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SENSORY AND TEXTURAL CHARACTERISTICS OF LOW-SUGAR COCOA SAUCES SWEETENED WITH STEVIOL GLYCOSIDES

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Abstract: The aim of this work was to evaluate the possibility of using steviol glycosides (E 960) as an alternative to sucrose sweetening substance in production of low-sugar cocoa sauces. On the basis of the obtained results it was found that the more sucrose was replaced with steviol glycosides the less intense was sweetness and more intense were metallic and liquorice aftertastes in the sauces. Use of inulin or polydextrose in the sauce recipe had a significant effect on sensory and textural characteristics of the sauces. There were many significant correlations ($p < 0.05$) between the instrumental parameters that characterized the analysed sauces.
Keywords: steviol glycosides, cocoa sauce, sensory properties

INTRODUCTION

Carbohydrates provided with food are essential compounds for proper functioning of human body. However, too high consumption of carbohydrates, especially in the form of simple sugars contribute to a diet-related diseases. In order to give sweetness for food products natural ingredients are used, such as honey or sucrose. Nowadays, there are many known sweetening substances that are an alternative to sucrose. The intense sweeteners are widely used in production of food for diabetes and a light food. Though the intense sweeteners are used for their intended purpose and allowed doses, as well as they do not pose any risk to health, their presence in food products are reluctantly perceived by many consumers **(Juszczak 2012)**.

An alternative substance to synthetic intense sweeteners are steviol glycosides that are present in the leaves of *Stevia Rebaudiana* Bertoni plant. They are about 150-400 times more sweet than sucrose. Steviol glycosides are water soluble, resistant to changes in temperature and pH, as well as they do not ferment **(Ziembicka 2009, Mishra 2010)**. Due to sweetening properties of stevia it is a natural alternative substance to sucrose and synthetic intense sweeteners, not only intended for diabetes, but also people with overweight and obesity **(Mishra et al. 2010)**. Moreover, stevia can be consumed by people with phenylketonuria, because it is not a source of phenylalanine **(Savita et al. 2004)**. Stevia and its derivatives are also used in prevention of decay. Use of steviol glycosides in food products is regulated by Decree of Commission UE No. 1131/2011 from November 11th 2011 amending Annex II to the Regulation of the European Parliament and Council Regulation (EC) No. 1333/2008.

The aim of this work was to evaluate the possibility of using steviol glycosides (E 960) as an alternative to sucrose sweetening substance in production of low-sugar cocoa sauces.

MATERIALS AND METHODS

The materials were cocoa sauces composed of the following ingredients: cocoa powder (Maspex, Poland), defatted milk powder (SM Gostyń, Poland), rape oil (ZT Kruszwica, Poland), glucose syrup (Zetpezet Piła, Poland), soy lecithin (IP, Brenntag, Poland), sucrose (Diamant, Pfeifer & Langen Marketing, Poland), guar and xanthan gums (Hortimex, Poland), steviol glycosides (Stevija Reb. A, Holland), bulking agents: inulin (GR, Beneo Orafti,

Belgium) and polydextrose (Danisco, United Kingdom), potassium sorbate as preservative (Hortimex, Poland).

In order to prepare the sauces the milk powder was solubilized in an appropriate amount of water and then sucrose and/or steviol glycosides, as well as guar and xanthan gums were added. The resulting suspension was heated at 80°C with continuous mixing in a water bath for 5 min. Then inulin or polydextrose was added to the mixture. The resulting product was heated at 80°C with continuous mixing for 30 min. To the resulting system the following ingredients were added: rape oil, soy lecithin, sodium sorbate, glucose syrup and cocoa powder. The mixture was heated again at 80°C with continuous mixing for 30 min. The resulting sauce was cooled at room temperature and then was stored in refrigerator. In the recipes of the particular sauce samples sucrose was replaced with steviol glycosides (E 960) and inulin or polydextrose in the amount of 20-100%. The ratio of sweetness of steviol glycosides to sucrose was established as 250:1. The sauce samples were labelled as from S0 (the sauce sweetened with sucrose and without steviol glycosides) to S100 (the sauce in which 100% sucrose was replaced with steviol glycosides and inulin or polydextrose).

