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# EXPERIMENTAL CHARACTERISTICS OF FREEZING OF APPLE-PEAR PUREE WITH SWEETENING SUBSTANCES ADDITION

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Abstract. The presents experimental stusies on selected sweetening substances (glucose, saccharose, honey and cane sugar) used to obtain frozen homogeneous apple-pear puree. The analysed influence of the type and rate of addition (by weight) of the substances on the cryoscopic temperature of the investigated products proved to be significant. Increase in the rate of addition of the sweetening substances resulted every time in a decrease of the cryoscopic temperature of the purees under study. The investigated temperature dependences on the additives percentage by weight are well expressed by quadratic equations.

Keywords: freezing, cryoscopic temperature, fruit purees

## INTRODUCTION

Most fruits are characterized by low keeping quality in the fresh state, and only some are fit for longer storage. In the food industry various methods for fruit preservation are applied, but freezing is the most common. Fruits and purees preserved in this way maintain their nutritional value in a great measure, as well as their appearance and characteristic sensory attributes.

Most agricultural products, fruits and their products subjected to freezing show a high rehydration level that affects significantly their properties, mainly cryoscopic temperature - being one of the most vital physical qualities. The initial cryoscopic temperature is defined as the temperature at which ice crystals start forming in the structures of complex solutions in a product. This induces suitable changes of liquid solution concentration and cryoscopic temperature depends on the solution concentration, molecular weight and dissociation level of dissolved substances present in both food and additives. The additive activity in products is

most often explained with the Karrow`s and Webb`s hypotheses of so-called "ice moderator (retardant)" and "structural water". Of the added compounds, saccharides (among others, glucose, glucose syrup, fructose, honey) are of primary importance [3,4,5,6,9,10]. In freezing processing they are not only to develop the dessert properties (e.g. structural) but to preserve the product processed through water activity diminishment. The substances mentioned above are of varied sweetness and capacity to decrease the freezing point. Most of them reduce the product freezing point more than saccharose, so e.g. a glucose content should not exceed 25% [1,11,13].

Regarding the sweetening substances properties, the level to which the studied additives can affect the cryoscopic temperature of freezing apple-pear purees was analysed.

## MATERIAL AND METHODS

The experimental material was constituted by purees in the form of creamogen, obtained from raw, peeled, clean apples of *Yestar* variety and pears of *Concorde* variety, with removed inedible parts (Tab. 1).

**Table 1.** Average chemical composition in 100g of edible part of chosen fruits [2]

| Component | Apple | Pear |
|---|---|---|
| Water content (%) | 80-88 | 83.2 |
| Protein (%) | 0.2- 0.4 | 0.7 |
| Carbohydrates (%) | 8 -16 | 14.4 |
| Vitamin C (mg) | 9.2 | 5.3 |
| Vitamin A (j.m.) | 90 | 20 |
| Cellulose (g) | 2 | 2.1 |
| Ash (%) | 0.3 | 0.4 |

Puree was obtained from fully ripe fruits, yet not overripe, healthy and undamaged. It was produced according to the fixed basic recipe: raw apples 66.2%, pear 33.0%, ascorbic acid 0.8% considered the control sample. The prepared purees differed in w/w of the added sweetening substances (Tab.2).

The characteristics of "sweetness" resulting from differentiated w/w sweetening substances in the investigated purees was evaluated with the hedonic scale presented in the Figure 1. The studied substances sweetness varied considerably, subject to its share in a puree. The most recommended puree sweetness was one found between "quite sweet" and "sweet" in the hedonic scale [8].

In the ready to use apple-pear purees, pH of the control was determined by a digital pH-meter CP-215 Elmetron, whereas the total extract content with refractometric analysis [7,12].

**Table 2.** Percentage by weight of added sweetening substances

| Feature | Characteristic |
|---|---|
| Colour | proper for used fruits |
| Taste | proper for used fruits, sour and sweet |
| Flavour | proper for used fruits |
| Consistency | uniform, semi-fluid mass |
| Total extract (%) | 16 |
| pH | 3.5 |

The studies on the freezing process run were conducted with the help of an experimental measurement stand assuring suitable freezing conditions, current visualization of the process changes, as well as temperature measurement accuracy of ±0.1 K. The purees were frozen in a cabinet freezer with refrigeration temperature maintained at –32°C.

