thyroid gland in the neck, developing a goiter. Insufficient thyroid hormone production (hypothyroidism) can cause symptoms including: tiredness, weight gain, muscle weakness, slow heartbreak, constipation, puffy face, dry skin and hair loss. Taking too much iodine can also cause problems with health. It causes some symptoms such as iodine deficiency, including goiter, thyroid gland inflammation and thyroid cancer.

Iodine levels can be measured in the blood or the urine. When iodine deficiency is seen, it is best managed by ensuring that foods contain sufficient levels of iodine [2].

CONCLUSIONS

These results of the study allow us to conclude: some students do not pay attention to iodine foods consumption. The problem of iodine deficiency has a social significance and can affect the decline in the intellectual, educational and professional potential of young people.

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ИСПОЛЬЗОВАНИЕ МОЛЕКУЛ АНТОЦИАНОВОГО РЯДА, СОДЕРЖАЩИХСЯ В КРАСНОЙ СВЕКЛЕ В КАЧЕСТВЕ КИСЛОТНО-ОСНОВНОГО ИНДИКАТОРА

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Аннотация

Введение. В наши дни производителям различных бытовых и пищевых жидкостей необходимо контролировать их кислотность, чтобы их продукция выполняла свое назначение. Для этого используются кислотно-основные индикаторы. Актуальность исследования заключается в поиске более дешевой замены универсальному индикатору по Богену. **Цель исследования** – доказать возможность использования молекул антоцианового ряда в качестве кислотно-основных индикаторов. **Материал и методы.** Был проведен качественный анализ на содержание антоцианов в красной кормовой свекле, теоретический эксперимент, подтверждающий у них наличие свойств кислотно-основных индикаторов и практический эксперимент, подтверждающий теорию. **Результаты.** Антоцианы красной свеклы могут использоваться, как кислотно-основный индикатор. Является сложностью точное определение pH из-за большого содержания молекул пигмента в растворе и перекрытия цветов, однако посредством уменьшения, или увеличения концентрации можно определить pH более точно. **Выводы.** Необходимо популяризовать знания о кислотно-основных индикаторах. С точки зрения соотношения цена-качество, свекольный сок гораздо доступнее, нежели универсальный индикатор.
Ключевые слова: красная свекла, кислотно-щелочной индикатор

USING ANTOCYANIAN MOLECULES CONTAINED IN RED BEET AS AN ACID-BASE INDICATOR

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Abstract

Introduction. These days, manufacturers of various household and food liquids need to control their acidity in order for their products to fulfill their intended purpose. For this, acid-base indicators are used. The relevance of the study lies in the search for a cheaper replacement for the universal indicator according to Bogen. **The purpose of the study** is to prove the possibility of using anthocyanin molecules as acid-base indicators. **Material and methods.** A qualitative analysis was carried out for the content of anthocyanins in red fodder beet, a theoretical experiment confirming the presence of properties of acid-base indicators and a practical experiment confirming the theory. **Results.** Red beet anthocyanins can be used as an acid-base indicator. It is difficult to accurately determine the pH due to the high content of pigment molecules in the solution and the overlap of colors, however, by decreasing or increasing the concentration, one can determine the pH more accurately. **Conclusions.** It is necessary to popularize knowledge about acid-base indicators. In terms of price-quality ratio, beetroot juice is much more affordable than a universal indicator.
Keywords: red beet, acid-base indicator

INTRODUCTION

In the life of mankind, much depends on the acid-base balance, almost every biological fluid has its own acidity index (pH). Today, manufacturers of various household and food liquids need to control this parameter in order for their products to fulfill their intended purpose. For this, acid-base indicators of various transition intervals are used, but there are also universal indicators that work in the full pH range. For example, a universal indicator (according to Bogen) of the following composition is known: phenolphthalein (0.2 g), methyl red (0.4 g), dimethylaminobenzene (0.6 g), bromothymol blue (0.8 g), thymol blue (1.0 g), ethyl alcohol (1.0 l), sodium hydroxide (until a yellow color appears) [1]. The production and preparation of such an indicator requires a lot of financial and production costs, which pay off with a high purchase price on an industrial scale.

