SWEETENERS' SYNERGETIC EFFECT UPON THE SACCHAROSE'S SWEETNESS DEGREE

Iuliana CIOARBĂ
"Ştefan cel Mare" University-Suceava, Food Engineering Faculty
Amelia BUCULEI, Ioana REBENCIUC
Technical College of Food Industry, Suceava

Abstract
The study of edulcorants' synergism upon the saccharose's sweetness degree was primary based on several tastings of some saccharose and sweeteners solutions combined in different proportions. The edulcorants solutions' tasting represents a qualitative approach that rises to the level of scientific research. The tasting's results represent information that is both registered and processed. In the case of tasted sweeteners, the tasting team provided information in order to establish a certain score regarding the intensity of the sweetness degree perceived.
Key words: sweetness degree, sweeteners, intensitz of sweeteness degree

Rezumat
Studiul sinergismului edulcoranţilor asupra gradului de îndulcire al zaharozei a fost bazat pe mai multe degustări ale unor soluţii de zaharoză şi îndulcitori aflate în proporţii diferite. Degustarea soluţiilor de edulcoranţi reprezintă o abordare calitativă care se ridică la nivel de cercetare ştiinţifică. Rezultatele degustării oferă informaţia care este înregistrată şi procesată. În cazul îndulcitorilor testaţi, echipa de degustare oferă informaţii în scopul stabilirii unui scor evident referitor la intensitatea gradului de îndulcire perceput.
Cuvinte cheie: grad de îndulcire, îndulcitori, intensitatea gradului de îndulcire

Résumé
L'étude du sinérgisme des édulcorans sur le degré d'adoucissement de la sacchrose a été établi selon plusieurs dégustations des solutions de sacchrose et édulcorans dans différentes proportions. La dégustation des solutions d'édulcorans représente un sujet qualitatif qui se situe au niveau de récherche scientifique. Les résultats de la dégustation offrent l'information qui est enregistrée et processée. Dans le cas des édulcorans testés, l'équippe de dégustation offre des informations pour établir un score évident regardant l'intensité du degré d'adoucissement perçu.
Mots clef : degré dţadoucissement, édulcorans, l'intensité du degré d'adoucissement

Introduction

As it is well known, the sweetening power represents the ratio between saccharose's concentration in an environment and the edulcorant's concentration which develops a sweet taste of the same intensity in the same environment [1].

$$P_i = \frac{C_{saccharose}}{C_{edulcorant}}$$

The (tasters) tasting team, were/ was represented by persons who didn't have any special training in this field but were especially interested in it. The team's members were representatives of both genders, non- smokers, non-consumers of spicy food, they didn't suffer from illnesses (influenza, rhinitis etc.) of the sensory analyzers that could affect their perceptions and also, didn't follow any medical treatment that could negatively influence the sensorial analysis. The moment of tasting was established to be 1-2 hours after the meal and at least 1 hour before the next one, that time being considered the best time of the day because the gustative papillae are in this interval free from residues. Those who participated at the tasting process should as well not have any sensation of hunger before the analysis. The quantity of solutions used during the process was small.

Materials and methods

The methods used to determine the sweetening power can be direct and indirect as they can imply or not an explicit comparison between saccharose and edulcorant.

The method used for these determinations was the direct method. The direct method implies the comparison between some edulcorant solutions of different concentrations with a standard saccharose solution.

The direct methods can be applied in two ways: the pair method and the rank method. In the case of the pair method, each subject receives a series of pairs of samples, each pair consisting in the standard solution and an edulcorant solution. The edulcorant solution's concentration for which the appreciations generally are "the sample tastes sweeter than the standard solution", is used to calculate the sweetening power. When the rank method is applied, the subject receives a series of edulcorant solutions in the increasing order of their concentration and, he/ she is asked to situate the standard saccharose solution in this series. The method used for the study of the sweeteners' synergetic effect was the rank method.

