RESEARCHES CONCERNING THE OBTAINING OF LACTO-FERMENTED CABBAGE JUICE – FUNCTIONAL FOOD♦

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Abstract: The purpose of this study is to emphasize the evolution of the most important components of the cabbage juice during the lactic acid fermentation: reducing sugars, ascorbic acid, amino acids. The cabbage juice was obtained from white cabbage, thermally treated at 80 ^{0}C for 5 minutes and inoculated with a brine inoculum with 10^5 cells/mL lactic bacteria mixture. The lactic acid fermentation was performed in a thermostat at 25 ^{0}C, during 5 days. During this time were accomplished analytical determinations for *pH*, titrable acidity, lactic acid, total sugar, reducing sugar, vitamin C and amino acids. Important changes were established referring to the reducing sugar content (which decreased from 4.63 g/100 g to 1.3 g/100 g) and lactic acid (which increased from 0.121 g/100 g to 1.02 g/100 g). The ascorbic acid has had a slowly involution from 23.58 mg/100 g to 19.81 mg/100 g. The amino acids content has had a tangible quantitative increasing during lactic acid fermentation.

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Keywords: *cabbage juice, lactic acid fermentation, reducing sugars, lactic acid, vitamin C, amino acids*

INTRODUCTION

The functional food is an important part of the human diet. The modern research, in particular those dealing with the immunity system have shown that this food, because of its active components has a positive impact upon the human health. According to some research, the consumption of fermented protection foods maintains the human health to a positive level, because they have an increased amount of carbohydrates, Omega-6 fatty acids, dietary fibers, carotenoids, folic acid, vitamin C, vitamin E, potassium, magnesium. They also contain proteins, vitamins from the B group, calcium, zinc but they do not contain saturated fats and cholesterol [1, 2]. Lactic fermentation is a process through which the foods are pre-digested by the useful enzymes, fungi and good bacteria. Fermented foods are easy digested; they have a higher enzymatic level and an important number of nutrients. After the fermentation the chemical composition changes, meaning that certain components can be consumed while others can undergo a significant increase and they can also form new bio-nutrients. Lacto fermented cabbage juice has numerous benefits for the consumers health: consolidate the immune system, improve the digestive illness, produce a digestive system healthy through the positive effects of the lactic acid bacteria, respectively of probiotics, assist to the weight and appetite adjustment through the diminishing of the appetite for sugar, sweet drinks, bread and pasta. Also, it has a sedative effect on the nervous system, being recommended in the ADD illness and children's autism [3, 4].
The lactic acid fermentation process is started by *L. mesenteroides* that produce acids. The activity initiated by the *L. mesenteroides* is continued by the lactobacilli (*L. plantarum and L. Cucumeris*). Finally, *L. pentoaceticus* continues the fermentation. Therefore a correct fermentation of the cabbage juice result lactic acid, small quantities of acetic acid and propionic acid, gas mixture, the most important being the carbon dioxide, and esters which contribute to the final product flavor [5, 6].
In this study, a variety of biologically active compounds in the cabbage juice has been analyzed. Their samples were derived from white cabbage that was fermented.

MATERIALS AND METHODS

The juice has been obtained from white cabbage according to the imposed methodology. After it's obtaining the juice was supplied to a thermal treatment at 80 ^{0}C, for 5 minutes. The samples have been observed for five days; then, they have been preserved by refrigeration. The juices were then supplied with brine inoculums with 10^5 cells/mL lactic bacteria mixture. The brine was obtained by a 3 day lactic acid fermentation of a mixture of chopped vegetables (carrots/cabbage) prepared with 2.5% NaCl. The lactic acid fermentation was performed in a thermostat at 25 ^{0}C.
The measured active components were: the reducing sugars, the lactic acid, the vitamin C, and the amino acids.

The determination of biochemical parameters was realized in accordance with the stipulated techniques and the existing methodology.
The mathematical analysis of the analytical data has been realized using Microsoft Excel XP – Trend lines. The evolution of the processes has been analyzed using the mathematical simulation [MEX_P] [7, 8].

RESULTS AND DISCUSSIONS

After the determination of the reducing sugars content during the lactic acid fermentation the results were presented in figure 1.