The relevance of the study lies in the search for a cheaper replacement for this indicator for its use in everyday life, the analysis of household and cosmetic chemicals, in addition, to study soil fertility, analyze and solve environmental issues.

The purpose of the study is to prove the possibility of using molecules of the anthocyanin series as acid-base indicators.

MATERIAL AND METHODS

As part of the work, an analysis of the literature on the qualitative composition of beet juice Beta vulgaris, including its subspecies - fodder beet Beta vulgaris subsp. vulgaris var. crassa. For the analysis, we used the information on the juice of plants that has a pronounced red color, which causes a high concentration of anthocyanin molecules in such root crops [2]. After that we carried out a theoretical analysis of a specific group of molecules (betalains) for the presence of acid-base properties in them, confirmed experimentally in domestic conditions.

We had conducted the study on the basis of the MAOU gymnasium № 35 in Yekaterinburg, Russia, and we had analyzed the results of the study visually to confirm the availability of using our indicator.

RESULTS

To prove the presence of properties of acid-base indicators in betalains, their structure was studied. Based on the structure and literature data describing the chemical properties of such compounds [4], we deduced the mechanisms of reactions of these compounds with acids and bases. After that, we conducted a practical experiment to confirm the presence of properties of acid-base indicators in betalains. Freshly squeezed concentrated juice of the red fruits of Beta vulgaris subsp. vulgaris var. crassa, when various substances were added to it, showed the properties of acid-base indicators without any additional manipulations for the extraction of betalains from it. This liquid can be used as a formulation for an acid-base indicator operating over the full pH range (0 to 14 under standard conditions). In an acidic environment (pH=0-4) beetroot juice acquires a dark red color, in a slightly acidic environment (pH=5-6) the solution becomes bright red, in a neutral (pH=7) – light red, in a slightly alkaline (pH = 8-9) – dark purple, and in alkaline (pH = 10-14) - yellow. It is difficult to accurately determine the pH due to the high content of pigment molecules in the solution and the overlap of colors, however, by decreasing or increasing the concentration, one can determine the pH more accurately.

DISCUSSION

The resulting beetroot juice concentrate contained a large number of substances, a qualitative analysis was not carried out, since the qualitative composition of beetroot juice, including the content of various pigments, was described. We were interested in a specific class of molecules of the anthocyanin series - betalains. To prove that these molecules have acid-base properties, it was necessary to prove the possibility of chemical reactions with acids and bases, and in order to prove that these molecules have the properties of acid-base indicators, it was necessary to find a qualitative sign in these reactions [3].

One substance from the betalain family, which is the main pigment constituent of beet juice, is shown in Fig. 1:

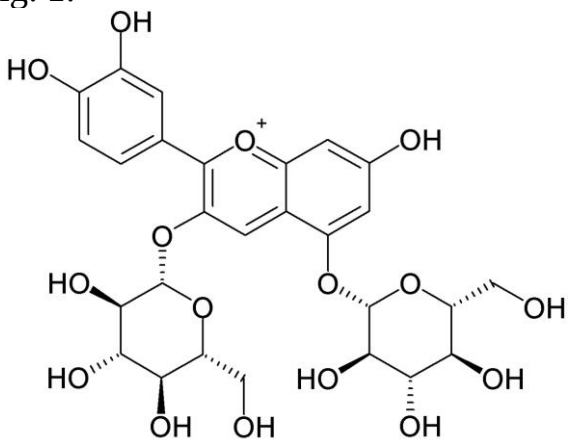

Fig. 1 Cyanidin-3,5-O-diglucoside

In the structural formula of this molecule, we have identified three parts: the main one, responsible for the color of this compound (cyanidin), and two optional ones (glucose residues). We did not study the details of the effect of glucose residues on the system of benzene rings, paying attention only to the cyanidin part of the molecule, since, in addition to this compound, beetroot juice contains other derivatives of it, which also give these liquid various shades of red color.