Sensory analysis of the samples was performed by trained 15 experts. The samples were presented in a random order and assigned product codes. Intense of the perceived sensation was assessed by five-point scale method, where "0" meant imperceptible sensation and "4" meant strongly perceptible sensation. The following attributes of palatability were evaluated: sweetness, bitterness, metallic aftertaste, liquorice aftertaste, while in the case of texture analysis, the following attributes were evaluated: viscosity, cohesiveness, adhesiveness and mouthfeel. Textural properties of the sauces were also analysed using texture analyser EZ Test (Shimadzu, Japan) by a penetration test. The sauce samples were placed in plastic containers of 75 mm diameter and subjected to penetration with probe of 28 mm diameter with 60 mm/min speed and 30 mm penetration depth. From the obtained curves the following parameters were determined: hardness, expressed as maximal force required to penetrate a sample, and penetration energy.

RESULTS AND DISCUSSION

Results of sensory evaluation of palatability attributes of strawberry sauces, given as mean values, are presented in Figure 1. The intensity of sweetness was decreasing with increasing amount of steviol glycosides, especially in the samples with more than 60% of sucrose substituted with steviol glycosides (Fig. 1a). Use of polydextrose as a bulking agent had an additional effect on the decrease in sweetness of the samples. Contrary, presence of inulin in S40 – S80 samples resulted in more intense sensation of sweetness. Bitterness that is characteristic attribute for food products with cocoa was increasing with increasing amount of sucrose substituted with steviol glycosides (Fig. 1b), and presence of bulking agents had not significant effect on its intensity. The was significant ($p < 0.05$) negative linear correlation ($r = -0.72$) between intensity of sweetness and bitterness. According to the literature data **(Savita et al. 2004, Mishra et al. 2010)** presence of steviol glycosides at higher concentrations in food products give metallic and liquorice aftertastes. That information is confirmed by the results of the present study (Figs. 1c,d). The more steviol glycosides was in the sauce the more intensive metallic and liquorice aftertastes were perceptible, especially in the samples with 60% and more sucrose removed. It is worth noting that use of polydextrose as a bulking agent in most cases resulted in decreased intensity of metallic and liquorice aftertastes. The degree of metallic aftertaste sensation significantly ($p < 0.05$) negatively correlated with sweetness ($r = -0.61$) and positively correlated with bitterness ($r = 0.61$).

Results of sensory evaluation of textural attributes of the sauces, expressed as mean values, are presented in Figure 2. In most cases, sensory viscosity of the sauces with inulin or

polydextrose was higher than that of the samples without the bulking agent (Fig. 2a). Similar results were obtained for evaluation of cohesiveness (Fig. 2b), wherein in the case of the samples with higher amount of steviol glycosides these with inulin were more cohesive.
There was significant ($p < 0.05$) linear correlation between sensation of cohesiveness and viscosity ($r = 0.67$). Evident effect of the presence of the bulking agents on adhesiveness was found – intensity of adhesiveness was lower in the sauce samples without bulking agent (Fig. 2c).