The cryoscopic temperature values were determined on the basis of the freezing curves obtained.

The statistical interpretation of results, covering variance analysis and regression equation, was analysed by "STATGRAPHIC" Microsoft [14].

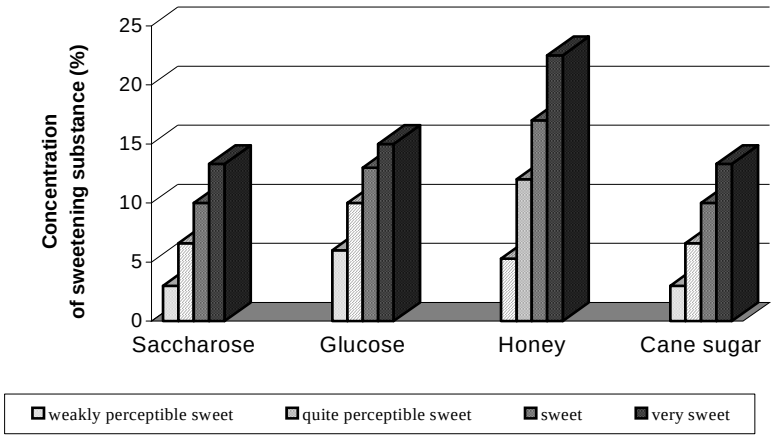


**Fig. 1.** Comparative evaluation of sweetness desirability level of studied purees

## RESULTS AND DISCUSSION

The apple-pear puree obtained showed semi-fluid, homogeneous consistency at very high comminution. The basic characteristics of the puree are given in Table 3.

**Table 3.** Characteristics of apple-pear puree produced

| Sweetening substances | Percentage by weight (%) |
|---|---|
| Saccharose | 3-13.3 |
| Glucose „Delekta” | 6-15 |
| Honey | 5.3-22.5 |
| Cane sugar „Muscovado” | 3-13.3 |

Analysis of the results showed that cryoscopic temperature value of apple-pear puree can be developed through the addaition of various sweetening substances. The changes of this value were presented graphically. Table 4 gives cryoscopic temperature of the samples with varied sweetening substances share.

**Table 4.** Cryoscopic temperature values of apple-pear purees obtained

| Sample No. | Ingredient type | Percentage by weight (%) | Cryoscopic temperature $T_{cr}$ (°C) |
|---|---|---|---|
| 1 | Control | 0 | –2.0 |
| 2 | Saccharose | 3 | –2.6 |
| 3 | Saccharose | 6.6 | –2.8 |
| 4 | Saccharose | 10 | –3.4 |
| 5 | Saccharose | 13.3 | –3.9 |
| 6 | Glucose | 6 | –4.0 |
| 7 | Glucose | 10 | –4.4 |
| 8 | Glucose | 13 | –4.7 |
| 9 | Glucose | 15 | –5.1 |
| 10 | Honey | 5.3 | –3.0 |
| 11 | Honey | 12 | –3.6 |
| 12 | Honey | 17 | –4.6 |
| 13 | Honey | 22.5 | –5.3 |
| 14 | Cane sugar | 3 | –2.6 |
| 15 | Cane sugar | 6.6 | –3.3 |
| 16 | Cane sugar | 10 | –3.7 |
| 17 | Cane sugar | 13.3 | –4.0 |

Figure 2 presents the temperature course of freezing apple-pear puree with saccharose addition. This substance is widely used for food sweetening as well as for preservation of products with high sugar content through water activity reduction. Analysis of the experimental data revealed that a saccharose additive caused a cryoscopic temperature fall; its value for the control was $T_{cr}$ = –2°C.

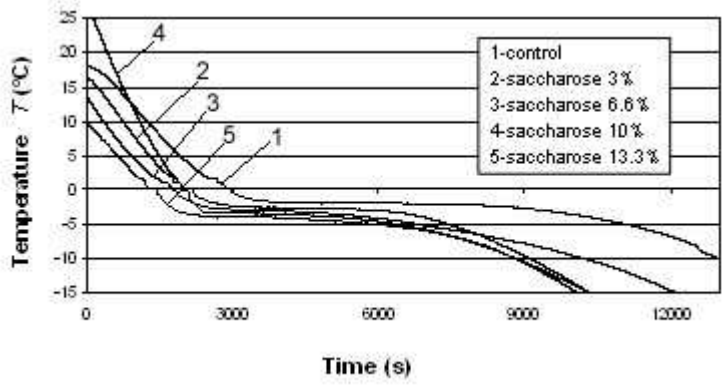


**Fig. 2.** Freezing curves of apple-pear puree with saccharose

Slight saccharose percentage weight in a puree brought a slight freezing temperature decline, whereas at the maximum saccharose share of 13.3% the cryoscopic temperature stabilized at the level of $T_{cr}$ = –3.9°C.

