Ovidius University Annals of Chemistry Volume 20, Number 1, pp.83-86, 2009

Mathematical model for the evaluation of the sea-buckthorn juice preservation

Iuliana MANEA and Lavinia BURULEANU

Valahia University Targoviste, Faculty of Environmental Engineering and Biotechnology, Unirii Bd. 18-24, 130082, Targoviste, Romania

Abstract The aim of this study was the monitoring of the main chemical parameters of the juice obtained from the sea buckthorn (*Hippophae L*) fruits during preservation. The results allowed lastly the settlement of some mathematics models very nearby of the reality in the strength connection with the prognosis. Sea-buckthorn berries have highly nutritious and medical values due to its big amount of vitamins: C, A, B_1, B_2, E, K, P. Ascorbic acid content is classified after the one found in the rose hips and acerola fruits. Sea buckthorn fruits harvested at the beginning of August have been used for the investigations. The pH values, the reducing sugars and the ascorbic acid content of the juices during preservation at refrigeration temperature were determined. The results have been statistically processed using two types of simple regression models (the linear and the polynomial models). The R squared obtained values denoted strong relationships between the vitamin C content and the time of preservation at refrigeration temperature.

Keywords: sea buckthorn, ascorbic acid, pH, mathematic models.

1. Introduction

Because of their remarkable chemical composition, the sea buckthorn fruits are utilized in food industry and in medicine. Nutrient and phytochemical constituents of the sea-buckthorn berries have potential value as antioxidants that may affect inflammatory disorders, cancer or other diseases. [1, 2]

The antioxidant properties may be proved to help eliminate some of the harmful chemicals found in the body that may affect the heart and its function. The food industry uses sea-buckthorn berries to obtain juices with and/or without sugar additives, mixed juices (mixtures of juices), jams, jellies, liqueurs, candies or dyes. [1]

The technological processing of the berries caused a total degradation of tetrahydrofolate and 5-formyltetrahydrofolate in the generated juice. The content of the main folate vitamin 5-methyltetrahydrofolate remained approximately unchanged during the whole processing from the berries to the concentrate.[9]

The storage of sea buckthorn juices for 7 days at cold temperature (6 degrees C) already resulted in a degradation of vitamin C of about 11% to 12%. [10]

The advantageous or destructive influence of each thermal treatment on the sea buckthorn juice quality was established through these researches.

As an independent variable (X) has been considered the analyzed evolution time and (Y), as a dependent variable, has been considered the oxidation process which determine the degradation of vitamin C. [3, 4] The mathematical regression allows a dynamical data processing so it has correctly modelled the interdependence of different biochemical parameters for a long period of time. Consequently, it has finally leaded to the creation of some models which are very close to reality and on the basis of which we can make predictions. [7, 8]

The study aims to quantify the losses on ascorbic acid of the sea-buckthorn juice during preservation at refrigeration temperature in order to find the optimum variant which assures the maximum vitamin C content.

2. Experimental

Sea buckthorn berries were harvested in hilly areas and specifically processed by sorting,

ISSN-1223-7221

removing of the wooden parts. The fruits were selected, washed, pressed and the juice was clarified by centrifugation.

Volumes by 100mL juice were distributed in dozes without letting the air in, with a view to analyse them weekly. Thus the influence of the air on the results of the chemical analysis was excluded.

The samples were submitted to different preserving conditions such as refrigeration (sample S1), pasteurization at 80 degrees C for 10 minutes (sample S2) or mixing up with robinia honey in proportion of 1:1 (sample S3).

The experimental batches were noted as follows: M - sea buckthorn berry juice (the control batch), S1 - refrigerated juice; S2 - pasteurized juice; S3 - juice mixed with honey.

All the samples were kept in a dark place at refrigeration temperature and were analysed weekly (for 12 weeks). The vitamin C content, the reducing sugars, the pH values and the colour intensity of the juices were determined. The biochemical determinations were done according to actual methodologies [11].

