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Effect of the preservation processes on the storage stability of juice made from carrot, celery and beetroot

Alina Profir*, Camelia Vizireanu

"Dunărea de Jos" University of Galati, Faculty of Food Science and Engineering, Domnească Street, 47, RO-800008, Galati, Romania

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Abstract

In the last years there has been an increased interest for promoting a healthy diets based on fruits and vegetables consumption. These can provide the necessary vitamins and minerals needed for the development of human organism. One of the challenges of vegetables consumption is the choice of processing treatment to minimize losses caused by the heat, light, oxygen, pH, water content and natural biological enzymes systems.

The purpose of this research is to study the effect of pasteurization, ohmic heating and lactic fermentation on the storage stability of juice made by carrot, celery and beetroot. The juice acidity, pH and vitamin C have been measured during two weeks to quantify the changes occurred on storage after this preservation process. Also it has been tested the viability of probiotic bacteria in vegetables juice. The lactic fermented juice has been shown a better stability during storage, with a good viability of probiotic bacteria.

Keywords: Vegetables juice, storage, preservation processes, ohmic heating, lactic fermentation, probiotic.

1. Introduction

The interest for a better nutrition has been known a development in the last years. At a global level is more often promote the consumption of fruits and vegetables for there health benefits. Vegetables contain high levels of minerals and vitamins and a low level of fat. Therefore they have an important role on the functioning of the digestive system, excretory system, skeletal system and bloodstream. The vitamins have the capacity to prevent chronic diseases including heart problem, high cholesterol levels, eyes and skin disorders. They are in a synergism with minerals in the order to proper function of human body. Minerals are necessary for metabolic function of human body, water balance and bone health.

Antioxidants compounds from vegetables can help the human body to develop the ability to fight with oxidant stress and diseases. Antioxidants are agents who compete with free radicals and prevent the damage caused by them. Several antioxidants like carotenoids, flavonoids, polyfenols and vitamin C have been found to be pharmacologically active as prophylactic and therapeutic agents [1]. Also antioxidants improve the self life of the food products. The bioavailability of the antioxidants depends on the quantity and the type of antioxidant, the interaction with other nutrients, solubility, stability during storage and degradation in gastrointestinal tract [2].

Choosing the best manner to consume the vegetables is quite difficult. Juicing is a simple way to increase the consumption of vegetables in an efficient manner. Juicing can improve the ability of human body to absorb all nutrients from vegetables by "pre-digesting" them. But vegetable juice is very perishable and is ideally to consume it immediately. The consumption of raw vegetables juice is a way to avoid losses during processing but may have a potential negative impact on human health due to the presence of pathogenic microorganisms. They can cause vomiting, diarrhea, and in worst case hepatitis and even kidney failure.

Corresponding author: *e-mail:* alina.leescu@ugal.ro

Cooking vegetables may inhibit the development of pathogenic microorganisms but can either destroy some nutrients from vegetables. High temperature cooking may reduce availability of water-soluble nutrients such as thiamin, folic acid, vitamins B, vitamin C, potassium, phosphorus, calcium, magnesium, iron and zinc [3]. However bioavailability of some nutrients like beta carotene is increased after cooking.

Ohmic heating is an alternative thermal processing method that can heat the entire mass of food system resulting a better quality and a less energy consumption than conventional thermal processing. The factors of the food system that may influence the ohmic heating process are: electrical proprieties; specific heat; particle type, size, concentration, shape and orientation in the electric field; temperature. This process is recommended to process two phase food systems with large solid particles immersed in liquid food because the solid particles can be heated faster than liquid [4].

Another manner to consume the vegetables is to ferment them. By lactic fermentation bacteria transforms the sugars available from juice in acids that create a new flavor. Probiotic bacteria found in fermented juice can have a benefic effect on human health.

The vegetables chose for this study, beetroot, carrot and celery, are a good source of vitamins and minerals. Also they are a good support for the development and survival of lactic bacteria.

Beetroot belongs in the *Amarathaceae* family, in the *Beta* genus. Its scientific name is ***Beta vulgaris.*** Beetroot is an excellent source of vitamin C, vitamin B, betanin, folates, iron, magnesium, manganese, phosphorous and potassium. It is beneficial for digestive problems, such as constipation, for the skeletal system, and for a good circulation of blood. Also the sugar can cause problems on diabetics. Fermented juice of beetroot doesn't have this deficiency.