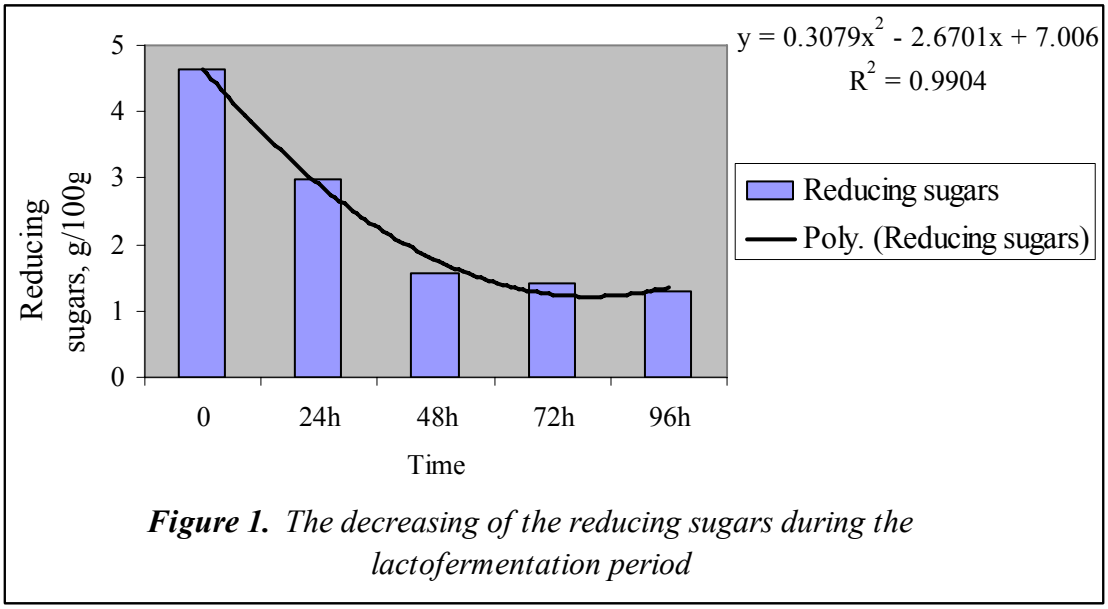

Figure 1. *The decreasing of the reducing sugars during the lactofermentation period*

There can be noticed a decreasing tendency during the whole duration of the process until the final moment of the fermentation, because these components represent the substratum of the lactic bacteria. The intensity of these processes depends on the species and the sort, being also influenced from some external factors: the temperature.
The reducing sugars content from the juice obtained after cabbage mincing, pressing and filtering was by 4.63 g/100 g. After stopping the lactic acid fermentation therefore keeping at the refrigeration temperature, the juice content in reducing sugars was by 1.3 g/100 g.
The decreasing of the sugars content during the accounting processes is accompanied by the energetic value reducing. The quality of the carrots, from the commercial and technological point of view, depends both on the sugar content.
As far as the vitamin C is concerned, according to figure 2, this has been degraded to a fairly small measure during the lactic acid fermentation. This is why the lacto-fermented cabbage juice represents an important source of vitamin C, especially in the cases when there are few sources of fresh vegetables and fruit.
The vitamin C content of the raw material and the juices was the following: in fresh cabbage – 36.6 mg/100 g; in fresh juice – 23.58 mg/100 g, in the lacto fermented juice –

19.81 mg/100 g respectively. The remaining of the ascorbic acid content near the initial value represent one of the benefits of the lacto fermented cabbage juice, because this is an important antioxidant, together with flavonoids, having a significant role in the cancer prevention.