The mathematical analysis of the analytical data has been realized using Microsoft Excel X_P – Trend lines. All the mathematical lines use trend lines. The evolution of the processes has been analysed using the mathematical simulation [MEX_P] [5, 6]

3. Results and Discussions

The ascorbic acid, the reducing carbohydrates and the pH values were determined before the introducing of the samples in refrigerator.

At the initial moment of the analysis the pH values of the juices varied between 2.7 (the control batch) and 3.25 (the juice mixed with honey batch), while the reducing sugars content, expressed as g glucose/100mL, varied between 1.85 (sample S2) and 16.92 (sample S3) (Fig.1).

The highest ascorbic acid concentration was determined in the sea buckthorn fruits, while the least in the juice mixed with honey because of dilution.

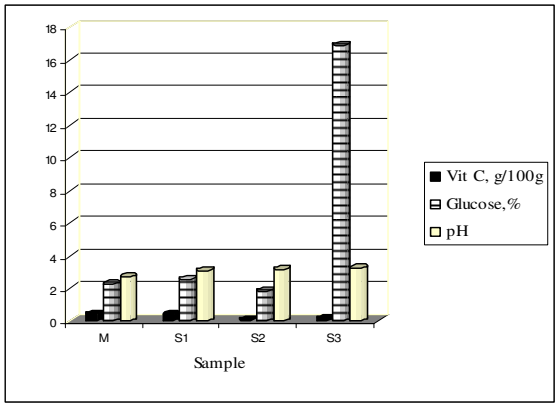

Fig. 1 The initial chemical parameters of the analyzed samples

During preservation of the juices at the refrigeration temperature, the ascorbic acid content was substracted gradually (Fig.2)

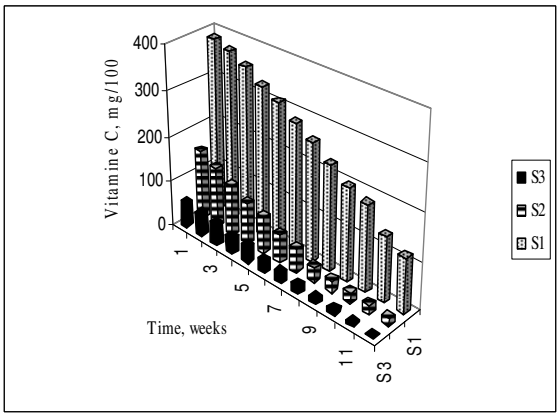

Fig. 2- The evolution of the vitamin C content in samples

The non-thermally treated juice has the highest content in vitamin C after the 3 month period of being kept as mentioned above, while the thermal treatment of the juice has a destructive action on vitamin C (losses about 85.71%).

A mathematical model allows a better configuration of the experiments, a better understanding of the results and it can force to develop an intuitive thinking.

All the mathematical models use trend line. They are used to represent graphically the data trends and to analyze prediction issues referred to as regression analyses. The trend lines are the most efficient if the value of R squared is 1 or close to 1.
A linear trend line is a straight line which approximates the best simple linear data sets. The data are linear if the model, in its data points, lochs like a line.

The linear model figures out the approximation of the smallest square roots for a line represented by the equation (1):

$$y = mx + B \qquad (1)$$

where, m represents the inclination and B the intersection.

The relations obtained by the modelling and the specific values of the determination coefficient are:

- y- the process of vitamin C degradation rendered by the value of vitamin C;
- x- the time of preservation at the refrigeration temperature.

As the linear model does not describe in the best way the evolution of the analysed phenomenon, there has been attempted a polynomial model.

In the analyzed study the best modelling results have been obtained using a polynomial trend model, for the vitamin C, where R squared has the biggest value (Fig. 3).

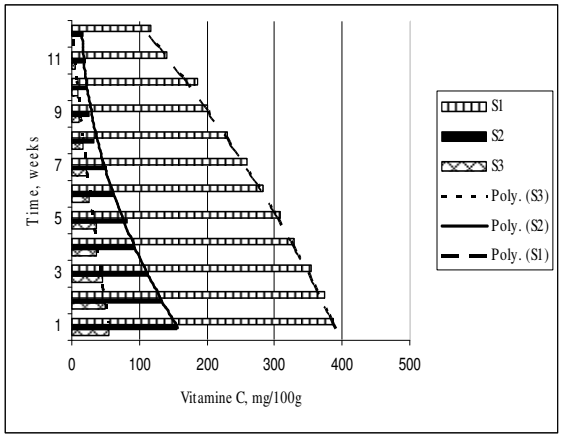

Fig. 3 The decreasing of the vitamin C content during preservation at the refrigeration temperature.

