

Heat Treatment Effects on the Biochemical and Nutritional Content of Double Concentrate Tomato Paste

M.E. Boumendjel
Quality Control Laboratory. Aurès Cannery.
Algeria. e-mail : Boumendjel@hotmail.com

A. Boutebba
Badji-Mokhtar Annaba University
Faculty of Sciences. Annaba. Algeria

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Abstract

This paper deals with the valuation of the effect of heat treatment on nutrients contents of tomato cans. Increasing heat temperatures reduce significantly Brix values at 110°C. Lane-Eynon method reveals that all forms of major sugar in tomato paste are reducing ones. ACP statistical analysis demonstrates that decreasing of protein values was highly correlated with the sugar values variations along with decreasing in pH values. Such a decrease seems to be more important at 110°C than at 100°C. Student *t* test identified a significant difference between viscosity at 100°C and 110°C, and being correlated to proteins content rather than of sugar. Antioxidants (lycopene and tocopherol) preserve paste consistency and are more stables than ascorbic acid.

INTRODUCTION

Heat treatments enables to stabilize tomato preserves for long storage periods. During the heating process, these treatments induce biochemical variation in food composition. We were interested on biochemical and nutritional variations induced at different levels of heat treatments on double concentrate tomato paste.

MATERIALS AND METHODS

Samples of tomato paste were heated at both temperatures: 100°C and 110°C ($\pm 2^\circ\text{C}$) in baths of boiling water for 25 to 30 minutes ($\pm 1\text{min}$). They were cooled directly until an approximate temperature of 35°C ($\pm 2^\circ\text{C}$). Samples were, thereafter, numbered and preserved to the refrigerator to 5°C ($\pm 0,1^\circ\text{C}$). Our results were expressed by the different repetitions average. The statistical analysis was achieved by mean of Minitab and ADE-4 softwares. Nutritional composition was determined according to the following methods:

Reducing Sugars

Determination of sugars was carried out by the Lane-Eynon protocol according to the CEE 1764/86 method.

Protein Content

Crude protein content was determined using the Kjeldahl method (BÜCHI Digestion/Distillatory unit K-435, Germany) with $g=6.25 \times N$.

Viscosity

Bostwick viscosimeter was used and results were expressed in centimeters of rate flow for a given volume released into a channel during 30 seconds at 25°C.

Refractive Index

Refractive index was measured according to the CEE 1764/86 method using an Abbe refractometer (PLEUGER 2WA, Italy) and transcribed on Brix values.

Ascorbic Acid

A standardized solution of 2:6-dichlorophenolindophenol was used for the direct titration of vitamin C in suitable dilution according to Tillmanns method.

Lycopene

Lycopene was determined at 502nm with photometric and HPLC method (Grolier, 2000). Antioxidants BHT was employed to control oxidation or isomerization.

Tocopherol

The determination of tocopherol was carried out by the Rougreau (1981) photometric dosage at 510nm, and extraction with petroleum ether.

RESULTS AND DISCUSSION

Proteins and Sugars

There was a significant difference ($P < 0.01$) between the influence of temperature on protein content at 100°C and 110°C, correlating a decrease of proteins and sugars for $r = 0.92$ (Fig.1). These correlation was more important at elevated temperatures indicating probably a Maillard reaction with elevating heat treatment temperature ($r = 0$ at 100°C vs. $r = 0.86$ at 110°C). Measurements of sugars before and after inversion indicate that almost present sugars are reducing ones. The reaction between reducing sugars and proteins can be characterized in a number of ways (Eichner et al., 1996) and low decrease in pH values (< 0.05) with heating is known to occur in part due to formation of organic acids and loss of basic aminogroups of protein as a result of the Maillard reaction (Teodorescu, 1991).

Viscosity

Statistical data indicate a significant difference between viscosity at 100°C and 110°C ($P < 0.001$). The presence of reducing sugar in the tomato paste should not be considered as an important element that can contribute to texture ($r = -0.23$). Statistical data indicate a more important correlation between viscosity and proteins ($r = 0.50$), showing the importance of proteins in the final formulation of the paste viscosity.

Viscosity and Antioxidants

The deterioration of pectin, cellulose and other polymers induce a reduction of the consistency, which permits a higher penetration of heat (Smith, 1961). We noticed that the viscosity is inversely proportional to Lycopene and Tocopherol content ($r = -0.89$ and $r = -0.95$) probably by a protection of the native structure of polysaccharids avoiding the oxidative reductive depolymerizations (Mitchell and Hill, 1991).

