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**Research Article**

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# Rheological Properties of Tomato Paste from the Romanian Market

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**Abstract** Five commercial tomato pastes from the Romania market, made by different manufacturer, were studied to examine their rheological properties. The rheological properties of tomato pastes were investigated by a rotational viscometer, Brookfield viscometer (Brookfield Engineering Inc, Model RV – DV I Prime) with RV spindles. The Brookfield viscometer DV I Prime with disk spindles represents an easy and cheap method for rheological characterization of non-Newtonian fluids, in this case of tomato pastes.

**Keywords** rheology, structure, tomato pastes, quality

## 1. Introduction

Tomatoes (*Lycopersicon escullentum*) are widely consumed either raw or after processing and can provide a significant proportion of the total antioxidants in the diet [1, 2]. This is largely in the form of carotenes [3] and phenolic compounds [4]. Carotenoids represent a large group of phytochemicals that may contribute to health and disease prevention [5].

Recently, there has been renewed attention given to the antioxidant content of tomatoes because many epidemiological studies suggest the association of this crop with a range of health benefits such as the prevention of prostate cancer [6].

To assess the quality of semi-solid food products, it is necessary to understand their rheological properties. Tomato pastes rheological characterization is required for product and process development and to ensure consumer acceptability.

As shown by Aguilar et al. [1], the rheological properties of are determined by the size of solid phase particles. Those properties can be created or modified by controlling the particle size distribution (milling degree) in the manufacturing process. The rheological properties are also influenced by its dry matter content, the presence of oil fraction and the addition of thickeners [2].

The aim of this work was the determination of rheological properties of tomato pastes from the Romanian market and to reveal differences among these samples.

## 2. Materials and Methodology

### 2.1. Materials

Five commercial tomato pastes have been made in Romania by different manufacturers. According to the composition information from the labels, all products have been manufactured without thickening agents. Samples of tomato pastes were marked with symbols T1 to T5. In the period of analyses the samples were stored at room temperature and prior to measurement they were gently stirred for homogenization.

### 2.2. Methods

#### 2.2.1. pH and Titratable Acidity

Tomato juice (10 g) was blended with 20 mL of deionised water in an ultrahomogeniser. The mixture was heated to 100 °C, then 20 mL of deionised water were added and the resulting mixture was cooled to 20 °C. pH was measured at this temperature with a pH-meter. Afted determination of pH, the solution was titrated with 0.1 N NaOH to pH 8.1 and the results were expressed as percentage of citric acid (g of citric acid per 100 g fresh weight (fw)).

#### 2.2.2. Soluble Solids

Soluble solids of tomato juice were determined using a digital refractometer (ATAGO, Tokyo, Japan) at 20 °C and results were reported as degrees Brix.

#### 2.2.3. Determination of Rheological Properties

Viscosity measurements were carried out on the yogurt samples at ambient temperature (25 °C), with a Brookfield viscometer (Brookfield Engineering Inc, Model RV- DV II Pro+) at 2,5; 5; 10; 20; 50; and 100 rpm with RV spindle (RV3, RV4, RV5, RV6 type). The spindle was used in accordance with the sample nature to get all readings within the scale [7, 8].

The samples in 300 mL of beaker with a 8.56 cm diameter (according to the Brookfield requests) were kept in a thermostatically controlled water bath for about 10 min before measurements in order to attain desirable temperature of 25 °C.

First measurements were taken 2 min after the spindle was immersed in each sample, so as to allow thermal equilibrium in the sample, and to eliminate the effect of immediate time dependence.

Flow curves with a controlled shear rate (CSR) at a temperature of 25 ± 0.3 °C; the shear rate was increased from 1 to 100 $s^{-1}$ during 10 min.

All data were then taken after 40 s in each sample. Each measurement was taken three times on the sample.

#### 2.2.4. Statistics

Samples were assayed in triplicate and results are given as averages ± SD. Student's t test was used for the statistical evaluation and $p < 0.05$ was considered statistically significant.

## 3. Result and Discussion

### 3.1. Quality Parameters of Tomato Juices

In Fig. 1 the pH of commercial tomato juices is presented.

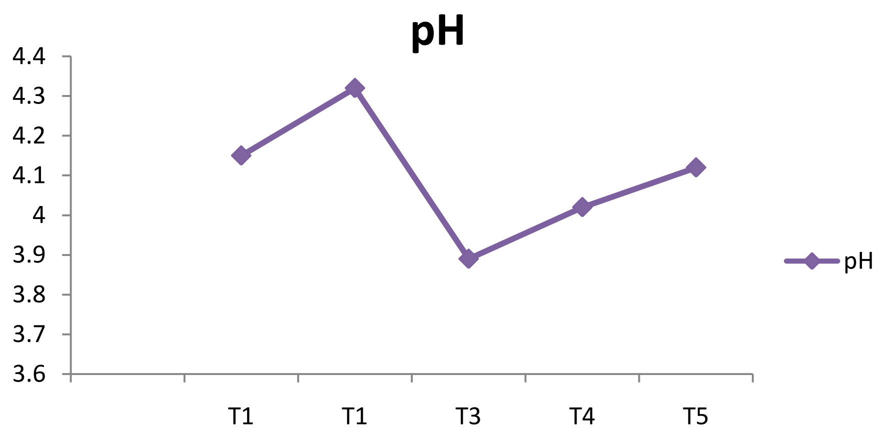


*Figure 1: pH of commercial tomato pastes*

As seen from the Fig. 1, the pH of tomato pastes from the Romanian market varies between 3.89 (sample T3) and 4.32 (sample T2).