Carrot belongs to the *Apiaceae* family of the genus *Daucus* and is known scientifically as ***Daucus carota***. Carrots contain vitamin C, vitamin B, beta-carotenes, calcium, copper, iodine, iron, magnesium, manganese, phosphorous, potassium and sodium. Is an excellent tonic of organism. It can be effective in preventing skin and eyes disorders, anemia and circulatory problems.

Celery is another vegetable that belong to *Apiaceae* family. It is known scientifically as ***Apium graveolens*** var. ***rapaceum*** and it belong to genus *Apium*. Celery is a good source of vitamin K, vitamin C, phosphorous, copper, calcium, magnesium, manganese and zinc. Because the synergism between contained vitamins and minerals, celery can improve cell metabolism, the strength and development of skeletal system and may prevent anemia.

2. Materials and Method

2.1 Materials

The vegetables used for this study: carrot, beetroot and celery, were purchased from a local supermarket. They have been washed, peeled and sliced. The vegetables have been juiced with a centrifugal juicer.

2.2 Preservation process

The juice obtained has been processes in the following ways:

- A part of the juice obtained has been pasteurized on a water bath at 70ºC for 3 minutes.
- Another part of the juice has been ohmic heated to approximately 70ºC. In order to obtain this temperature juices has been treated for about 1 minute. The characteristics of ohmic heating batch installation are: electrodes type-cylindrical stainless steel, diameters of the electrodes-0.5cm distance between electrodes 10cm, voltage gradient-17.5 V/cm [5].
- A blend of the juice obtained from all three vegetables and treated by ohmic heat has been inoculated with a lyophilized termophilic culture provided by Enzymes & Derivates: DI-PROX YBA 986, which contains *Bifidobacterium infantis, Lactobacillus acidophilus, Lactobacillus bulgaricus* and *Streptococcus termophilus.*

After the processes were applied to juices, they were stored for two weeks at 4 ºC.

2.3 Analyzes performed on raw juices were: dry matter using Abbe refractrometer; sugars using Schoorl method; proteins using Kjeldahl method; carotenoids dosage using spectrophotometric method; vitamin C dosage using iodometric method; flavonoids content using spectrophotometric method; polyfenols content using Folin-Ciocâlteu method, pH using a pH meter provided by Metrohm Instruments; acidity using titration method.

To assess the stability of processed juices during storage were followed changes occurred over the content of vitamin C, the acidity and pH using mentioned methods.

Viable cell counts (CFU/mL) were determined by standard plate method with MRS broth medium after 48 h incubation at 37ºC.

3. Results and Discussion

3.1Analysis of raw material

Raw juices of the vegetables that are the subject of this study have been analyzed to quantify the amount of the principal biocompounds contained. They are a rich in water, with a dry matter content of 9 to 12g/100mL juice. The water content had a significant influence on juicing efficiency. The higher efficacy has been realized on juicing of beetroot (58-62%), followed by carrot (33-35%) and the lowest has been realized by celery juice (20-25%).

The vegetables juices are rich in sugar so that they can be a good support to lactic fermentation. Vegetables juice has low protein content, the biggest amount has been found in beetroot juice. Proteins from juices can be a source of nitrogen important for the development of lactic bacteria.

The juices are rich in antioxidants compounds, the biggest amount of vitamin C is found in celery juice, flavonoids in carrot juice and polyfenols in beetroot juice. Carrot juice is rich also in carotenoids who are precursors of vitamin A.

The value of pH levels is higher than 6 and approached to optimal pH of lactic bacteria development (5.5-5.8). The difference between the pH levels of juices is insignificant.

