STUDY ON THE POSSIBILITIES OF DIVERSIFYING THE ASSORTMENTS OF LACTIC ACID FERMENTED JUICES

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Abstract: The suitability of carrots and red beet for the preparation of vegetable juices processed by lactic acid fermentation was tested. The influence of glucose addition on the final acidity of the juices and the evolution of some chemical parameters during the lactic acid fermentation of cocktails obtained from carrot and red beet were tested. The following analytical parameters were studied during fermentation: *pH*, titrable acidity, reducing sugars and amino acids content. The substratum amount of the batches was varied between 1.4 g/100 g (cocktail carrot-beet 1:3) and 3.6 g/100 g (beet juice with glucose added). Before the fermentation starting the *pH* values of the juices ranged between 5.88 (cocktail carrot-beet 1:3) and 6.15 (carrot juice), while after 96 hours the limits of the same parameter were 3.99 (carrot juice with glucose added) and 4.27 (cocktail carrot-beet 1:1). The largest reduction of the content of reducing sugars was registered in the case of the cocktail carrot-red beet (1:3), which retained about 30% of the initial amounts after 96 hours of fermentation. The lactic acid content was varied between 0.14 and 1.25 g/100 g. No significant differences were determined through the analysis of the amino acids content of the juices, but

the dynamics of this parameter was correlated with the stability of the final products. This way it was possible to compare the course of fermentation of different vegetable juices and to recommend the optimum variant from the sensory and shelf-stable point of view. The correlation between some analytical parameters was also realized, with a view to systematize the experimental data.

Keywords: *vegetables, lactic acid fermented juices, safety foods*

INTRODUCTION

The worldwide apparent trend of increasing interest in products prepared from vegetables processed by lactic acid fermentation is due to consumers' increasing preference of natural, biological methods of preservation as well as to the new data suggesting favorable chemo protective (health protecting) effects of such foods [1].
After storage some vegetables haven't this minimum content in reducing sugars, because it registers different quantities of losses [2], depending on the conditions of keeping (temperature and time of storage). Also, from this point of view great differences exist because of species, sort, and area of origin.
The vegetable juices processed by the lactic acid fermentation introduce change in the beverage assortment [3]. In a lot of countries consumption of the lactic acid fermented vegetable juices increases (Kopec, 2000, mentioned by [1]). Lactic acid-fermented juices are produced mainly from cabbage, red beet, carrot, celery and tomato [3]. The lactic acid - fermented juices preserve themselves high proportion of protective substances of the previous raw material [1]. Lactic acid bacteria are considered to have several beneficial physiological effects such as antimicrobial activity enhancing the immune potency [4] and to prevent cancer and lower serum cholesterol levels [5].

MATERIALS AND METHODS

Fresh vegetable juices were obtained at the end of January 2009 by extracting the juice from the raw materials using a home-made apparatus. After the thermal treatment they were inoculated with a culture of the lactic acid bacteria at 10^6 CFU/mL juice. The inoculum was originated in the epiphytic microbiota of vegetables. The experimental were the following: S1 - carrot juice, S2 - carrot juice with glucose added (1%), S3 - red beet juice with glucose added (1%), S4 - cocktail obtained from mixing carrot juice and red beet juice in proportion of 1:1, S5 - cocktail obtained from mixing carrot juice and red beet juice in proportion of 1:3 (the best size established through sensorial analysis). Thus treated juices were poured into graduated flasks, which were covered with sterile stoppers and left to ferment in a thermostat for 96 hours at 28 ^{0}C. During the fermentation, samples were withdrawn at 24 hours for analytical determinations and sensory assessment.
The following analytical parameters were studied during fermentation: *pH* values by the electrometric method, total acidity expressed as lactic acid through titration with NaOH

0.1N in presence of phenolphthalein, reducing sugars according to Schoorl and amino acids content according to Sörensen.

RESULTS AND DISCUSSIONS

From the viewpoint of the lactic acid production and adequate *pH* reduction during the fermentation process, the carrot vegetable juices (batches S1 and S2) have proven to be suitable substrates for lactic acid fermentation and the glucose addition seems to be important in the interval 72-96 hours.
At the initial moment of fermentation the reducing sugars of the juices were ranged between 1.4 g/100 g (cocktail carrot-red beet 1:3) and 3.6 g/100 g (carrot juice with glucose added). The dynamics of this parameter (expressed as g glucose/100 g) during 96 hours of lactic acid fermentation it is showed in figure 1.

