

Stabilizer Substance in Producing the Beet Juice

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Abstract: This paper reports of study the color stability of the beetroot juice. Stabilizing additive to beet juice is available as a supplement of concentrated. This publication emphasizes the state of modern science about problem of the stability of natural color of juice beetroot.
Keywords: beetroot, juice of beetroot, stability, color

INTRODUCTION

Analysis of the current food market shows that in terms of environmental degradation in the world there is a requirement in the manufacture of pure natural products. One of such type of food is juices (Ahmed MSU, 2009, Wojdyło A. et al., 2014).

Quality of juice is currently one of the most topical issues for the dairy industry. Juices made from fresh fruit, are characterized by certain properties: physico-chemical, microbiological, sensory. Modified parts juice influences its consumer properties (Nwachukwu, E. and Aniedu, U. I., 2013).

Obvious need for food products having functional properties, which not only provide energy and structural needs, but also have a positive, the resulting effect on the human body as a whole or its individual organs. Development of the food industry in recent years is characterized by a steady trend towards the use of technology in the functional drinks natural plant materials as a source of biologically active substances (Yu LJ, Rupasinghe HP., 2013).

In addressing healthy eating significant role for drinks based on natural raw materials , among which a special place is occupied products of juice industry - juices, fruit drinks, nectars.

Replacement of artificial food dyes with natural colorants is a current marketing trend of juice industry (Espín J.C., 2000, Abdel-Aal el-SM., 2008, Wrolstad RE, Culver CA., 2012).

Food scientists frequently have the assignment of replacing artificial colorants with natural alternatives. This can be challenging, as naturally derived colorants are usually less stable, and all desired hues might, in fact, not be obtainable.

The technology of natural colorants is widely discussed in papers of many authors (Kong J.M. et al., 2003).

Red beet (Beta vulgaris L.) is cultivated throughout the world for its roots, which are used as a food and as a source of natural dye (Amnah, M. A. Alsuhaibani, 2013).

Red beet products used regularly in the diet may provide protection against certain oxidative stress-related disorders in humans (Kanner J. et al., 2001).

Antioxidant nutrients from vegetables are believed to be a class of compounds that exert their effects in humans by preventing oxidative processes which contribute to the onset of several degenerative diseases. A new class of dietary cationized antioxidants was found in red beets (Beta vulgaris L.). These antioxidants are betalains, and the major one, betanin, is a betanidin 5-O-beta-glucoside.

Beetroot is rich in mineral nutrients (Ensminger AH et al., 1986).

Table 1. Average nutrition facts per 100ml of fresh beetroot

Energy	45 kcal - 193 Kj
Protein	0,7 gr
Total lipid (fat)	0,1 gr
Ash	0,55 gr
Carbohydrate	10,2 gr
Calcium (Ca)	16 mg
Iron (Fe)	0,80 mg
Magnesium (Mg)	23 mg
Phosphorus (P)	40 mg
Potassium (K)	235 mg
Sodium (Na)	78 mg
Vitamin A	2 µg RAE
Vitamin C	4,9 mg

Several studies have demonstrated that betalains from beetroots possess powerful antiradical and antioxidant activity (Kujala et al., 2002).

Attractive color is one of the main sensory characteristics of fruit and vegetable products (Herbach, K.

M., 2004, Krenn L. et al. 2007).

Unfortunately, the color of beet juice, as one of red juices, is unstable and easily susceptible to degradation, leading to a dull and weak juice color (Borges G. et al., 2010).

Colorants rich in acylated anthocyanins (purple carrot, red radish, and red cabbage) display great stability due to intramolecular copigmentation. The protection of red chromophore is higher for diacylated anthocyanins in red radish and red cabbage. For colorants without acylated anthocyanins (grape-marc, elderberry, black currant, and chokeberry), intermolecular copigmentation plays a key role in color protection. Colorants rich in flavonols and with the highest copigment/pigment ratio show a remarkable stability (Malien-Aubert C., 2001).

Anthocyanins are the natural vegetable dyes, giving the petals of flowers, fruits, leaves and stems of color from pink to dark purple. For each species of plants qualitative composition of anthocyanins is very specific and depends on the varietal characteristics and growth conditions of fruits and berries.