The concept of "sweetening power" has some limits, being connected to the taste perception which is mostly a subjective matter. It must be reminded the fact that the intensity of the sweet taste perceived, for a given solution, differs from one person to another.

Results and discussion

Taking on account those mentioned above and on the basis of the information obtained, there were given scores for the intensity of the sweet taste perceived and diagrams as this below were made, being interpreted as it follows:

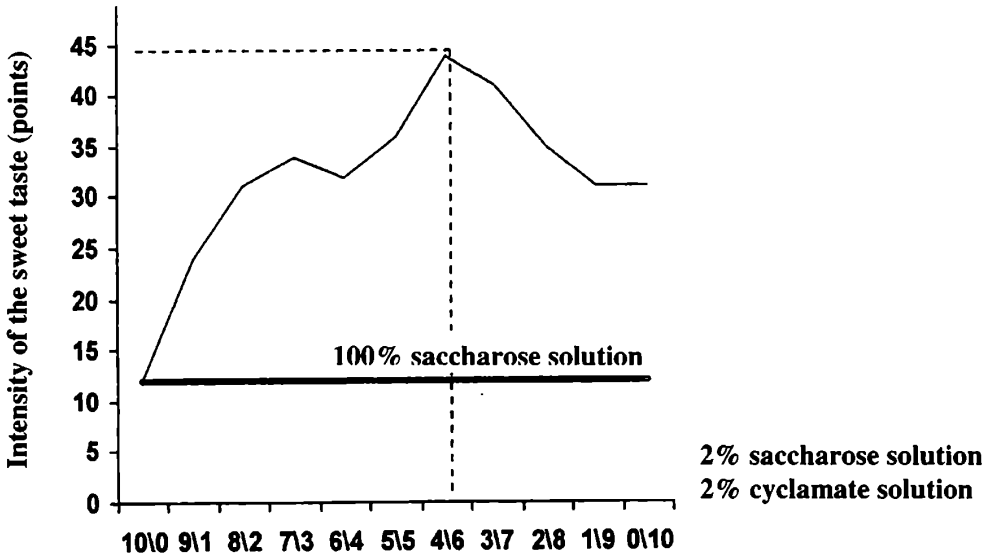

Fig. 1. The variation of the intensity of the sweet taste in a mixture of 2% saccharose solution and 2% cyclamate solution

In the case of cyclamate and saccharose mixture, the experiment starts with a saccharose solution (marked with 12 points) in which a cyclamate solution is gradually introduced along with the decrease of saccharose solution's quantity. It is noticed that the intensity of the sweet taste gradually increases up to the percentage of 70% saccharose and 30% cyclamate then it decreases a little, rising up again and reaching the maximum intensity of the sweet taste at the percentage of 40% saccharose

and 60% cyclamate. At this level (44 points on the scale of the intensity of the sweet taste) at which the ratio saccharose/ cyclamate is 2/3, we can assert that the sweet taste has increased by approximately 4 times compared to the initial saccharose solution.

Regarding the secondary tastes, in the case of cyclamate as well, it was made obvious the pronounced metallic residual taste and the bitter one. The metallic residual taste was perceived in most of the cyclamate/ saccharose mixtures at almost all proportion, reaching its maximum with the pure cyclamate.

In order to study the sodium cyclamate's sweetening power variation compared to a saccharose solution of different concentrations (1%, 2%, 3%, 4%, 5%), several tastings were made and their results can be seen below:

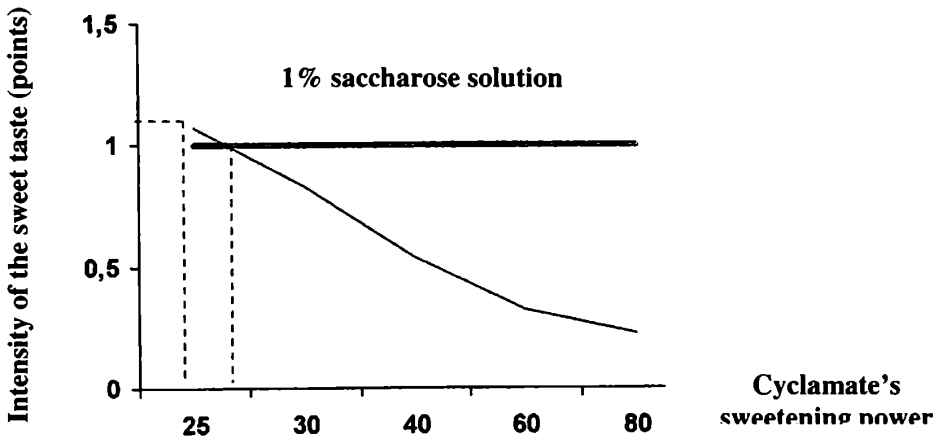

Fig. 2. Cyclamate's sweetening power compared to a 1% saccharose solution

When the cyclamate solution's intensity of sweet taste is compared to a 1% saccharose solution it can be noticed that the cyclamate's sweetening power is situated around the value of 27 (on a scale from 20 to 80). The cyclamate solution's intensity of sweet taste (1.08) is higher than the 1% saccharose solution's sweet taste (considered to be 1) when the cyclamate's sweetening power is 25, the following being the gradual decrease of intensity of the sweet taste along with the increase of cyclamate's sweetening power.

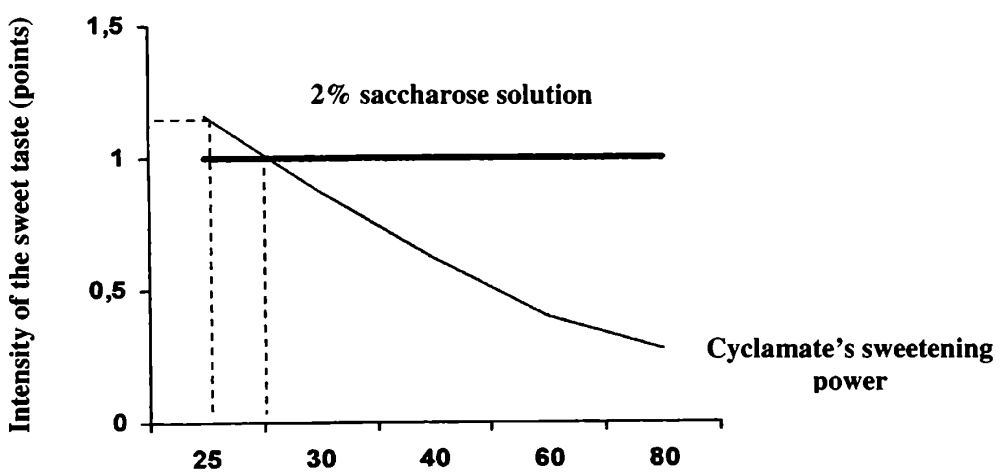

Fig. 3. Cyclamate's sweetening power compared to a 2% saccharose solution

When comparing the cyclamate solution's intensity of sweet taste to a 2% saccharose solution it can be noticed that the cyclamate's sweetening power is situated around the value of 28. The cyclamate solution's intensity of sweet taste (1.16) is higher than the 1% saccharose solution's sweet taste (considered to be 1) when the cyclamate's sweetening power is 25, the following being the gradual decrease of intensity of the sweet taste along with the increase of cyclamate's sweetening power.

