APTEFF, 39, 1-212 (2008) UDC:634.71:664.037.5:543.635+543.92
DOI: 10.2298/APT0839063R BIBLID: 1450-7188 (2008) 39, 63-68
Original scientific paper

COLOUR CHANGES OF BLACKBERRY AS AFFECTED BY FREEZING RATE

Dobrila G. Ranđelović, Ljubo O. Vračar and Aleksandra N. Tepić

Fast frozen blackberry partially change its surface colour from characteristic black to copper-redish colour. This change decreases the market value, especially when the product is intended for export. For these reasons classic tunnels for slow freezing are being more widely used nowadays. In order to clarify mentioned phenomena, a detailed monitoring of preparation process and freezing, as well as changes of frozen blackberry fruits in industrial conditions was carried out. Along with sensory evaluation of surface colour changes, chemical analysis of reference parameters of fresh and frozen fruits were performed. The results of sensory evaluation confirmed evident colour change of fruits frozen by slow (and fast) treatment; the chemical analysis confirmed unchanged total solids and anthocyanin content, as well as changes in pH value and vitamin C, in comparison to fresh blackberry fruits.

KEYWORDS: Blackberry, freezing, anthocyanin, sensory evaluation, chemical analysis

INTRODUCTION

The main colour constituents of blackberry are anthocyanins, of which cyanidin-3-glucoside and cyanidin-3-rutinoside are being the predominant (1).

The importance of anthocyanins in human organism has been known for a long time, as their benefits in blood sugar control, coronary disease protection, cancer risk lowering, heart illnesses and Alzheimer disease, etc. have been established (2). Flavan part of anthocyanin molecule is characterized by a lack of electron, and that is the reason of its susceptibility to structural changes during processing and storage of anthocyanin-containing fruits. These changes are influenced by several factors, such as pH, sulphur dioxide, L-ascorbic acid, metal ions, increased sugar content, enzyme activity, temperature, etc. (3,4).

On the basis of above mentioned facts, it was assessed that it would be useful to carry out mentioned experiments, and, besides sensory analysis, to set changes of some cited parameters depending on the freezing rate of blackberry fruits.

Dobrila G. Ranđelović, B.Sc., Dr. Ljubo O. Vračar, Prof., Aleksandra N. Tepić, M.Sc., Assist., tepical@uns.ns.ac.yu, University of Novi Sad, Faculty of Technology, 21000 Novi Sad, Bulevar cara Lazara 1, Serbia

EXPERIMENTAL

Experiment was carried out in the factory RO "Vino Župa" in Aleksandrovac, freezing plant Brus, using the most wholesale cultivated variety of blackberry – Thornfree, form the region of Brus.

The preparation of blackberry fruits included reception in original packages (plastic containers with 5kg of fruits) and laying aside into chambers with temperature of 6°C to sub-cooling. To the moment of beginning of freezing, blackberry fruits were cooled to cca 10°C in the centre of the fruit.

After sampling ("zero" sample - fresh blackberry fruit), prepared blackberry fruits were frozen in:

- classic tunnel with temperature of -35°C, for 15 hours (slow freezing);
- continuous tunnel (fluidizer Frigoscandia, Sweeden) (5), with temperature of -35°C, for 14 minutes (fast freezing).

The reached temperature in the centre of fruits in both cases was about -18°C.

The sampling was carried out after finishing the freezing process. In order to compare these samples, the following chemical analysis (6) were done:

- total solids content - drying at 105°C until a constant weight was obtained,
- pH - potentiometrically,
- total anthocyanin content - Somers-Evans method (7),
- vitamin C content - Tilmans method,

Sensory evaluation of colour changes of blackberry was done according to point system (1 to 5 points), presented in Table 1.

Table 1. Sensory evaluation of blackberry fruit colour by point system [adapted from (8)]

Characteristic of colour	Points
Colour partially corresponding to fruit type	1
Colour corresponding to fruit type, with prominent deviation	2
Colour corresponding to fruit type, with less withdrawing nuances	3
Colour corresponding to fruit type	4
Characteristic - perfect colour	5

During setting the experiment in this work, the results of Janković et al. (9, 10) were taken into consideration, claiming that:

- colour change is not dependent on the initial total anthocyanin concentration;
- colour change of frozen blackberry fruit is not the consequence of temperature "shock";
- the final freezing temperature does not influence the change of colour.