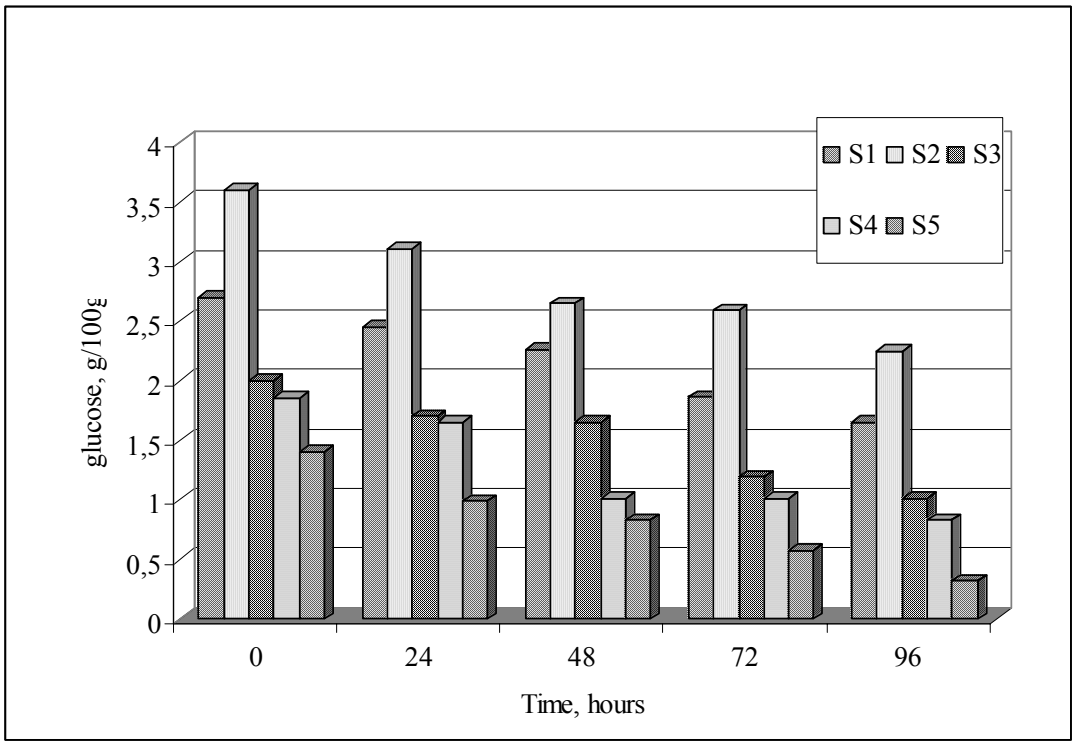


Figure 1. *The evolution of the reducing sugars during lactic acid fermentation of vegetable juices*

Although the differences between the reducing sugars of the batches were higher at the beginning of the process, it can be observed that the quantities consumed as substratum by the lactic acid bacteria were closed. So, after 96 hours of fermentation about 1 g glucose was metabolized in lactic acid as principal final product. From the analyzed vegetable juices only the sample S2 (carrot juice with 1% glucose) was differentiated by the others through a different amount of sugars consumed, it being about 1.35 g. The diminishing of the reducing sugars content in percentages was significant in the case of cocktails (55.67% for S4, respectively 77.14% for S5), but these batches were

characterized at the initial moment of fermentation through a smaller values of this parameter.

With a view to obtain lacto fermented juices with a higher stability the content of sugars in raw materials must be sufficient (at least 40 $g.dm^{-3}$, according [2]). Neither the individual juices nor the cocktails carried out the mentioned criterion. Only the carrot juice with glucose added was near, from this point of view. The data obtained concerning the chemical parameters of lactic acid fermented carrot juice was indicated however that the stability of the final product can be achieved if the *pH* values decrease rapidly.

Figure 2 show the dynamics of the *pH* values of batches during the analyzed period of time. Before the fermentation starting the *pH* values of juices varied between 5.88 (cocktail carrot-beet 1:3) and 6.15 (carrot juice). After 96 h of fermentation this parameter ranged between 3.99 (carrot juice with glucose added) and 4.27 (cocktail carrot-beet 1:1).