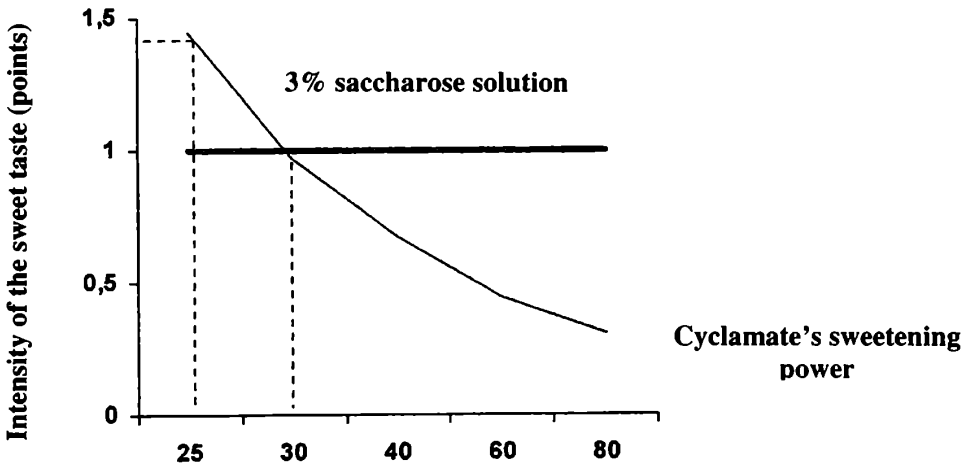

Fig. 4. Cyclamate's sweetening power compared to a 3% saccharose solution

When the cyclamate solution's intensity of sweet taste is compared to a 3% saccharose solution it can be noticed that the cyclamate's sweetening power is situated around the value of 29.8. The cyclamate solution's intensity of sweet taste (1.45) is higher than the 1% saccharose solution's sweet taste (considered to be 1) when the cyclamate's sweetening power is 25, the following being the gradual decrease of intensity of the sweet taste along with the increase of cyclamate's sweetening power.

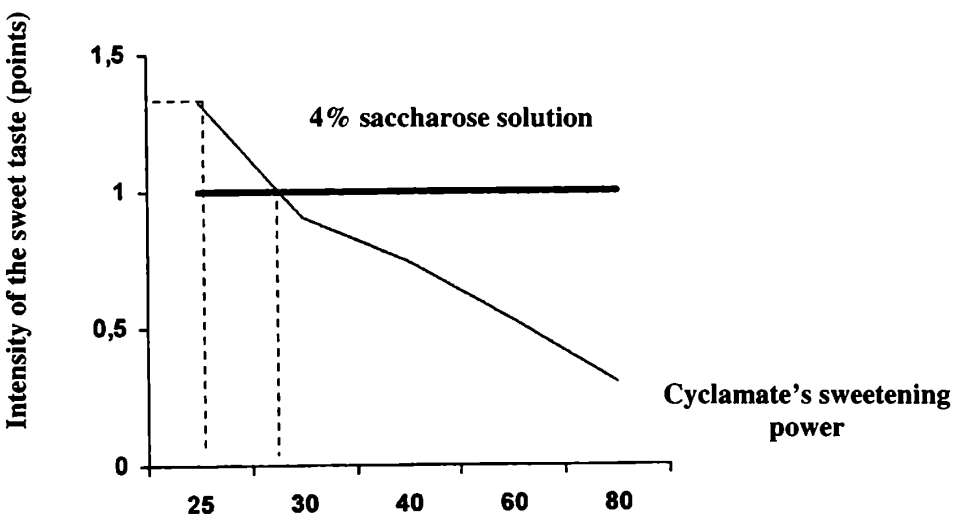

Fig. 5. Cyclamate's sweetening power compared to a 4% saccharose solution

When comparing the cyclamate solution's intensity of sweet taste to a 4% saccharose solution it can be noticed that the cyclamate's sweetening power is situated around the value of 29. The

cyclamate solution's intensity of sweet taste (1.33) is higher than the 1% saccharose solution's sweet taste (considered to be 1) when the cyclamate's sweetening power is 25, the following being the gradual decrease of intensity of the sweet taste along with the increase of cyclamate's sweetening power.

