Colle et al. 2010).

Consistency of tomato products is strongly affected by the composition of pectins, which are high molecular weight polysaccharides of partially methylated units of D-galacturonic acid (Anthon et al. 2002; Van Buggenhout et al. 2009). Removal of methyl groups from methoxyl pectin by pectin methyl esterase (PME) has been used to increase consistency in some foods by allowing cross linking of divalent cations with pectin molecules (Anthon et al. 2005; Plaza et al. 2008).

Based on the above mentioned, enzymes involved in pectin modification could have important applications for tomato industry (Van Buggenhout et al. 2009). The present study proposes the use of a commercial preparation of PME, NovoShape™, as a strategy to increase tomato paste consistency and, therefore, its commercial value. The main variables to carry out the study are enzyme/substrate

ratio and reaction time and temperature, which are reported in order to determine the best conditions to use PME preparation in tomato paste industry.

MATERIALS AND METHODS

Materials

Tomato pastes were purchased from commercial brands Aconcagua Foods and Dos Caballos. A commercial preparation of pectin methyl transferase (EC. 3.2.1.11) from *Aspergillus aculeatus,* was used in the assays (NovoShape™, Novo Nordisk, Bagsvaerd, Denmark).

Sample preparation

Commercial tomato pastes were adjusted to 12ºBrix by addition of distilled water. NovoShape™ was added to previously homogenized samples at 0.1, 0.5 and 1% w/w and incubated at 40, 50 and 60ºC for 3 hrs in water bath with temperature control. Enzymatic reaction was stopped by thermal shock at 100ºC during 5 min and the paste obtained was reconstituted to reach 12ºBrix with distilled water. Samples were measured with a Bronswick consistometer (CSC Scientific, USA).

Consistency measurement

This method determines consistency of almost any viscous substance by measuring the distance a material flows under its own weight during a time interval of 30 sec in a Bronswick consistometer at 20ºC. Made of stainless steel, unit has spirit level and two levelling screws. Trigger-held gate is spring-operated to permit instantaneous release. Trough is graduated in 0.5 cm divisions and requires 75 mL sample. The details of the present procedure are mentioned in ASTM F1080-93.

Statistical analysis

Samples were measured in duplicate and significant differences were determined by ANOVA ($P < 0.05$) using the software GraphPad Prism version 5.01.

RESULTS AND DISCUSSION

Consistency is highly dependent on crosslinking of pectin with divalent cations such as calcium (Slavov et al. 2009; Wei et al. 2009; Yoo et al. 2009). However, the fact that the treatments with 0.5% w/w and 1% w/w of NovoShape™ increased tomato paste consistency throughout 3 hrs of assay ($P < 0.05$) without addition of divalent cations suggests that consistency is not limited by these elements in tomato paste, which can be observed in Figure 1a and c.

It must be taking into account that the lower the Bronswick value of consistency, the higher the sample consistency. A Bronswick consistency value decreased from 6 cm/30 sec to 4 cm/30 sec, which could increase the commercial value of tomato paste in about 50%, and therefore was considered the value to be reached in these experiments. Samples treated with 0.1% w/w NovoShape™ showed similar consistencies compared to control conditions (Figure 1a).

Incubation for longer times would probably result in a higher paste consistency; however, those treatments could not be considered because of the delay involved in processing several thousand tons of tomato per season, taking into account the productivity as criteria. Treatment with 1% w/w NovoShape™ increased consistency to 4 cm/30 sec in half time compared to the same preparation at 0.5% w/w (Figure 1b and c). Despite the shorter time necessary to reach the target consistency with NovoShape™ at 1% w/w, this amount of enzyme preparation represents a high cost to be used in practical applications in tomato paste industry. Therefore, treatment with NovoShape™ at 0.5% w/w is recommended when a compromise among consistency, productivity and enzyme cost is considered.

A sudden change in consistency was observed at 0.5% w/w NovoShape™ during the second hour of treatment compared to the first one (Figure 1b). This is probably due to a threshold of pectin demethylation necessary to sustain the cross linking with divalent cations in the paste to increase consistency. It has been shown that PME from *Aspergillus aculeatus* cleaves methoxyl groups in a random way and the determinant factor in gel formation by calcium/pectin interactions is the number of successive carboxyl groups along the pectin backbone and not only their total number (Axelos et al. 1996). Based on the latter, the higher change in consistency observed during the second hour of treatment might be related to the time necessary to have enough successive carboxyl groups free to interact with divalent cations in tomato pectin treated with NovoShape™.