RESULTS AND DISCUSSION

The results of chemical analysis of fresh, fast and slow frozen blackberry fruits are presented in Table 2.

Table 2. The main chemical composition of fresh, fast and slow frozen blackberry fruits

Sample	Total dry metter (%)	pH	Total anthocyanin (mg/100g	Vitamin C (mg/100g)
Fresh	14.65	3.07	38.06	14.43
Fast frozen	14.56	2.73	38.4	11.87
Slow frozen	14.93	2.95	38.6	9.54

The results of chemical analysis of fresh blackberry fruit show that the raw material used was of a high grade, with relevant parameters corresponding those found in the pertinent literature (6).

The results of analysis of frozen fruits in continuous tunnel ("fast" process) and classic tunnel ("slow" process) show that total solids and total anthocyanin content remained practically unchanged, which is in agreement with the findings of other authors (9). However, they also show the evident change of the pH in both freezing processes to fresh fruit, as well as among each other. The lowest pH was measured in fast frozen fruits, which is interpreted as consequence of faster increase of soluble solids concentration in unfrozen substances of fruit. This phenomenon confirms the knowledge that total anthocyanin content remains constant during freezing process, and that the surface change of colour is a consequence of the change in pH value. Janković et al. (9, 10) supported this hypothesis by the fact that at constant pH, the alkali anthocyanin extract from blackberry does not change its colour during the change of freezing rate. These authors also stated that the change of pH in the blackberry fruit cell occurs in the second stage of freezing, when the temperature of -5°C at the centre of the fruit is to be decreased to -18°C or lower. This statement can also be confirmed by visual observation of freezing.

The measured change (decrease) in vitamin C content during freezing process is just a confirmation of the other investigations (11, 12, 13). The greater decrease in vitamin C content in slow frozen fruits is just a confirmation of the fact that time is always a very important parameter in all operations which in any sense can influence the negative changes of the product.

The results of sensory evaluation of surface colour of fresh and frozen blackberry fruits (according to Table 1) are presented in Table 3. During sensory evaluation, the results of Janković et al. (9, 10) were taken into consideration, claiming that:

- colour change is not dependent on the initial total anthocyanin concentration;
- colour change of frozen blackberry fruit is not a consequence of temperature "shock";
- the final freezing temperature does not influence the change of colour.

The results confirm that all five evaluators recognized and graded fresh fruit with best marks (5 points); slow frozen fruits were assessed as corresponding to fruit type; fast frozen fruits, with partially copper-reddish colour, were characterized as partially corresponding to fruit type.

APTEFF, 39, 1-212 (2008) UDC:634.71:664.037.5:543.635+543.92
DOI: 10.2298/APT0839063R BIBLID: 1450-7188 (2008) 39, 63-68
Original scientific paper

Table 3. Results of sensory evaluation of blackberry fruits

Evaluator	1	2	3	4	5
Sample	Points				
Fresh blackberry fruit	5	5	5	5	5
Fast frozen blackberry fruit	1	1	1	2	1
Slow frozen blackberry fruit	4	4	4	3	4

The results confirm that all five evaluators recognized and graded fresh fruit with best marks (5 points); slow frozen fruits were assessed as corresponding to fruit type; fast frozen fruits, with partially copper-redish colour, were characterized as partially corresponding to fruit type.

Figures 1, 2 and 3 illustrate the results of sensory evaluation.

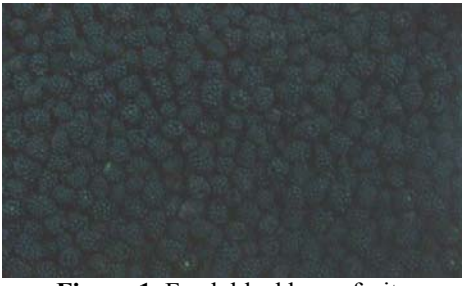

Figure 1. Fresh blackberry fruits

Figure 2. Slow frozen blackberry fruts

Figure 3. Fast frozen blackberry fruits

On the basis of the above results, several conclusions can be made. Blackberry fruits of Thornfree variety (whose characteristics were in correspondence to the literature data) used in this experiment were of high grade quality. Total solids and total anthocyanin contents remained practically unchanged during both freezing processes. The changes in the pH and vitamin C content were in direct dependence on the freezing rate; in fast frozen fruits, higher decrease of pH and lower decrease of vitamin C content was measured, in comparison to slow frozen fruits. On the basis of the literature data, it can be said that fast freezing leads to high quality products. However, as the appearance of frozen fruits is concerned, experience has shown that frozen blackberry is an exception, i.e., slow freezing seems to be a better method. Explanation of this phenomenon is to be sought for in the future, in order to clarify these unusual colour changes.