Chemically, anthocyanins are representatives of natural polyphenolic compounds - glycosides of heterocyclic compounds aglycones - benzopiril derivatives (Fig. 1).

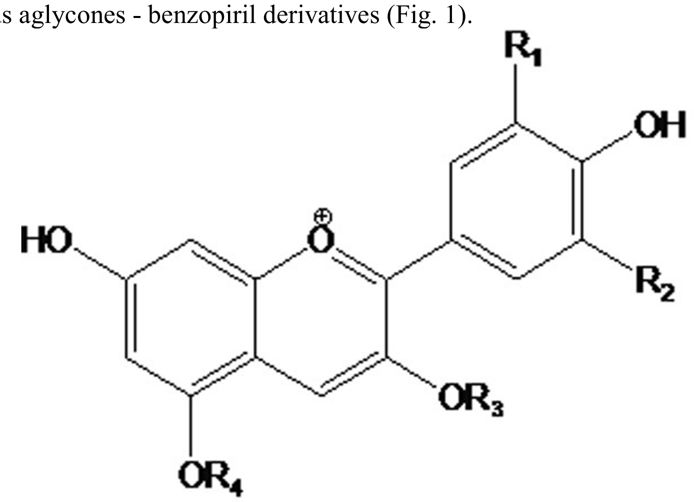

Fig.1 Molecular formula of anthocyanins.

All variety of colors depends on the structure of anthocyanins, the position and number of functional groups in their frame. Qualitative compositions of anthocyanins are generally specific for the particular plant species and relatively stable.

The beet color represents by two types of pigments: red (betatsianin) and yellow (betaksantin). Usually, in the growing and in the mature plant the petiole color may range from a dark purplish red to an orange-red, or it may be red in the middle and orange at the margins (Wesley K., 1936).

Total, red pigment has 95% of all pigments. Betanin is the main red pigment. The heat destroys betanin on 50%. The destruction depends on the temperature, the concentration of pigment, pH of the medium, in contact with oxygen, with metal ions (Harmer R.A., 1980). An important problem in juice industry is the preservation of color in beet production.

MATERIALS AND METHODS

Materials: This study was designed to investigate the stability of color of beetroot juice blended with different berry juices to stabilize color. Research objects were samples of beetroot, chokeberry, elderberry, blackcurrant. All raw materials were ripe and grew in normal conditions.

High performance liquid chromatography:
We studied the composition of anthocyanins in blended beetroot juices and several kinds of berries. Qualitative and quantitative composition of the anthocyanin was established by high performance liquid chromatography (HPLC)/mass spectrometry (MS). For the analysis of anthocyanins comminuted samples weighing 1 g were subjected to washing with 20 ml of methanol containing 1% hydrochloric acid (HCl) and in an ultrasonic bath for 30 min. After washing, the samples were centrifuged for 7 min, and filtered through a nylon filter, then placed into the bottle prior to injection into the HPLC system.

Statistical analysis: HPLC analysis was performed using Surveyor system with diode array detector and the software package CromQuest 4.0 (development Thermo Finnigan, San Jose, CA, USA).

RESULTS AND DISCUSSION

Technology of producing of beetroot included the washing, the sorting and the inspection. The produce of beet juice started under the influence of steaming temperature ~ 120±5°C for 15-20 min, to remove peel. Next step was blanching in water at a temperature of 95°C. The purification of beet peel occurred in machines. The inspection purified beet was the next stage. In crusher purified beet was milled to particles sized 2-3 mm.

The resulting mass was pressed using a press. The next step was straining the mixture through holes with diameter 0.6-0.8 mm. Separation, filtration were the following production stages. Beet juice was concentrated under vacuum until it comprises around 60-65% of total solids. The concentrated juice was mixed with different berry juices with further bottling and storage.

For berry juice (chokeberry, elderberry, blackcurrant) performed with the washing, sorting and inspection. Shredding berries produced up to 0.5 mm. After grinding the berries have been compressed directly as a squeezed juice. Freshly squeezed juice was concentrated. The juice was directed through the extraction filter with holes 0.5-0.7 mm, and the obtained pomace was extracted exposed at 45 ° C for 60-65 minutes, then squeezed and further the mixture was filtered (0.75 mm).