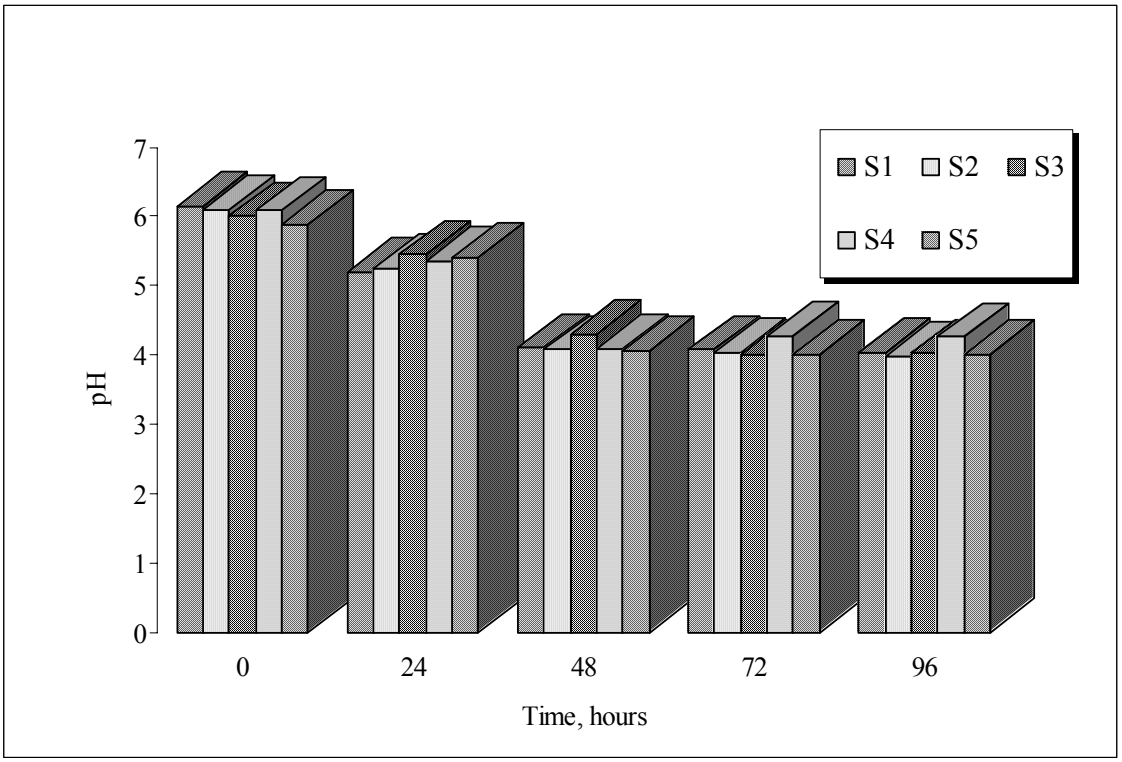


Figure 2. *The evolution of the pH values during lactic acid fermentation of vegetable juices*

A quickly decrease of this parameter in the first 24 hours was determined in the case of the samples S1 (0.95 unities) and S2 (0.85 unities). In the same time the increase of the lactic acid content was about 0.4 g/100 g for both samples, which was represented a guarantee for the shelf life of the fermented juices.

For the others batches the differences between the *pH* values after 24 hours of fermentation were about 0.47 unities for sample S5, respectively 0.73 unities for the sample S4. In all the cases the interval 0-48 hours was the period of maximum decrease of *pH*. Virtually this parameter was diminished with moreover 1 unity in the carrot

juice, respectively carrot juice with glucose added. The influence of the reducing sugars as supplement it wasn't thus obviously.

A significant leap concerning the evolution of *pH* in the second day of lactic acid fermentation was established in the cocktail with 3 parts of red beet juice in composition, which was correlated with a higher increase of titrable acidity.

The *pH* values were diminished slowly after 48 hours, excepting the cocktail S4. In this batch the parameter was ranged from 4.1 to 4.28 in the interval 48-72 hours, due to the development of the adulteration microorganisms.