REFERENCES

1. Robinson, W. B., Bertino, J. J. and Witcombe, J. E.: Objective measurement and specification of colour in red wines. Am. J. Enol. Vitic. **17** (1966) 118-123.
2. Jeličić, A., Rajaković, LJ.: Antocijani – biljni pigmenti, Hemijski pregled, Beograd (2005).
3. Fenema, O.: Water and Ice. In: Food Chemistry, 3rd edn. Marcel Dekker, New York (1996) pp. 18-94.
4. Goodman L. P. and Markakis P.: Sulphur dioxide inhibition of anthocyanin degradation by phenolase. J. Food Sci. **30** (1965) 135-139.
5. Janković, M.: Tehnologija hlađenja, Beograd (2002) pp. 133-137.
6. Vračar, LJ.: Priručnik za kontrolu kvaliteta svežeg i prerađenog voća, povrća i pečurki i osvežavajućih bezalkoholnih pića, Novi Sad (2001) pp. 58-61; 108-111.
7. Vukosavljević, P.: Bistrenje soka maline primenom ultrafiltracije i mikrofiltracije, PhD thesis, University of Belgrade (2006).
8. Ćirić, D., Biserka Vujičić, Bardić, Ž.: Priručnik za kontrolu kvaliteta sirovina i proizvoda od voća i povrća, Tehološki fakultet, Novi Sad (1975).
9. Janković, M., Milanović B.: Uticaj brzine zamrzavanja na promenu boje kupine, Prvo savetovanje prehrambenih tehnologa Srbije, Zbornik radova, Poljoprivredni fakultet, Beograd (1991) pp. 97-105.
10. Janković, M., Kandić, M.: Tenologija berbe, transporta, zamrzavanja i čuvanja, maline i kupine, Savetovanje u Arilju, Zbornik radova (1993) pp. 24-31.
11. Vereš, M.: Principi konzervisanja namirnica, Beograd (2004) pp. 232-254.
12. Zlatković, B.: Tehnologija prerade voća i povrća, Beograd (2003) pp. 107-112.
13. Lovrić, T., Piližota, V.: Konzervisanje i prerada voća i povrća, Nakladni zavod Globus, Zagreb (1994) pp. 27-30; 108-111.

APTEFF, 39, 1-212 (2008) UDC:634.71:664.037.5:543.635+543.92
DOI: 10.2298/APT0839063R BIBLID: 1450-7188 (2008) 39, 63-68
Original scientific paper

ПРОМЕНА БОЈЕ КУПИНЕ ЗАВИСНО ОД БРЗИНЕ ЗАМРЗАВАЊА

Добрила Г. Ранђеловић, Љубо О. Врачар и Александра Н. Тепић

У пракси је познато, да брзо замрзнути плодови купине карактеристичну, површинску црну боју, мењају делимично до бакарно-црвенкасте. Ова појава у знатној мери умањује вредност замрзнуте купине на тржишту, а нарочито у извозу. Из тих разлога, данас је све шира примена класичних тунела са споријим замрзавањем што је знатно испод савремене технологије замрзавања уопште.

У циљу доприноса разјашњењу наведене појаве обављено је детаљније праћење редовног процеса припреме, замрзавања и промена на замрзнутом плоду купине у индустријским условима (хладњачи).

Поред сензорске оцене промене површинске боје, обављене су и хемијске анализе на референтне параметре свежег и замрзнутог плода.

Резултати сензорске оцене потврђују евидентну промену боје плодова купине замрзнутих спорим и брзим поступком, а хемијске анализе показују непромењен садржај укупних сувих материја и антоцијана, док се pH и садржај витамина C мењају у односу на свеже плодове купине.

Received 31 March 2008
Accepted 30 Septembar 2008