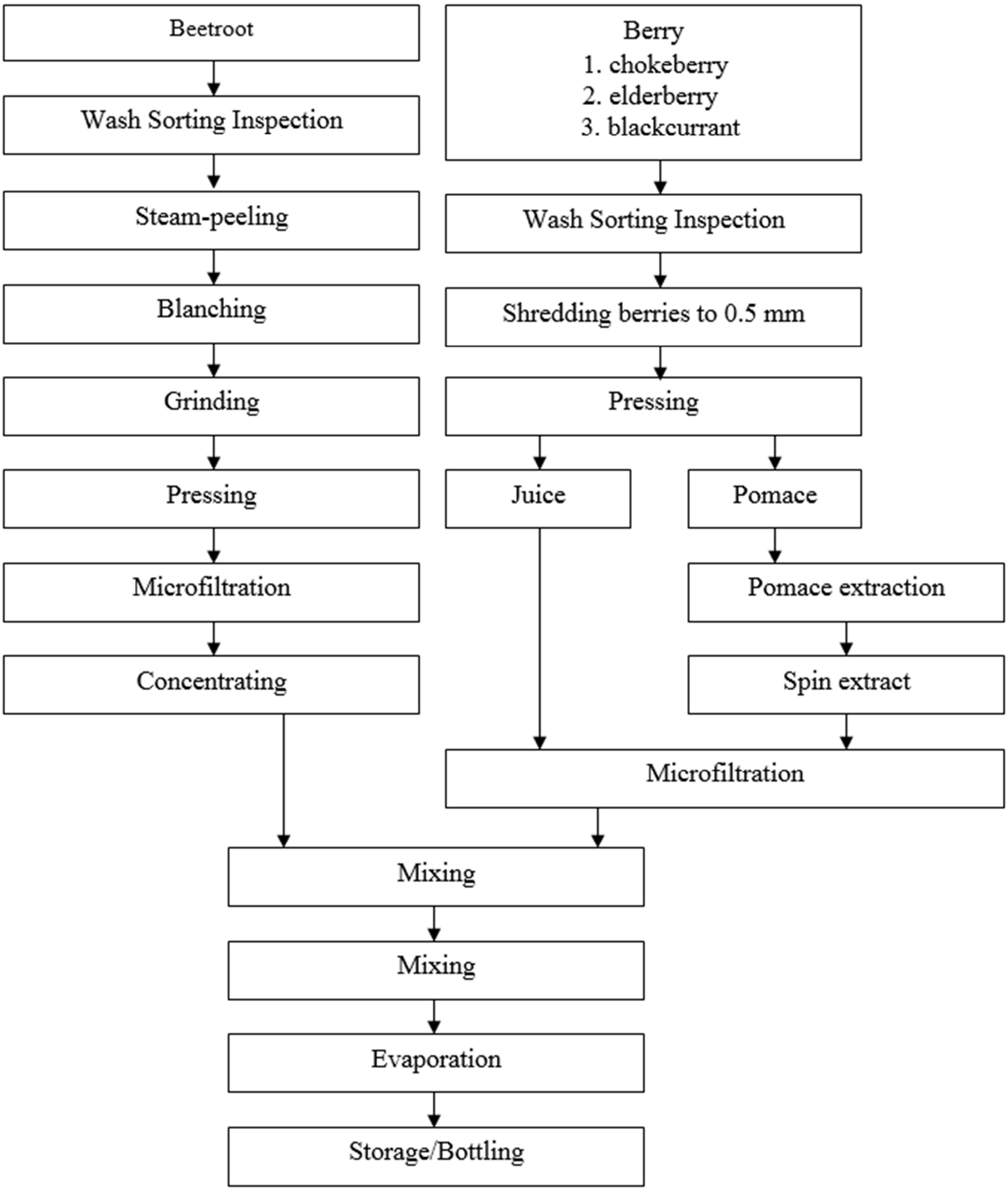

Fig. 2. Technology of blended juice.

To stable the color of the concentrated beetroot juice we added different kind of berry juices – chokeberry, elderberry, blackcurrant.