Table 1. Composition of raw juices ($p<0.05$***)***

Parametres	Celery	Carrot	Beetroot
Dry matter (g/100 mL)	11.3	10.1	8.97
Proteins (g/100mL)	1.2	1	1.38
Total sugars (g Glucose/100mL)	7.92	6.4	6.62
Fats (g/100mL)	0.28	0.2	0.17
Ash (g/100mL)	1.9	2.5	0.8
Vitamin C (mg Ascorbic acid/100mL)	9.57	7.18	8.03
Carotenoids (mg Beta-carotene/100mL)	0.51	7.24	0.21
Flavonoids (g Quercetin/100mL)	0.4	0.77	0.68
Polyfenols (g Gallic acid/100mL)	0.7	0.32	1.2
Acidity (Thomer degrees)	2.8	1	1,6
pH value	6.09	6.19	6.06

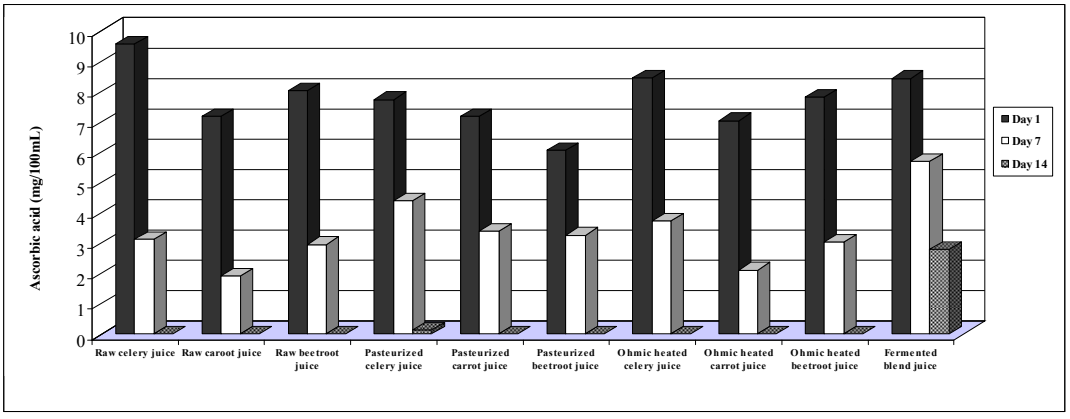

Figure 1. Evolution during storage of Vitamin C

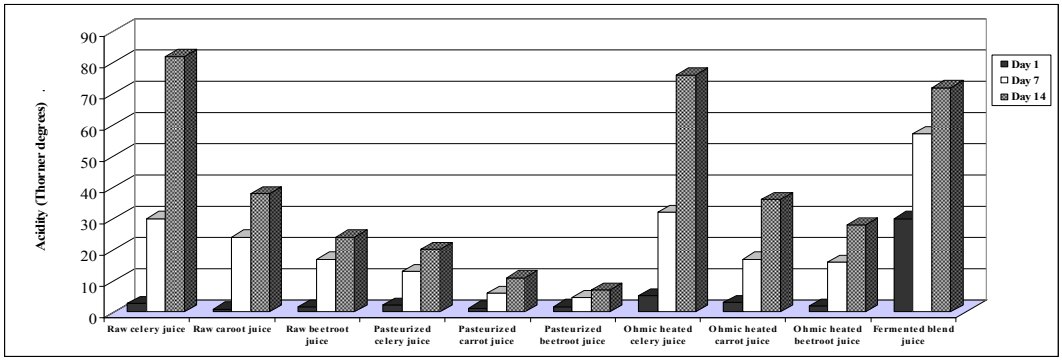

Figure 2. Evolution during storage of acidity

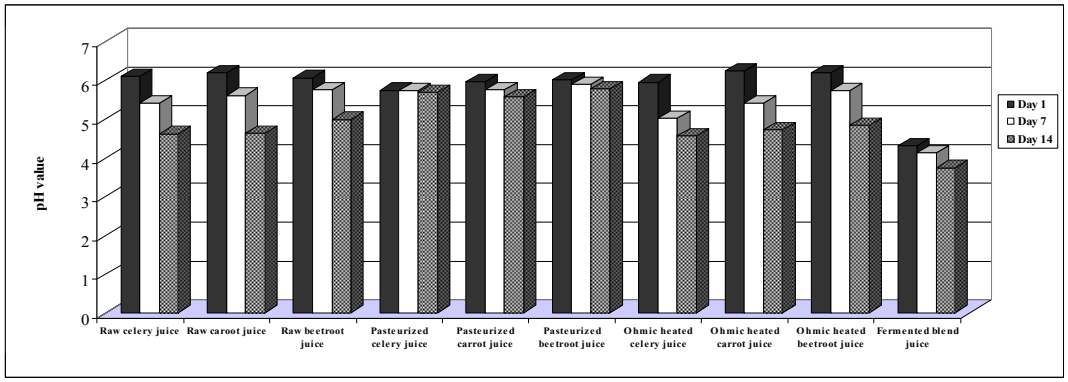

Figure 3. Evolution during storage of pH

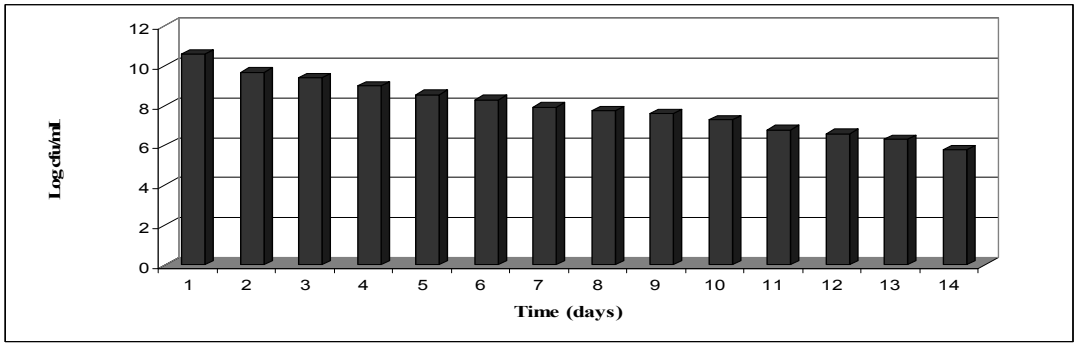

Figure 4. Viability of probiotic bacteria during storage

3.2. Evolution during storage of juices

In order to evaluate the stability during storage of the juices after the preservation processes the changes occurred in amounts of vitamin C, acidity and pH.

The losses of vitamin C have been higher after pasteurization than after ohmic heat process. Fermentation process has no influence on the content of vitamin C. During storage the higher stability was found in fermented juice due to the low pH according with the results obtained by *Cioroi Maria* (2009) [6]. The ohmic heated juices had a similar evolution to that of untreated juices.

After the ohmic heat process has started an increase of acidity so that at the end of the storage period had values similar to those of raw juices. A high acidity has been found also in fermented juice. Pasteurized juices had demonstrated the lowest increase of acidity and a better stability than ohmic heated juices.

The difference between the pH of raw juices was insignificant. After pasteurization process has been a small decrease of pH, which isn't found after ohmic heat process.