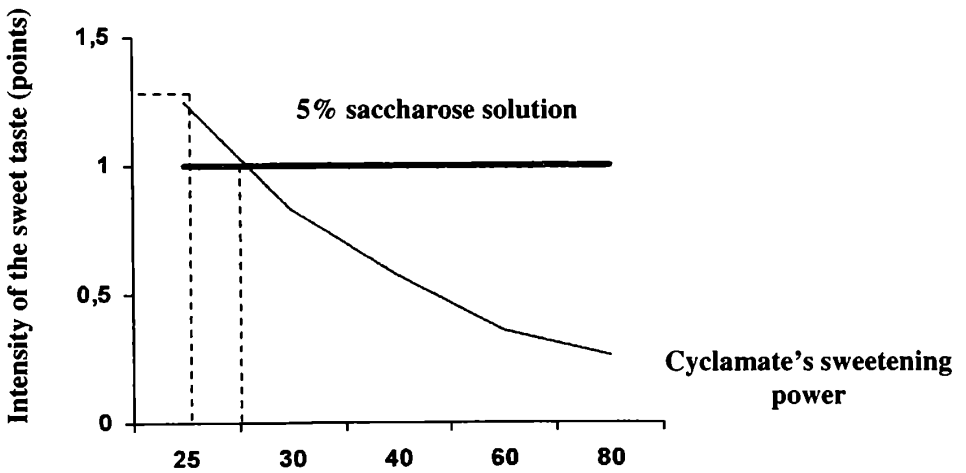

Fig. 6. Cyclamate's sweetening power compared to a 5% saccharose solution

When the cyclamate solution's intensity of sweet taste is compared to a 5% saccharose solution it can be noticed that the cyclamate's sweetening power is situated around the value of 28. The cyclamate solution's intensity of sweet taste (1.25) is higher than the 1% saccharose solution's sweet taste (considered to be 1) when the cyclamate's sweetening power is 25, the following being the gradual decrease of intensity of the sweet taste along with the increase of cyclamate's sweetening power.

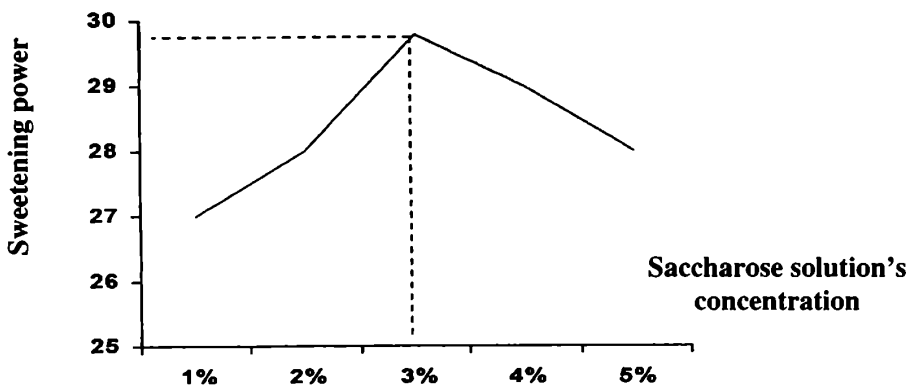

Fig. 7. The variation of cyclamate's sweetening power taking on account the saccharose solution's concentration

As a conclusion, we can assert that a cyclamate solution's sweetening power increases along with the increase of saccharose solution's concentration up to the value of 3% (when it reaches the maximum value of 29.8), and after these, it decreases along with the increase of saccharose solution's concentration, fact illustrated in figure 7.