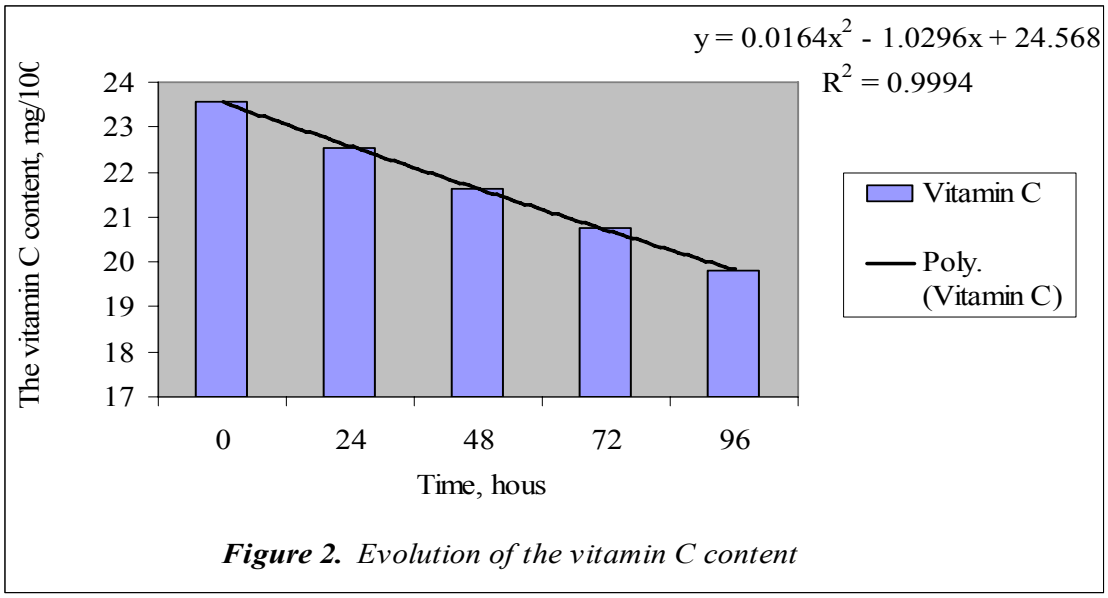

Figure 2. *Evolution of the vitamin C content*

Once the reducing sugars are consumed the lactic acid is formed, which is pointed out by the increasing of the samples' acidity (figure 3), which, due to its bioactive role influences the finite product in a positive way from a sensorial point of view. Equally, the amino-acids undergo an involution during the lacto-fermentation a part of them being dizamined or reacting with the alcohols formed during the fermentation.

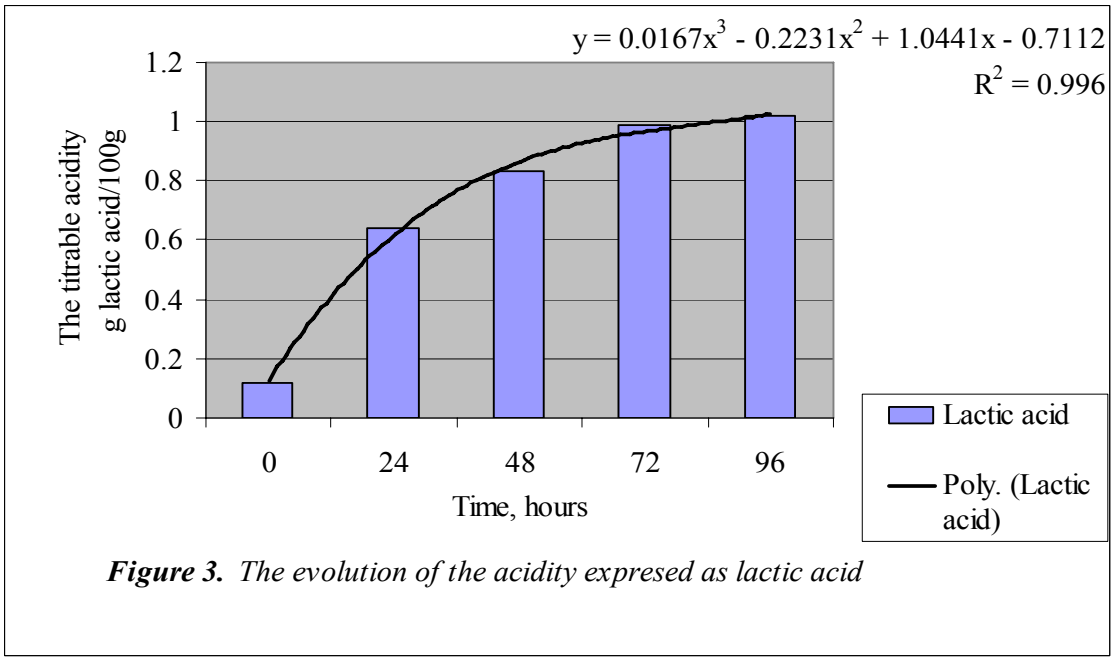

Figure 3. *The evolution of the acidity expresed as lactic acid*

Concerning the amino acids content, during lactic acid fermentation process it decrease in the first 48 hours from 0.041 $gN_2/100$ g to 0.0395041 $gN_2/100$ g, afterwards increase slowly to 0.05 g $N_2/100$ g (figure 4).