Antioxidants

Lycopene levels variation (-5.87%) is less important than ascorbic acid (-20%). The decrease of ascorbic acid levels is inversely proportional to heating temperatures with -15% at 100°C and -25% at 110°C. Our results confirm the good stability of carotenoids during the thermal treatments (Nguyen and Schwartz, 1998). We also found that the non excessive thermal treatments do not produce considerable change on the global content in lycopene. However, they affect *Cis* and *Trans* isomers percentages of lycopene (Shrama and Le Maguer, 1996). A reduction of lycopene level is correlated to viscosity variations ($r = -0.89$), which intervenes as a restrictive factor to the penetration of heat (Veera and Sangchai, 1987). Stahl and Sies (1992) demonstrate that carotenoids destruction is inversely proportional to the viscosity of matrix concluding to the importance and the role of viscosity in the preservation of the different nutriments. Decreasing in tocopherol level (Fig. 2) is appreciably low (-1.95%) vs. lycopene (-5.87%) and ascorbic acid (-20%), because of the good stability of tocopherols to the heat treatments.

Brix Index

Heat treatments induce a significant difference between heating at 100°C and 110°C ($P < 0.01$). Decrease in Brix values is correlated to variation on biochemical compounds of tomato paste such as: proteins ($r = 0.98$), salts ($r = 0.97$) and sugars ($r = 0.86$). The induced concentration of Brix increases the consistency of tomato paste enhancing

the thermal resistance properties of the paste and correlating them to $r=0.53$ (Fig. 1).

CONCLUSION

It was demonstrated that the corresponding vitamin losses are weak, because of the importance of the viscosity of the matrix, alone the vitamin C disappear during the sterilization in more elevated proportions. Lycopene and vitamin E appear more resistant. The thermal treatments can sometimes helpful while increasing the lycopene *cis* isomer values. The Brix variations are owed to reactions of compounds mainly as: Proteins and sugars. Nutriments perdition remains minor in relation to the used thermal treatments.

ACKNOWLEDGEMENTS

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Figures

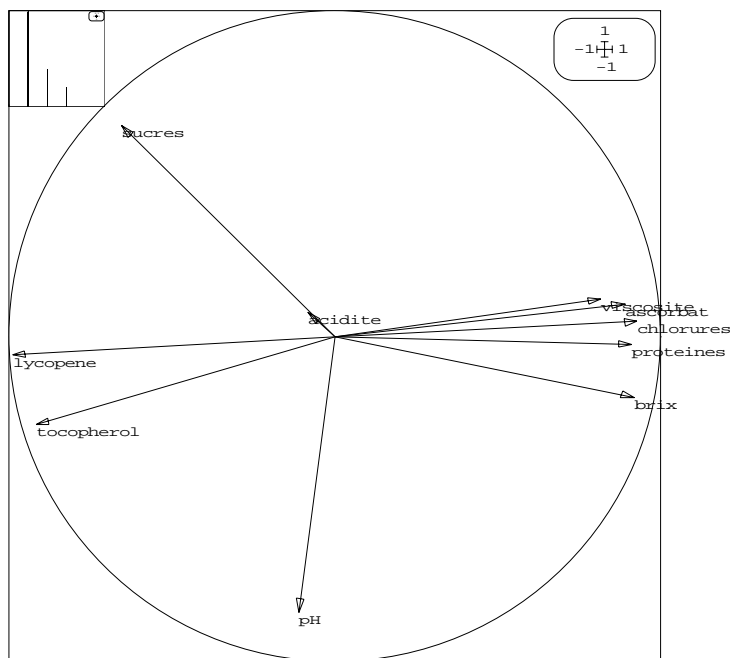


Fig. 1. Correlation circle

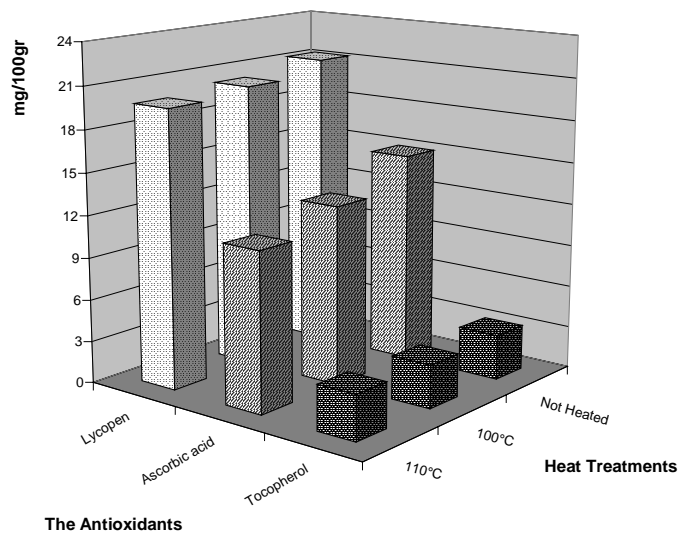


Fig. 2. Variation of antioxidants level through the heating treatments temperatures