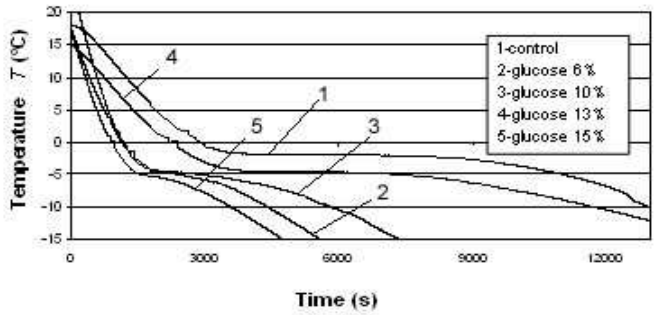


**Fig. 3.** Freezing curves run of apple-pear puree with glucose

A similar run of cryoscopic temperature changes was recorded for puree samples with crystalline glucose addition (Fig.3). This additive caused a substantial fall of cryoscopic temperature value. The smallest additive (6%) of glucose made cryoscopic temperature fix at the level of $T_{cr}$ = –4°C. However, a glucose content rise up to 15% decreased cryoscopic temperature to $T_{cr}$ = –5.1°C which is bound to result from the glucose characteristics.

The dependence of cryoscopic temperature value on the amount of saccharose added (Fig.4) may be expressed with a quadratic equation (correlation coefficient R = 0.99). It is worth noting that simple sugars have lower molecular weight compared to disaccharides, and the lower the sugar molecular weight the greater the cryoscopic temperature decline (Fig.5).

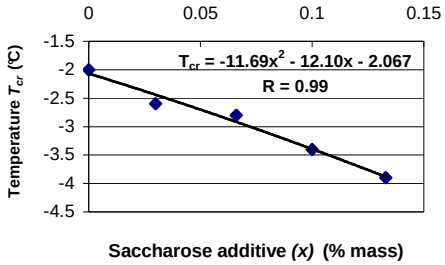


**Fig. 4.** Relation between cryoscopic temperature $T_{cr}$ and saccharose content $x$ in puree

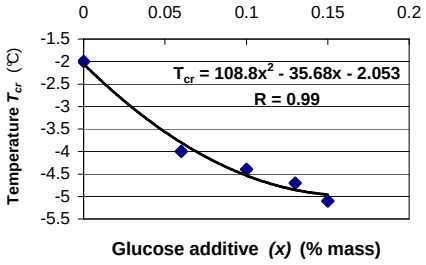


**Fig. 5.** Influence of glucose $x$ on value of cryoscopic temperature $T_{cr}$

Cane sugar as a supplement to recipe composition also induced a cryoscopic temperature decrease in the puree samples (Fig.6). Cryoscopic temperature fall in these samples was similar to that observed with saccharose additive. A 3% cane sugar content in puree affected slightly its cryoscopic temperature ($T_{cr}$ = –2.6°C), while its maximum content 13.3% decreased the temperature to $T_{cr}$ = –4°C. According to the obtained equation, the cryoscopic temperature value changes after the dependences of the quadratic equation (Fig.8).

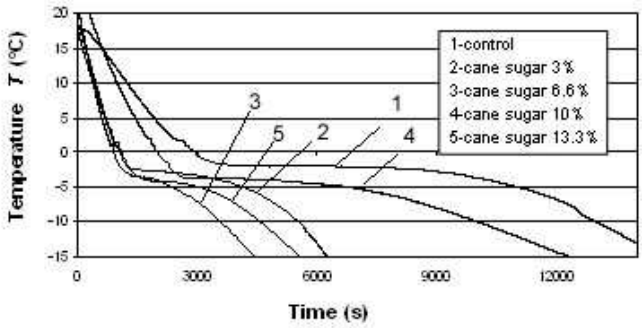


**Fig. 6.** Freezing curves of apple-pear puree with cane sugar

A detailed analysis of results indicates that the greatest depression of cryoscopic temperature values was obtained with artificial honey of fluid consistency (Fig.7). Probably it results from its chemical composition where dry weight is about 75-80% with glucose, lactose and saccharose, and maximum water content about 21%. Honey contains simple sugars, so it exerts greater impact on cryoscopic temperature decrease in purees. At 22.5% honey content, cryoscopic temperature level reached $T_{cr}$ = –5.3°C.