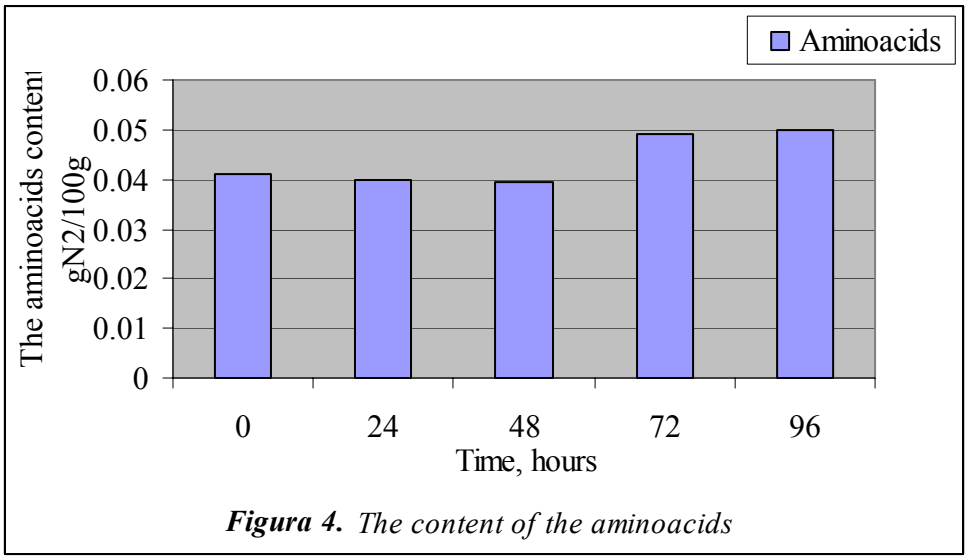

Figura 4. *The content of the aminoacids*

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 following equation:

$$y = mx + B$$

where, m represents the slope and B the ordinate to origin.

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

y – the process of lacto fermentation rendered by the reducing sugar, respectively vitamin C and lactic acid.

x – the time during the lacto fermentation period.

As the linear model hasn't rendered in the best way the evolution of the analyzed phenomenon, there has been attempted a polynomial model and power model.

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 following equation:

$$y = b + c_1 x + c_2 x^2 + c_3 x^3 + ... + c_6 x^6$$

where b and c_1-c_6 are constants.

The polynomial trend model hasn't rendered in the best way the evolution of the lactic fermentation.

The curved line of the model, its equation and the determination coefficient are present in figure 1 (for the reducing sugars), figure 2 (for the vitamin C) and figure 3 (for the

lactic acid). In all the analyzed cases the calculated coefficient R^2 (R squared) has risen – above 0.99. The lacto fermentation conditions offer clear conditions for a polynomial evolution.

CONCLUSIONS

The lacto fermented cabbage juice is a valuable functional food through the microorganisms involved, the changes in composition that occur during fermentation, and most importantly the effect of these foods and their active ingredients on human health.
The lacto fermented cabbage juice represents an important source of vitamin C (19.81 mg/100 g) that exercise an antioxidant action in the human body.
The amino acids content is changing slowly, reaching at the final of lactic acid fermentation at 0.05 g N_2/100 g.
The energetic value of the lacto fermented cabbage juice is small, because the reducing sugars are transformed under the lactic acid bacteria action, the lacto fermented juice having a content of 1.3 g/100 g reducing sugars.
The acidity of lacto fermented juice, expressed as lactic acid, reached to 1.02 g/100 g.
The lacto fermentation is a biochemical process which can be described by a polynomial mathematic trend model for the evolution of vitamin C, reducing sugars, lactic acid.

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