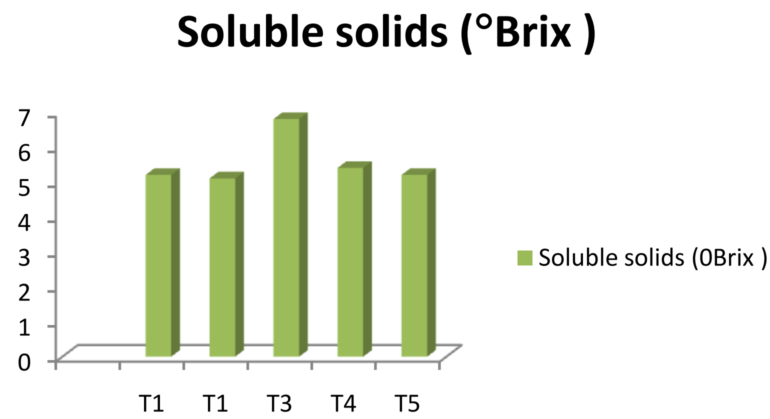


*Figure 2: Soluble solids ($^0$Brix) of tomato pastes from the Romanian market*

Soluble solids in the commercial tomato pastes ranged from 5.1 to 6.8$^0$ Brix.

The titratable acidity of commercial tomato pastes is indicated in Fig. 3.

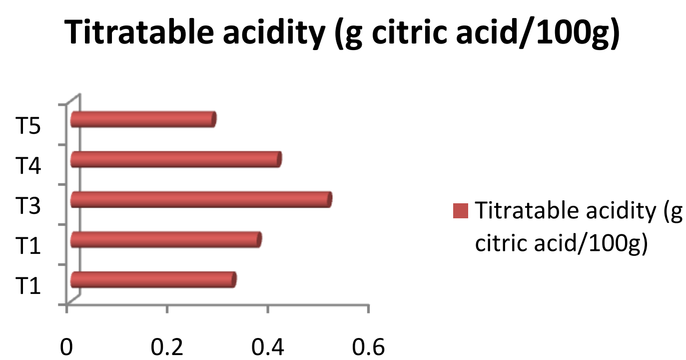


*Figure 3: Titratable acidity of commercial tomato pastes*

The low acidity in commercial juices could be explained on the basis on technological treatment carried out by the manufacturers, aimed to achieve low acidity tomato juices, which have a better consumer acceptance. Manufacturers add sugar to offset acid taste and get a sweeter product, and this was shown on some of the labels of the commercial tomato juices bought for this study.

**3.2. Rheological properties**

Examples of flow curves are shown in Fig. 4.

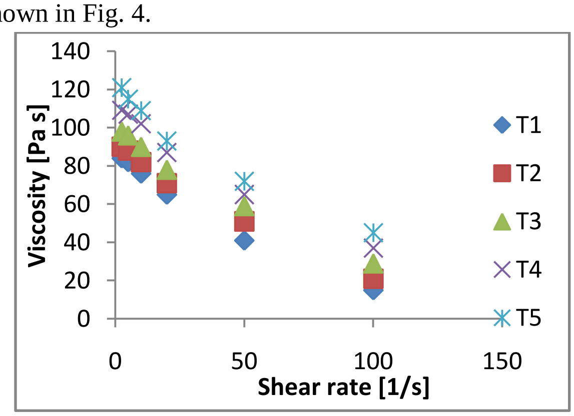

*Figure 4: Flow curves (CSR mode) of tomato pastes*

The parameters of the rheological model employed to describe the experimental data are given in Table 1. The power law model is a good fit with the experimental data ($R^2 > 0.98$). But that model does not take into account the yield stress, which is a very important rheological parameter [9]. Although all investigated mustards exhibited non-Newtonian flow, which confirms earlier observation on the rheology of mustards [9, 10].

The values of flow behavior index (n) are lower than 1 for all the cases, which showed quasiplastic nature of the juice.

**Table 1:** Rheological parameters of power law model describing flow curves of tomato juices

| Sample | K [$Pa \cdot s^n$] | n | $R^2$ |
|---|---|---|---|
| T1 | 389.94 | 0.34 | 0.991 |
| T2 | 432.22 | 0.33 | 0.982 |
| T3 | 589.78 | 0.32 | 0.992 |
| T4 | 375.33 | 0.33 | 0.993 |
| T5 | 574.32 | 0.32 | 9.98 |

## 4. Conclusion

The low acidity in commercial juices could be explained on the basis on technological treatment carried out by the manufacturers, aimed to achieve low acidity tomato juices, which have a better consumer acceptance. Manufacturers add sugar to offset acid taste and get a sweeter product, and this was shown on some of the labels of the commercial tomato juices bought for this study. Soluble solids in the commercial tomato pastes ranged from 5.1 to 6.8° Brix.

The commercial tomato pastes differed in their rheological properties. The course of flow curves confirmed that tomato pastes have a non-Newtonian character.

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