In the case of an aspartame solution synergism (solution that presents the particularity of having its availability term expired), compared to a 2% saccharose solution, the results were the followings:

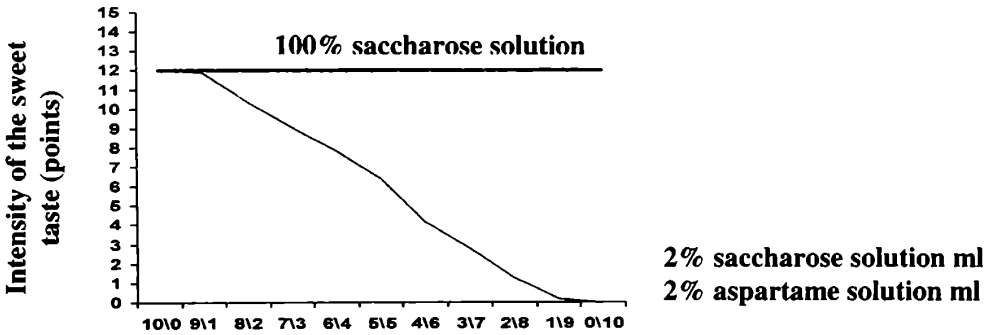

Fig. 8. The variation of the intensity of the sweet taste in a mixture of 2% saccharose solution and 2% aspartame solution

The experiment starts with a saccharose solution (marked with 12 points) in which it is gradually introduced an aspartame solution along with the decrease of saccharose solution's quantity. It can be noticed the fact that the intensity of the sweet taste gradually decreases thus, at a 100% aspartame solution the sweet taste can no longer be perceived. It is possible for the sweet taste to be influenced by the aspartame's availability term expiration thus secondary hydrolysis products appear (aspartic acid, phenylalanine, methanol etc.).

Regarding the other tastes perceived besides the sweet taste, it can be specified that as the sweet taste grows less strong along with the increase of aspartame percentage in mixture with saccharose, the typical bitter- metallic taste becomes stronger.

A 2% saccharine solution's synergism upon a 2% saccharose solution's sweet taste can be observed in figure 9:

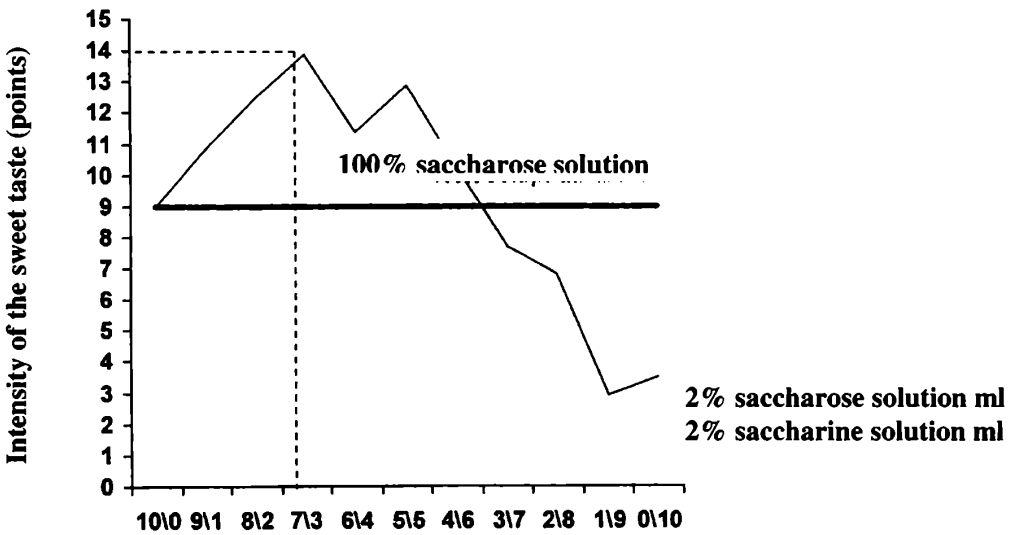

Fig. 9. The variation of the intensity of the sweet taste in a mixture of 2% saccharose solution and 2% saccharine solution

Regarding the mixture of a 2% saccharose solution with a 2% saccharine solution, when starting with a 2% saccharose solution (marked with 9 points) and gradually introducing in it a 2% saccharine solution, it can be observed the fact that the intensity of the sweet taste increases reaching its maximum value at 13.9, more specifically at the mixture of saccharose/ saccharine at a ratio of 7/3. At this point we can say that the sweet taste has increased by 1.5 times compared to the initial saccharose solution. After these, the sweet taste decreases a little when 6 parts of saccharose are mixed with 4 parts of saccharine. Then, when the mixture is formed by 5 parts saccharose and 5 parts saccharine the increase occurs again up to 12.9 being followed by a gradual decrease of the sweet taste, thus, at the mixture ration of 1 part saccharose and 9 parts saccharine the intensity of the sweet taste represents just 1/3 of the initial taste of saccharose solution.