Figures 2 and 3 show the reactions of the cyanidin base with acid and base, respectively, the reactions are written using reference literature [4]. Trichloroacetic acid, which has a high strength and acidic reaction of the medium, was taken as the acid, guanidine, an organic base, was taken as the base:

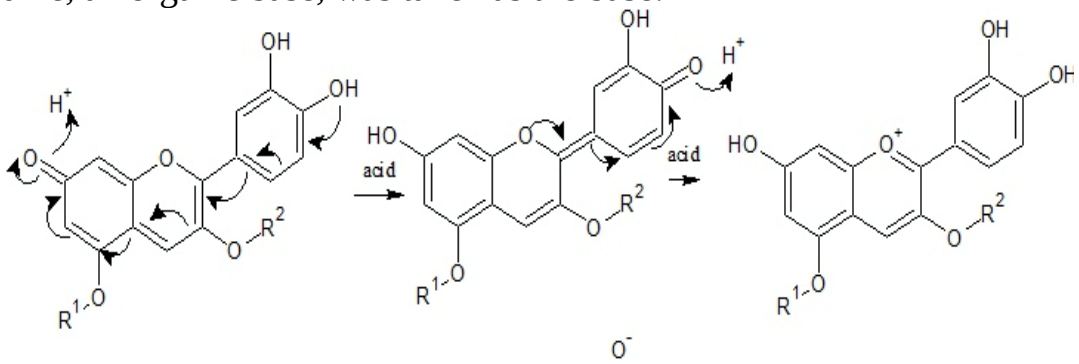

Fig. 2 Reaction of cyanidin with acid (trichloroacetic)