It can be also observed that the difference between the carrot juice with and without glucose added concerning the *pH* value in the interval 0 - 96 hours of fermentation was the same - 2.11 unities. The influence of the glucose addition on this parameter was insignificant, because at the end of the analyzed period of time the sample S1 has a *pH* value by 4.04, while the sample S2 was characterized through a value by 3.99.

An effective influence of supplement of fermentable substratum wasn't also obvious in the case of the raw material with smaller initial reducing sugars content. Thus, during the lactic acid fermentation of the red beet the decrease of *pH* was slowly, it being the smaller between the analyzed batches. As result, the adulteration process was beginning after 48 hours, although the *pH* was continued to decline. The evolution of the lactic acid (figure 3) indicates the changes in the microbial balance.

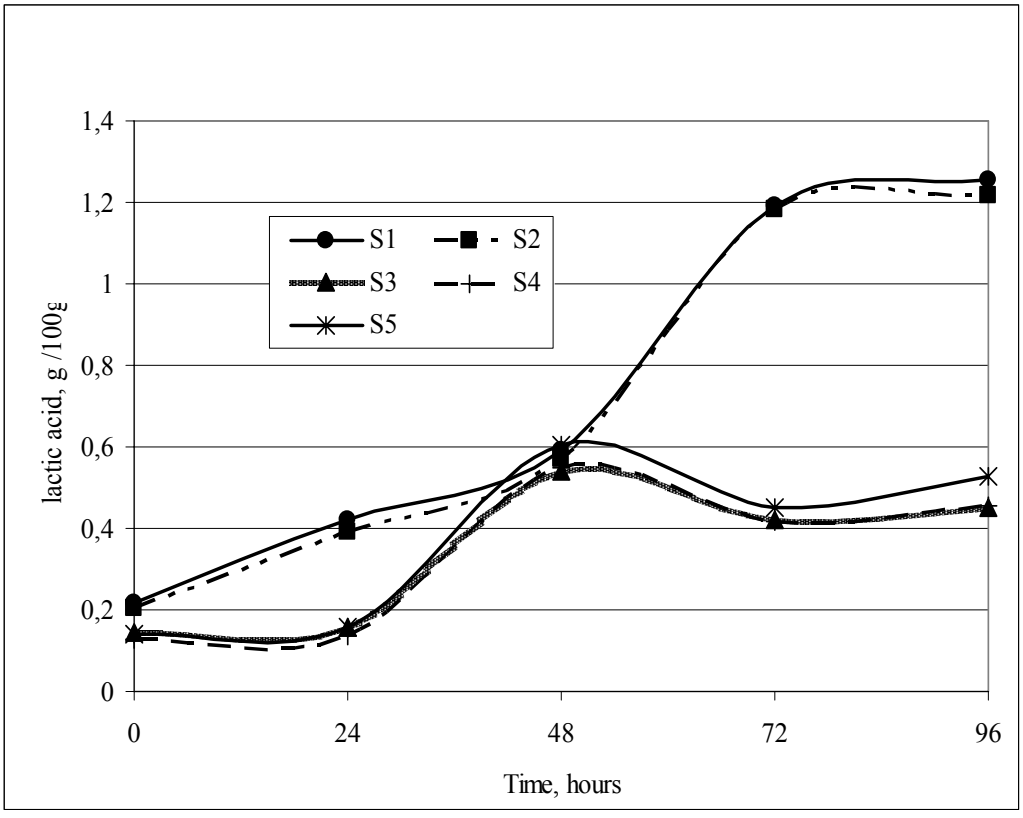


Figure 3. *The dynamics of titrable acidity of vegetable juice during lactic acid fermentation*

At the initial moment of fermentation the vegetable juices don't contain lactic acid, they being characterized through a smaller amount of organic acids.

It can be observed that in the batches on the basis of carrot juice the accumulation of lactic acid was beginning from the first 24 hours of fermentation, it being continuously until the end of the analyzed period of time. It seems also that the glucose added don't influence positive the lactic acid production. In this case the initial content of reducing sugars by 2.7 g/100 g was adequate for a vigorous fermentation of the carrot juice, a final titrable acidity by 1.25 g/100 g ensuring on the one hand the stability of the final product and on the other hand its desirable sensorial characteristics. The residual content of glucose was masked the acidity which can be defined by some consumers as excessive.