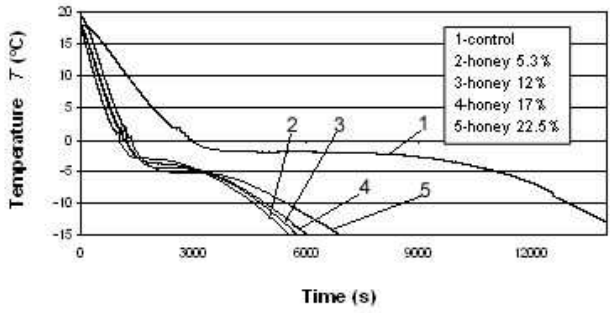


**Fig. 7.** Changes of freezing point run in apple-pear puree with honey

The dependence of cryoscopic temperature value on honey content in puree is presented in Figure 9.

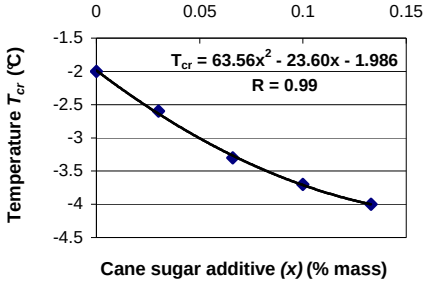


**Fig. 8.** Relation between cryoscopic temperature $T_{cr}$ and cane sugar content $x$ in puree

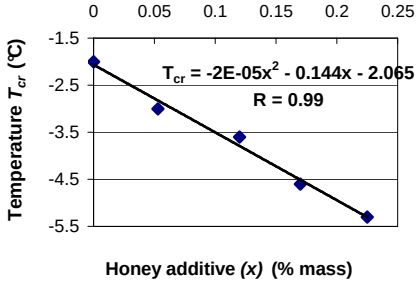


**Fig. 9.** Influence of honey $x$ on value of cryoscopic temperature $T_{cr}$

## CONCLUSIONS

1. Cryoscopic temperature of the studied samples of apple-pear puree depends on the chemical composition; its values were contained between $T_{cr}$ = –2°C (control) and $T_{cr}$ = –5.3°C (with 22.5% of artificial honey).

2. In each apple-pear puree sample studied a sweetening substance additive decreased adequately its cryoscopic temperature value. The higher the quantity percentage of sweetening substance addition, the greater the decline of cryoscopic temperature of the investigated samples.

3. The changes of cryoscopic temperature values of purees in the function of sweetening substances percentage weight can be expressed as a quadratic polynomial with high correlation coefficients.

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# DOŚWIADCZALNA CHARAKTERYSTYKA ZAMRAŻANIA PRZECIERU JABŁKOWO-GRUSZKOWEGO Z DODATKIEM SUBSTANCJI SŁODZĄCYCH

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S t r e s z c z e n i e . W pracy przeprowadzono badania eksperymentalne nad wykorzystaniem wybranych substancji słodzących (glukoza, sacharoza, miód, cukier trzcinowy) do otrzymania mrożonego homogennego przecieru jabłkowo-gruszkowego. Analizowano wpływ rodzaju i udziału masowego tych substancji na kształtowanie się wartości temperatury krioskopowej badanych przecierów. Wykazano istotny wpływ rodzaju i udziału masowego dodawanej substancji na kształtowanie się badanej wielkości. Zwiększając udział masowy dodawanej substancji słodzącej doprowadza się każdorazowo do obniżenia wartości temperatury krioskopowej badanych przecierów. Zbadane zależności tej temperatury od masowego udziału dodatków dobrze opisują równania drugiego rzędu.

S ł o w a k l u c z o w e : zamrażanie, temperatura krioskopowa, przeciery owocowe