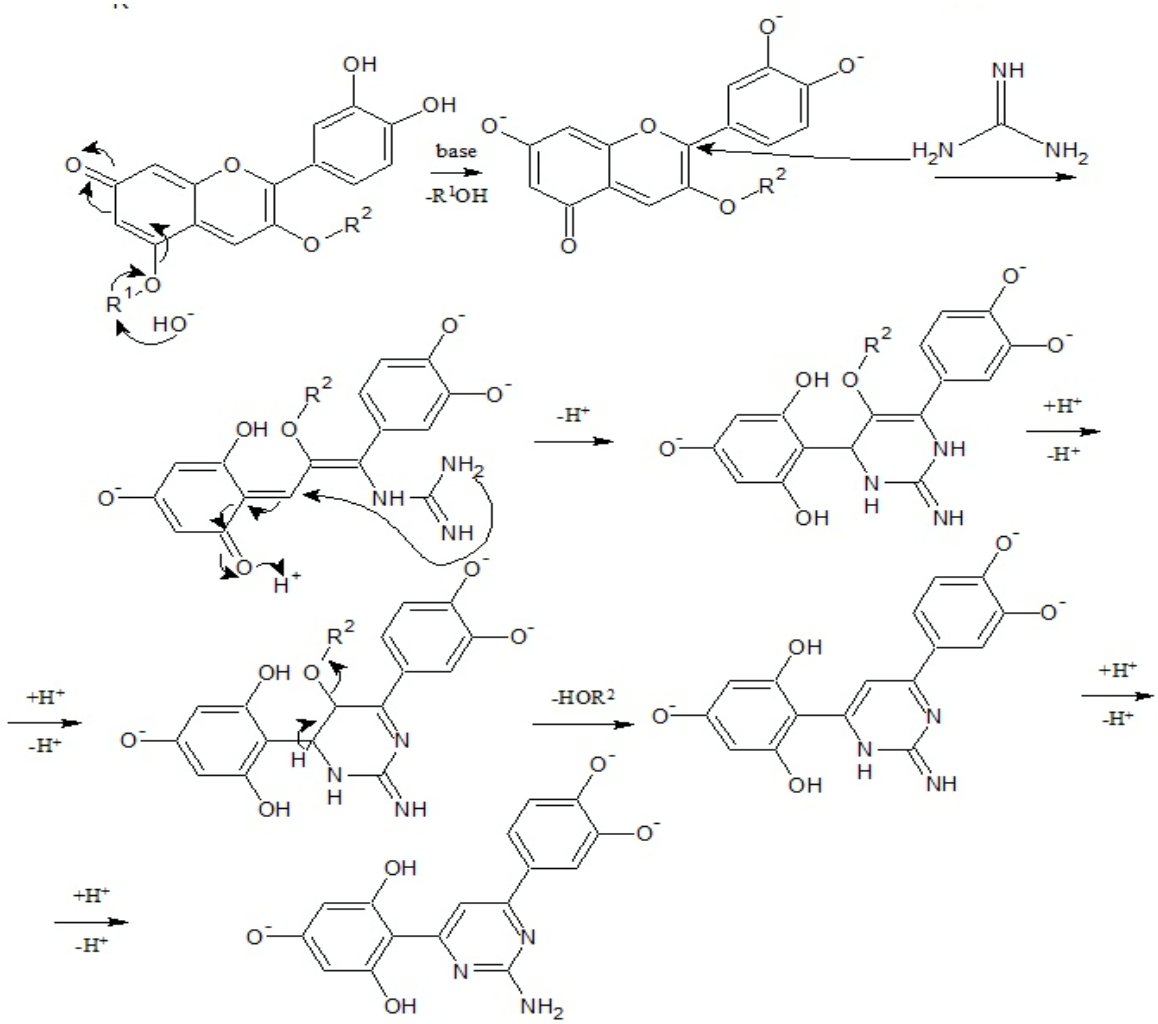

Fig. 3 Reaction of cyanidin with a base (guanidine)

Final molecules:

1. Reaction with acid: 2-(3,4-dihydroxyphenyl)-3,5-O-diglucoside-7-hydroxybenzopyryllium (dark purple)

2. Reaction with base: 2-amino-4-(3,4-dihydroxyphenyl)-6-(2,4,6-trihydroxyphenyl)-pyrimidine (yellow)

After conducting a theoretical experiment, having gained the understanding that this molecule has the properties of an acid-base indicator, a practical experiment was carried out in order to compare the possibility of replacing the universal indicator with beet juice. When hydrochloric acid (HCl) is added, the color of the universal indicator is bright crimson, the color of beetroot juice is dark red. When sodium hydroxide (NaOH) is added, the color of the universal indicator is bright blue, the color of beetroot juice is yellow. When adding silver nitrate ($AgNO_3$), the color of the universal indicator is pink, the color of beet juice is bright red. When calcium chloride ($CaCl_2$) is added, the color of the universal indicator is yellow, the color of beet juice is pale red. When sodium carbonate (Na_2CO_3) is added, the color of the universal indicator is bright blue, the color of beet juice is dark purple. Thus, we confirmed the presence of properties of acid-base indicators in beet juice.

CONCLUSIONS

1. Molecules of the anthocyanin series, containing cyanidin as their basis, can be used as acid-base indicators.

2. Upon receipt of this indicator, no additional procedures are required to obtain it, except for the extraction of juice from the red fruit of fodder beet Beta vulgaris subsp. vulgaris var. crassa.

3. This indicator is more accessible than the universal Bogen indicator, both from a financial and production point of view. Although it gives a less accurate result in terms of color difference, this result can be interpreted by various methods, including instrumental (titrimetric), obtaining a more and more accurate result.

4. In terms of price-quality ratio, beetroot juice is much more affordable than a universal indicator.

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ВЗАИМОСВЯЗЬ ЭМОЦИОНАЛЬНОГО И СОЦИАЛЬНОГО ИНТЕЛЛЕКТА У СТУДЕНТОВ-МЕДИКОВ ПЕРВОГО КУРСА

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