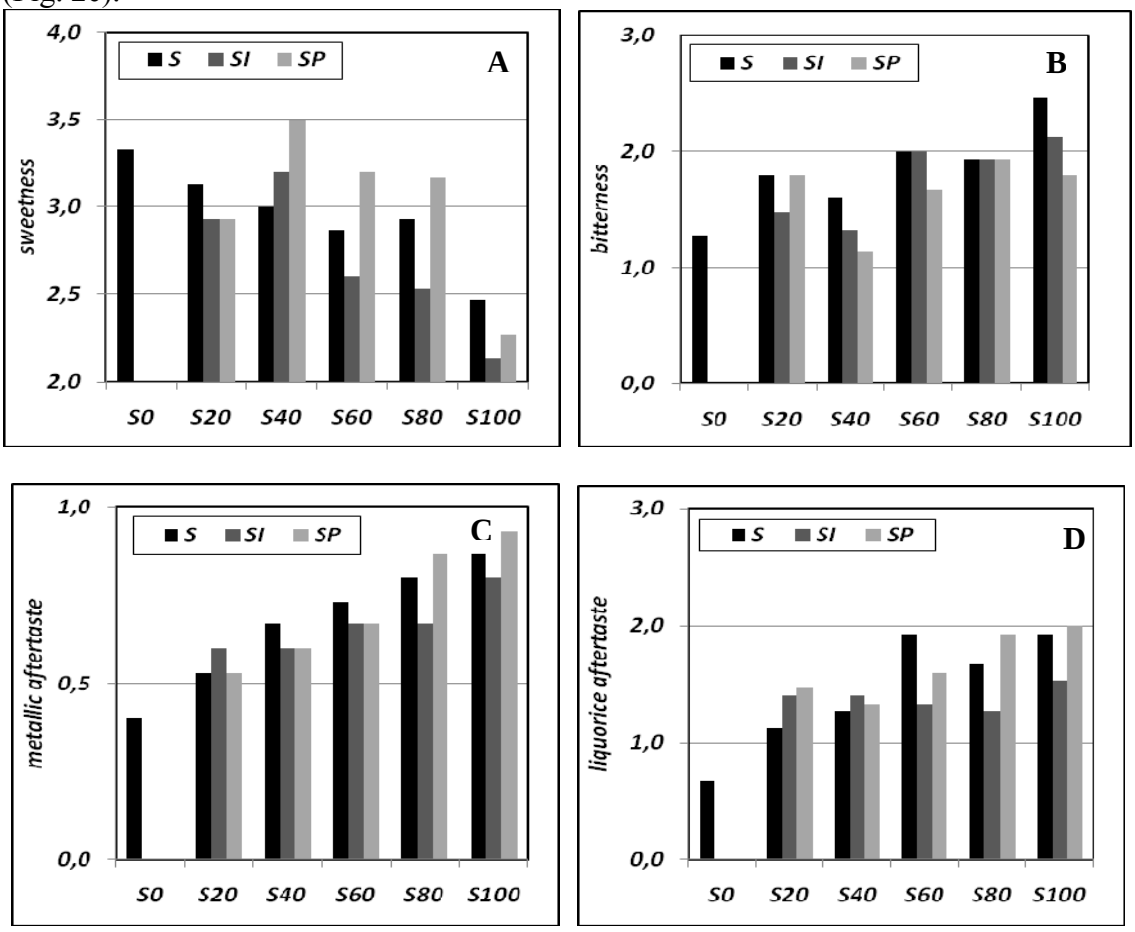
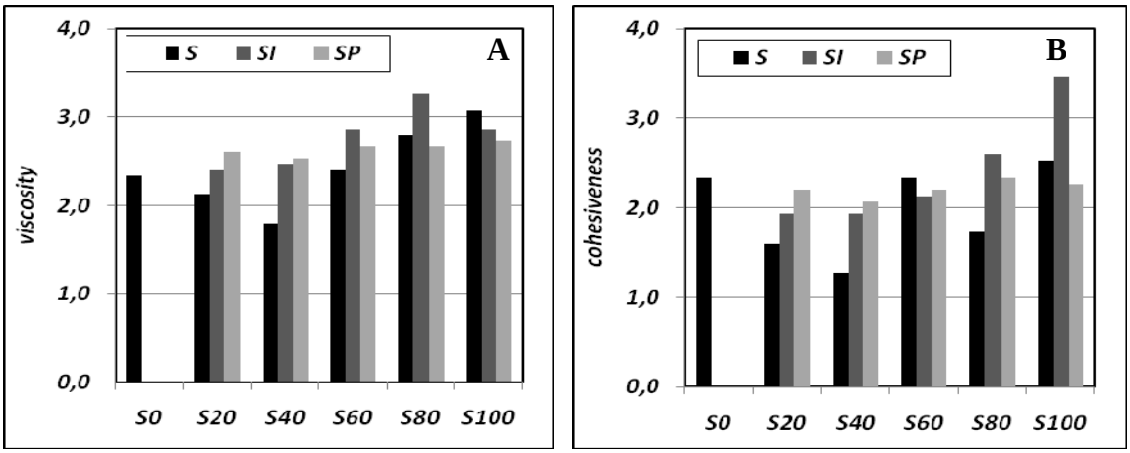


Figure 1 Sensory attributes of cocoa sauces sweetened with steviol glycosides (S) with inulin (I) or polydextrose (P) as a bulking agent.



Moreover, it was found that the sauces with inulin were characterized by significantly higher adhesiveness than the sauces with polydextrose. Sensation of adhesiveness was significantly

($p < 0.05$) positively correlated with sensation of viscosity ($r = 0.85$). An opposite correlation was observed for mouthfeel, sensation of which was decreasing with increasing from 40% amount of sucrose replaced with steviol glycosides. There were significant ($p < 0.05$) negative correlations between mouthfeel and sensation of viscosity ($r = -0.59$), cohesiveness ($r = -0.80$) and adhesiveness ($r = -0.61$).