Calculating the least squares fit through points by using the equation (2):

$$y = cx^b \qquad (2)$$

where *c* and *b* are constants
The polynomial trend model is a curved line which is used to illustrate the data fluctuation. Calculates the least squares fit through points by using the equation (3):

$$y = b + c_1x + c_2x^2 + c_3x^3 + \ldots + c_6x^6 \qquad (3)$$

where *b* and $c_1 \ldots c_6$ are constants.

The curved line of the model, its equation and the correlation coefficient are presented in the Table 1.

Table 1 The correlation equations and the R squared values obtained through the analysis of the vitamin C content of the samples

Sample	Equation	R^2
S1	$y=-0.6404x^2-16.663x+407.06$	0.9981
S2	$y=0.1226x^2-6.5662x+62.149$	0.9924
S3	$y=1.0166x^2-26.016x+181.07$	0.9964

In all the analyzed cases the calculated coefficient R^2 (R squared) has risen – above 0.99. The refrigeration temperature for preservations samples offers clear conditions for a polynomial evolution.

4. Conclusions

From chemical component point of view, the sea-buckthorn juice sample that was kept at 0-4 degrees C was the best.

The juice mixed with honey was the most appreciated taking into account the sensorial properties and the chemical composition.

The association between the refrigeration of the juice extracted from sea-buckthorn fruits and the keeping in the domain of the temperatures by $0\text{-}4^0$C ensures, after 12 weeks the highest amount of ascorbic acid in the final product. This aspect was emphasized both through chemical analysis and mathematical modelling.

5. References

* E-mail address: yulia1081967@yahoo.com

[1]. D. Rosch et al., Journal of Agricultural Food Chemistry, **51**(15), 4233-4239, (2004)

[2]. L.P.Solonenko and G.F. Privalov, *Experimental mutagenesis for sea-buckthorn (hippophae rhamnoides l.) breeding,* Institute of Cytology and Genetics, Siberian Department of Russian Academy of Sciences, Novosibirsk, Russia. (2000)

[3]. H. Motulsky, and A. Christopoulos, *Fitting Models to Biological Data using Linear and Nonlinear Regression – A Practical Guide to Curve Fitting,* Graphland Software, Inc., San Diego CA., (2003).

[4]. J.L. Devore, *Probability and Statistics for Engineering and the Sciences,* IV-th Ed. Belmont, Calif., Wadsworth, 1991.

[5]. *** - Electronic Statistics Textbook, StatSoft, Inc., Tulsa, OK, http:// www.statsoft.com /textbook/ stathome.html, (2004).

[6].*** - Microsoft Excel, Microsoft Corporation, http://office.microsoft.com, (2004).

[7]. R.R. Sokal and F. J. Rohlf., Biometry: *The Principles and Practice of Statistics in Biological Research.,* 2-nd Ed. New York, W. H. Freeman, (1995).

[8]. R.B. McCall, *Fundamental Statistics for the Behavioral Sciences.* VI-th Ed. Belmont, Calif., Wadsworth,(1994).

[9]. D. Gutzeit, B. Klaubert, M. Rychlik, P. Winterhalter and G. Jerz, Analytical and Bioanalytical Chemistry, **391**, 211-219, (2008).

[10]. D. Gutzeit, B. Klaubert, M. Rychlik, P. Winterhalter and G., Jerz, J Food Sci, **55**, 3978-3984, (2008).

[11]. I. Manea, L. Buruleanu, L, Manea, *Research on the Evolution of Sensorial and Chemical Characteristics of the Sea Buckthorn Juice Preserved through Different Methods,* Proceedings of 5th International Congress on Food Technology, vol.I, pp.209-214 (2007).