The secondary tastes perceived are those typical for saccharine: the residual one, the metallic one and the brackish one. The metallic taste is more pronounced at a ration of 5/5 for a saccharine/ saccharose mixture, as well as for the pure saccharine solution and, the brackish taste is more pronounced at a ratio of 2/8 for a saccharose/ saccharine mixture.

The most commonly used mixture ratio of sodium cyclamate and saccharine is 10/ 1 and the synergism of this mixture in ration with another 2% saccharose solution is underlined by figure 10:

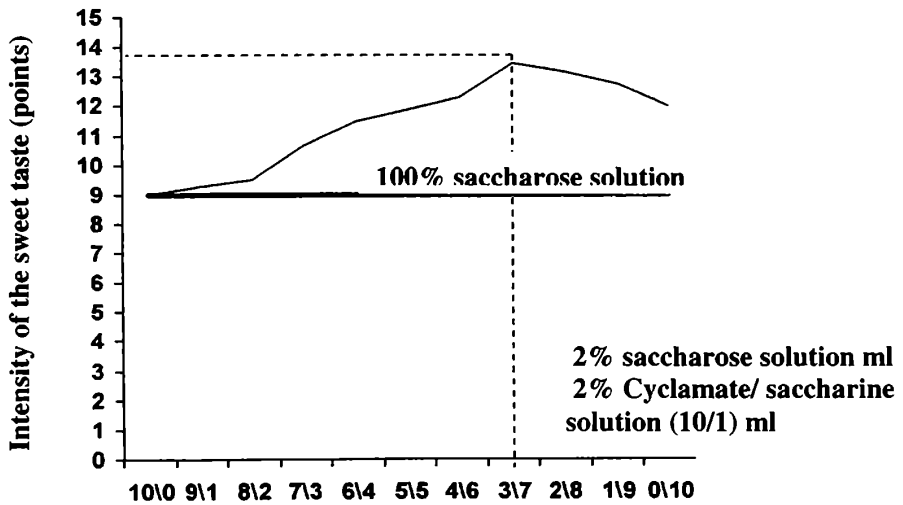

Fig. 10. The variation of the intensity of the sweet taste in a mixture of 2% saccharose solution and 2% cyclamate/ saccharine solution=10/1

Regarding the 2% cyclamate/ saccharine (10/ 1) mixture's synergism in ratio with a 2% saccharose solution, when starting with the 2% saccharose solution and gradually introducing in it the cyclamate/ saccharine mixture, it can be noticed the fact that the intensity of the sweet taste increases gradually reaching its maximum value at 13.5 when the mixture ratio is of 30% saccharose and 70% cyclamate/ saccharine mixture. At this point, it can be said that the intensity of the sweet taste has increased by 1.5 times compared to the initial saccharose solution. After this maximum point, the intensity of the sweet taste gradually decreases thus the cyclamate/ saccharine solution has an intensity of sweet taste by 1.33 higher than the initial saccharose solution.

Besides the sweet taste, in the case of cyclamate/ saccharine mixture (10/1) the sweeteners' typical residual bitter-metallic taste is perceived, especially in high percentage mixtures with saccharose. It must be mentioned the fact that a pleasant sweet taste is noticed when the ratio of saccharose with the cyclamate/ saccharine mixture is of 1/9, 2/8, 3/7 and even 4/6 but, beginning with the 5/5 ratio the pleasant taste is being replaced by the metallic one.