Anyway after the storage period the decrease of pH amount on ohmic heated juices was higher than the pasteurized juices. pH level of the juices is correlated with the acidity; with the increase of acidity appears a decrease of pH.

After fermentation process the pH was similar with the pH of fermented milk, proving so that vegetable juices can be a good substrate for lactic fermentation. The pH value of 4.3 obtained after the fermenting of juice is similar with that obtained by *Szilárd Kun* (2009) [7] and *Iuliana Manea* (2010) [8].

Vegetable juices have proved to be a good environment for the development of probiotic bacteria. They have demonstrated a good viability during the first week of storage. A fact which affects the viability of probiotic bacteria in a negative manner was the inactivation of existing microbiota during ohmic heat process. These results are much better than those obtained by *Lavinia Buruleanu* (2009) in a single vegetable juice [9].

4. Conclusion

Vegetables juice can be a good support for lactic fermentation because they have a good pH. Also they can provide compounds necessary for the development of lactic bacteria: carbohydrates, nitrogen, vitamins and minerals.

Pasteurization has been proved a better method to preserving vegetables juices compared to ohmic heating. A cause of the less influence of inactivation of existing microbiota from ohmic heated juices can be the time of the treatment.

Fermentation of vegetable juices is an effective method of preservation that provides better stability of bioactive compounds. The low pH of the fermented juice offers a good stability from some bioactive compounds like Vitamin C.

Compliance with Ethics Requirements

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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