Higher amount of red beet juice inhibit useful microbiota in the first 24 hours of fermentation, the lactic acid content lying on a tableland. In the next period of time the tendency of the evolution was the same in the batches S3, S4 and S5. The slowly increase of the total acidity in the interval 0-24 h was allowed the development of undesirable microorganisms, which were caused further, after 48 h of fermentation, the consumption of the lactic acid as carbon source. In the last interval of time (72-96 h) the production of lactic acid by lactic acid bacteria was surpassed this consumption. So, the final amount of lactic acid in juices on the basis of red beet juice was ranged between 0.45 g/100 g (S3 and S4) and 0.52 g/100 g (S5), it being insufficient for the microbiological stability of the products. Only 0.3 – 0.4 g/100 g lactic acid resulted from the survey of lactic acid fermentation of these vegetable juices. Quantities 3 times greater were determined in the case of the lactic acid fermentation of juices extracted from carrots (1.01 - 1.04 g/100 g after 96 h of fermentation). Virtually the increase of the lactic acid content was about 6 times toward the initial content of the carrot juices (S1 and S2).

The growth and the biosynthesis of the lactic acid bacteria cell components require a nitrogen source, one of them being represented by the free amino acids of the juices. On the other hand, the proteolytic activity of the lactobacilli contributes to the liberation of some amino acids, which stimulated the growth and the activity of other lactic acid bacteria. It is considered that the endoproteolytic activity of lactobacilli is associated with the cells membrane and the exoproteolytic activity is located intracellular [1]. These two opposite phenomena were determined alternative increases and decreases in the free amino acids content of the juices submitted to fermentation (figure 4).

In the case of the carrot juices with and without glucose added (S2 and S1) higher content of amino acids (expressed as glycine) were determined after 96 h of fermentation as against the others batches. This one can be explained through the development of the lactic acid bacteria, being correlated with a higher content of lactic acid in the fermented juices.

The beginning of the adulteration of samples S3, S4 and S5 in the interval 48-72 h was emphasized through the decrease of the titrable acidity, but also through the diminution of the amino acids content. After 96 h of fermentation, the losses of the initial amino acids content of the juices on the basis of red beet were ranged between 18.4% (S5) and 24.6% (S3). In the same time the increase of the glycine content was about 15.7% in the batch obtained from carrots juice with glucose added (S2), respectively 47.2% in the sample without glucose (S1).

The correlation between the consumption of the reducing sugars, respectively the decrease of the *pH* values of the vegetable juices and the time of the lactic acid fermentation was better described by polynomial functions in all the analyzed batches.