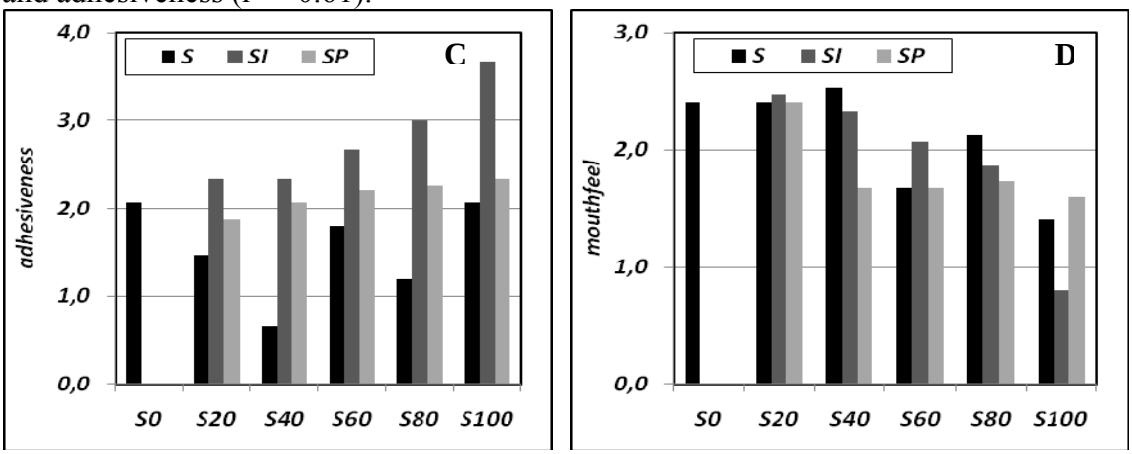


Figure 2 Sensory attributes of cocoa sauces sweetened with steviol glycosides (S) with inulin (I) or polydextrose (P) as a bulking agent.

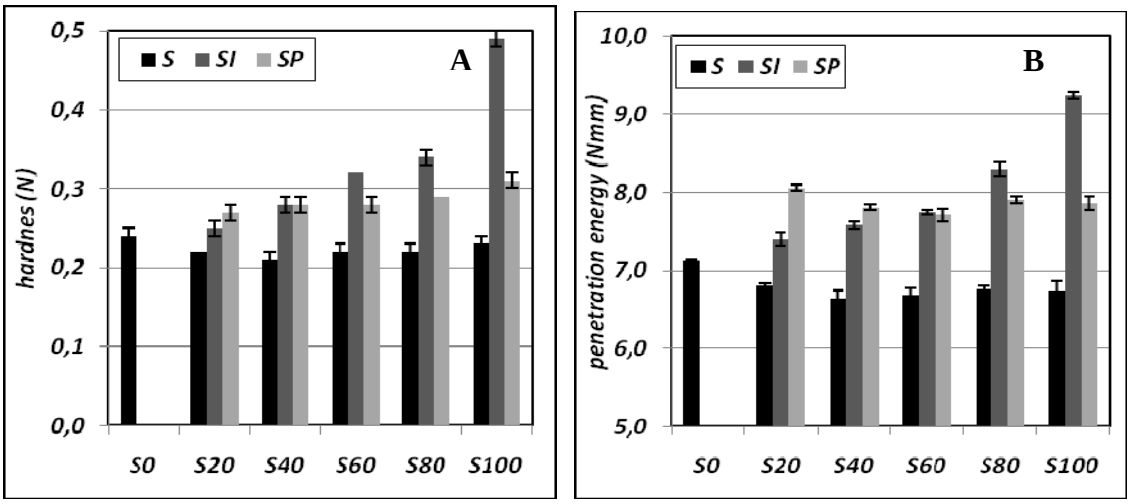


Figure 3 Textural attributes of cocoa sauces sweetened with steviol glycosides (S) with inulin (I) or polydextrose (P) as a bulking agent.

Values of textural parameters of the sauces determined by instrumental method are presented in Figure 3. In all cases the sauces with the bulking agent were characterized by higher values of hardness and penetration energy. In the case of the samples with lower sucrose concentrations (S80, S100) higher values of hardness and penetration energy were recorded for samples with inulin. Hardness measured instrumentally was significantly ($p < 0.05$) correlated with sensory perceived viscosity ($r = 0.51$), cohesiveness ($r = 0.79$), adhesiveness ($r = 0.87$) and mouthfeel ($r = -0.66$). Similar significant correlations were found for penetration energy and sensory attributes of texture.

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