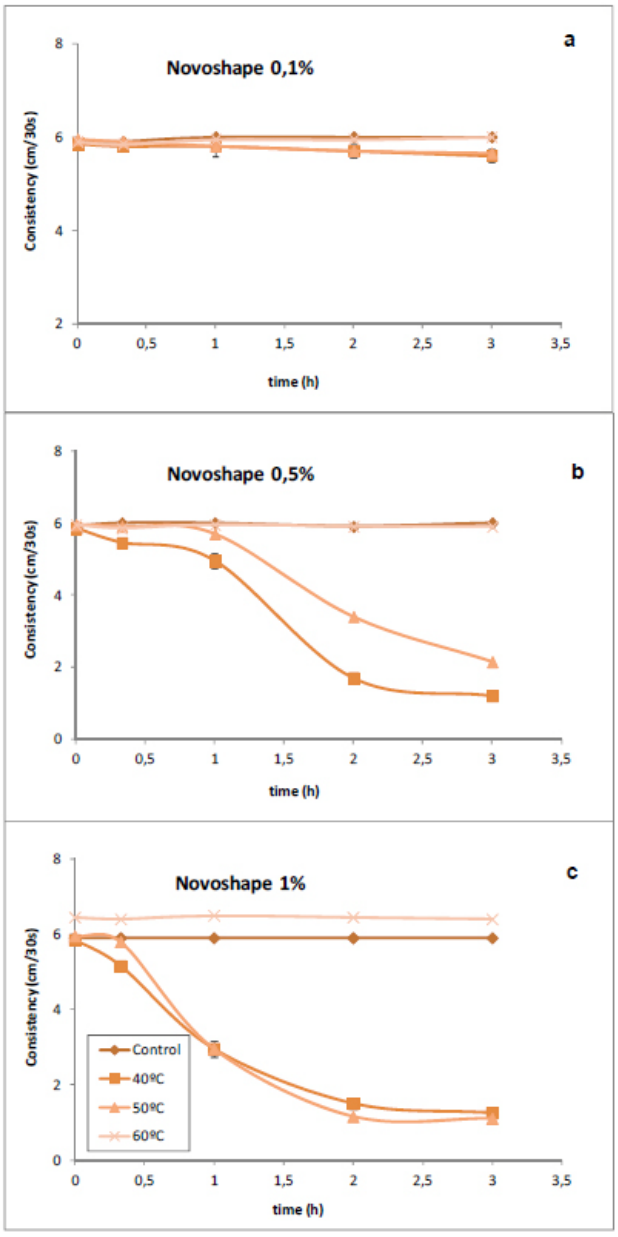

Fig. 1 Increasing of sample consistency of tomato paste using three different amounts of PME (NovoShape™) and temperatures (control at room temperature, 40ºC, 50ºC and 60ºC). (a) 0.1% NovoShape™; (b) 0.5% NovoShape™ and (c) 1% NovoShape™

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Treatment with 0.5% w/w NovoShape™ at 40ºC resulted in an increased consistency from 20 min onwards, meanwhile it took more than 1 hr to observe significant changes in paste consistency at 50ºC ($P < 0.05$) (Figure 1b). PME from *A. aculeatus* has been shown to follow a first order model of inactivation in the range of 46-56ºC (Duvetter et al. 2005). Therefore, a higher degree of enzymatic inactivation at 50ºC may explain why longer treatments were necessary to increase consistency at this temperature. Differences between 40ºC and 50ºC incubation treatments were not observed at 1% w/w NovoShape™ (Figure 1c), suggesting that despite the inactivation by temperature, remaining PME activity at this concentration was more than enough to saturate the system.

CONCLUDING REMARKS

Our results suggest that NovoShape™ added at 0.5% w/w could have important applications in tomato paste industry by increasing consistency and therefore its commercial value.

Availability of a PME less susceptible to high temperature and a complete economic evaluation may help to determine the feasibility of its use in tomato paste industry

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