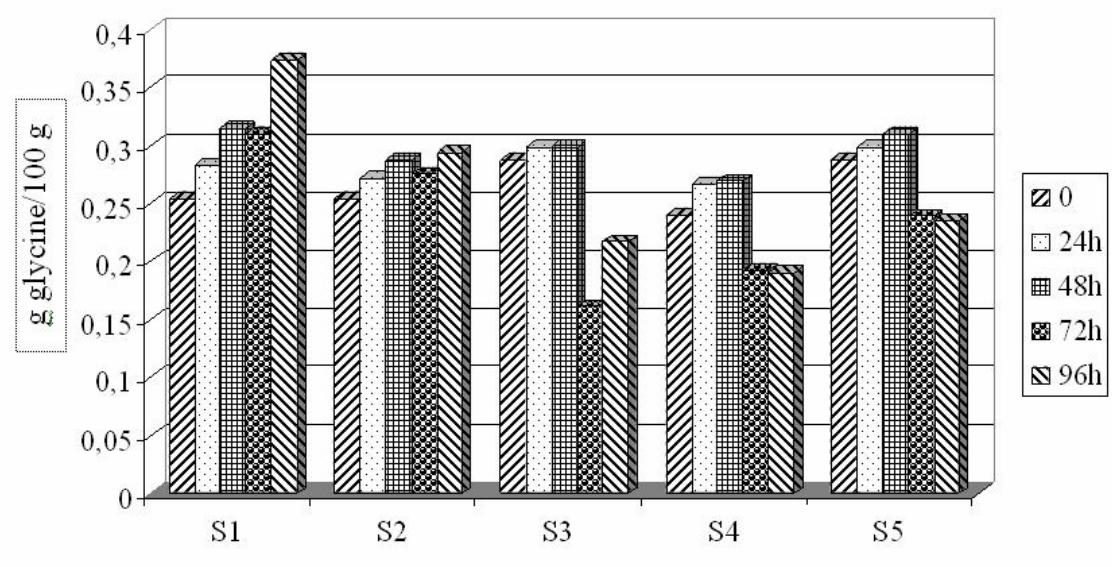
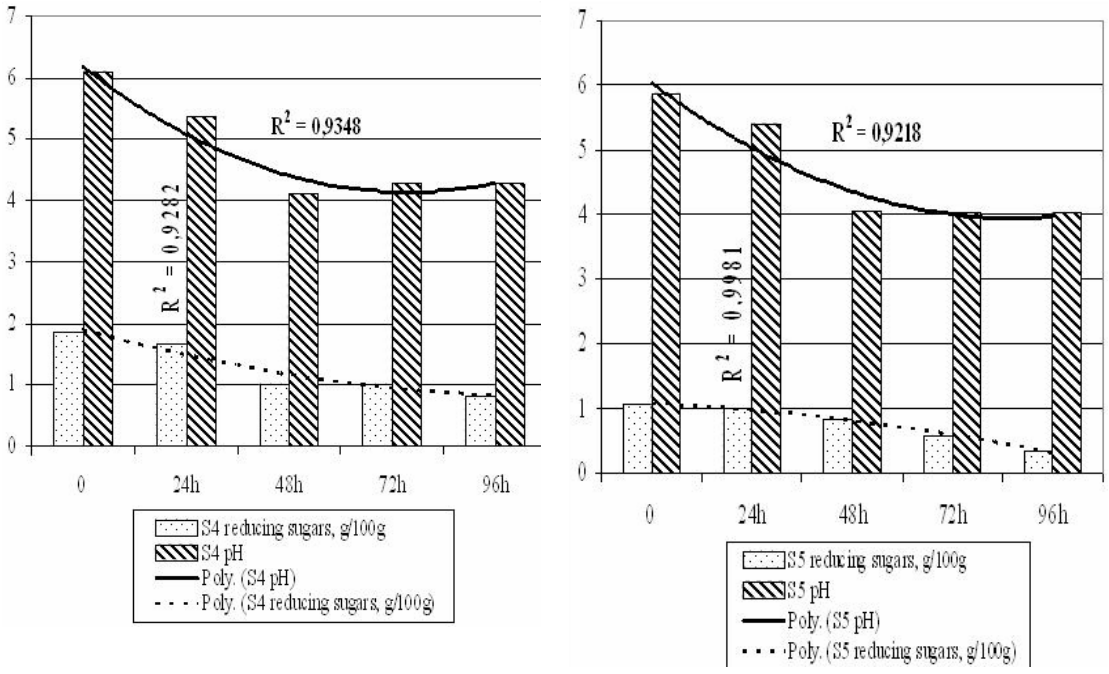


Figure 4. *The dynamics of the amino acids content of juices during lactic acid fermentation*

In figure 5 (*a* and *b*) are represented these dependences for the cocktails obtained from carrots juice and red beet juice.



a ***b***

Figure 5. *The dependence between the reducing sugars and the pH values with the time of the lactic acid fermentation (a – sample S4, b – sample S5)*

The coefficients of multiple correlations were registered values higher than 0.9, which denote a strong connection between the analyzed parameters.

CONCLUSIONS

Because of the smaller initial content of substratum, all the juices on the base of red beet had been an insufficient increase of acidity in the first 24 hours of fermentation, being favorable for the undesirable microorganisms development. On the other hand it seems that the lactic acid bacteria need some time for adaptation to the environment induced by the chemical composition of the red beet juice, especially by the presence of the coloring substances. Not even the supplement of glucose on the red beet juice was favorable in the conditions of the study.
If the *pH* decreases with about one unity in the first 24 hours of fermentation, the initial amount of the reducing sugars of the carrots juice by 3 g/100 g can ensure a normal evolution of the process, respectively the getting of a wholesome final product, with a higher stability.

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