Table 2. Amount of raw material of different mixtures

Raw materials	Mixture of beet juice and chokeberry	Mixture of beet juice and elderberry	Mixture of beet juice and blackcurrant
Concentrated beetroot juice	70%	70%	70%
Chokeberry juice	30%		
Elderberry juice		30%	
Blackcurrant juice			30%
Citric acid	0,5%	0,5%	0,5%
Ascorbic acid	0,5%	0,5%	0,5%

To assess the stability of color mixtures comparative characteristic of the total content of anthocyanins in mixtures of beet juice with chokeberry, elderberry and blackcurrant juices was held. Each mixture consisted the same amount of concentrated beetroot juice (70%) and berry juice (30%).

Table 3. Content of anthocyanins in the mixture of beet juice and chokeberry juice

Anthocyanins	Concentration in equivalents of cyanidin-3-glucoside, mg / l00g	Total content, %
Concentrated beetroot juice		
Betanin	217,5±12,3	12,25
Chokeberry juice		
cyanidin 3-galactoside	637,8±23,5	35,9
cyanidin 3-glucoside	8,5±1,1	0,48
cyanidin 3-arabinoside	850,7±22,9	47,9
cyanidin 3-xyloside	61,7±4,5	3,47
Total	1776,2	100

The results of HPLC showed that the mixture of beet juice and chokeberry juice has established the presence of two peaks areas anthocyanins: cyanidin 3-arabinoside (47,9%) and cyanidin 3-galactoside (35,9%). Betanin was present in 12,25%. Other anthocyanins were detected in small quantities: cyanidin 3-glucoside (0,48%) and cyanidin 3-xyloside (3,47%).

Table 4. Content of anthocyanins in the mixture of beet juice and elderberry juice

Anthocyanins	Concentration in equivalents of cyanidin-3-glucoside, mg / l00g	Total content, %
Concentrated beetroot juice		
Betanin	217,5±12,3	20,46
Elderberry juice		
cyanidin-3-sambubioside-5-glucoside	44,1±2,7	4,15
cyanidin 3-sambubioside	546,5±28,4	51,42
cyanidin-3-glucoside	230,4±11,7	21,68
cyanidin 3,5-diglucoside	24,4±1,5	2,3
Total	1062,9	100%

Analysis of the mixture of concentrated beet juice and elderberry juice showed that the predominant of anthocyanin cyanidin 3-sambubioside, which was the half of all anthocyanins. A significant amount of anthocyanins were distributed between cyanidin-3-glucoside (21,68%) and betanin (20,46%). Syanidin-3-sambubioside-5-glucoside and cyanidin 3,5-diglucoside were introduced in a small amount - 4.15% and 2.3%, respectively.

Table 5. Content of anthocyanins in the mixture of beet juice and blackcurrant juice

Anthocyanins	Concentration in equivalents of cyanidin-3-glucoside, mg / l00g	Total content, %
Concentrated beetroot juice		
Betanin	217,5±12,3	38,83
Blackcurrant		
delphinidin 3-glucoside	47,4±3,2	8,46
delphinidin 3-rutinoside	155,2±5,1	27,71
cyanidin 3-glucoside	27,7±2,5	4,95
cyanidin 3-rutinoside	112,3±5,0	20,05
Total	560,1	100

The main anthocyanins in the mixture of beet juice and blackcurrant juice are betanin, delphinidin 3-rutinoside and cyanidin 3-rutinoside, values of which are 38,83%, 27,71% and 20,05%, respectively. Also, delphinidin 3-glucoside (8,46%) and cyanidin 3-glucoside (4,95%) are shown slightly.

So, the results showed that the concentration of anthocyanins in mixtures of beet juice with chokeberry, elderberry and blackcurrant juices amounted to 1776,2 mg/100g, 1062,9 mg/100g, 560,1 mg/100g respectively.

Table 6. Concentration of anthocyanins in mixtures

Mixture	Total anthocyanins, mg / l00g
Mixture of beet juice and chokeberry	1776,2
Mixture of beet juice and elderberry	1062,9
Mixture of beet juice and blackcurrant	560,1

As a result, characteristics of the total content of anthocyanin was obtained in a mixture of concentrated beetroot juice and berry juice (chokeberry, elderberry, blackcurrant). The mixture of beet juice and chokeberry juice was the most highest content of anthocyanins which reflecting the high capabilities of chokeberry to stabilize the beetroot juice. Thus, the use of different kinds of berries as natural dyes can solve one of the most pressing technological issues in the power system - stabilizing or strengthening juice products.

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