A 2% aspartame solution mixed with a 2% saccharose solution manifests a synergism upon the saccharose's sweetness degree, fact underlined by figure 11:

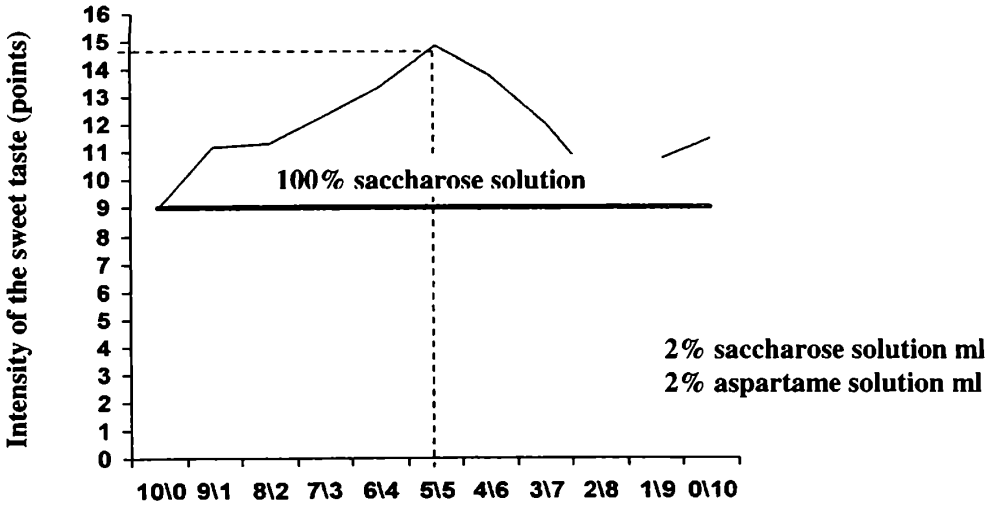

Fig. 11. The variation of the intensity of the sweet taste in a mixture of 2% saccharose solution and 2% aspartame solution

In the case of the study of aspartame's synergism in mixture with a 2% saccharose solution we start with a 2% saccharose solution (marked with 9 points) in which the aspartame is gradually introduced along with the decrease of saccharose solution's quantity.

It is noticed that the intensity of the sweet taste increases, reaching its maximum at a ratio of 50% saccharose with 50% aspartame. At this point (14.9 points on the scale of intensity of the sweet taste), when the ratio saccharose/ aspartame is 1/1 we can say that the sweet taste has increased by 1.65 times compared to the initial saccharose solution. After this maximum point, the intensity of the sweet taste gradually decreases down to 1% of the mixture 8 parts saccharose/ 2 parts aspartame. Then, the sweet taste increases again thus the 2% aspartame solution is perceived as being by 1.27 times sweeter compared to the initial saccharose solution.

Besides the sweet pleasant flavored taste perceived in most of the ratios of saccharose/ aspartame mixtures, it is also sometimes noticed a sour- metallic taste, typical for sweeteners, especially when the percentage of the saccharose/ aspartame mixtures are 3/7, 2/8 , 1/9.

Conclusions

In the matter of the sweeteners' synergetic effect upon the saccharose's sweetness degree it can be asserted that the sweeteners, in mixture with saccharose solutions, manifest a pronounced synergism, the mixture's sweetening power being at least 1.5 higher than that of saccharose. That is why, lately, the use of sweeteners/ saccharose mixtures are preferred for refreshments and not only.

For example, in the case of cyclamate/ saccharose mixture the sweetening power is approximately 4 times higher than the saccharose's sweetness degree, in that of cyclamate/ saccharine at a ratio of 10/ 1 with saccharose mixture, the sweetening power is 1.5 higher and in that of aspartame/ saccharose mixture is approximately 1.65 higher.

Regarding the sweeteners' typical bitter- metallic taste, it is stronger in the case of cyclamate and saccharine whereas in that of aspartame the taste perceived is rather pleasant and flavored.

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