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Sensory acceptability of chocolate with inulin[a]

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ABSTRACT

The objective of this research was to study the influence of inulin on the sensory characteristics of chocolate. Three types of chocolate (milk, hazelnut and rice) where sucrose was replaced by inulin and fructose were studied in comparison to corresponding ordinary chocolates. A questionnaire between eighty diabetics and fifty-two random consumers showed that the chocolate with inulin was well accepted. It was stated that questioners were aware of the nutritional quality of functional foods. Consumer test using 7-point hedonic scale to assess the preference was performed with 65 children aged between 11 and 13 years. They assessed ordinary chocolate as favourite. Then three difference tests: duo-trio, triangular and paired comparison test were used to determine whether there is a sensory difference between ordinary chocolate and chocolate with inulin. The results showed that the sensory differences existed. Finally a sensory panel of 7 trained assessors performed an analytical test with quantitatively characterisation of eight sensory attributes. It was established that there were statistical significant differences between sensory properties of these types of chocolate. The main differences appeared in sweetness and solubility. In general, the acceptability of chocolate with inulin was good. However, the chocolate with less sugar, high content of dietary fibre and lower energy value is considered as a functional food.

Key words: chocolate, inulin, sensory analysis, sensory tests

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IZVLEČEK

SENZORIČNA SPREJEMLJIVOST ČOKOLADE Z INULINOM

Proučevan je bil vpliv inulina na senzorične značilnosti čokolade. Raziskava je obsegala primerjavo treh običajnih čokolad (mlečno, lešnikovo in riževo) s čokoladami, v katerih je bila saharoza nadomeščena s fruktozo in inulinom. Rezultati ankete med naključnimi potrošniki in diabetiki so pokazali dobro sprejemljivost čokolade z inulinom. Potrošniški preskus, izveden s 7 točkovno hedonsko lestvico, je pokazal, da 11 do 13 letni otroci dajo prednost običajni čokoladi. Trije preskusi razlikovanja: primerjava v parih, duo-trio in triangel preskus kažejo, da med navadnimi čokoladami in čokoladami z inulinom obstajajo senzorično zaznavne razlike. Za kvantitavno oceno senzoričnih značilnosti posameznih čokolad je bil izveden analitski preskus s sedemčlanskim panelom. Ocenjevali so osem senzoričnih lastnosti s 5-točkovno lestvico. Ugotovljeno je bilo, da se navadne čokolade in čokolade z inulinom statistično značilno razlikujejo, zlasti v sladkosti in topnosti. Splošna ugotovitev je bila, da je sprejemljivost čokolade z inulinom, ki vsebuje manj sladkorja, več vlaknine, ima manjšo energijsko vrednost in ima zato lastnosti funkcionalnega živila, dobra.

Ključne besede: čokolada, inulin, senzorična analiza, senzorični preskusi

INTRODUCTION

Inulin was defined in the early 1800s as the carbohydrate substance isolated from the root of Inula helenum. We now know that it is present in a wide range of plants, including common vegetables and fruits (Coussement, 1999). Inulin is a polydisperse fructan and it is a mixture of oligomers and polymers of chain of fructosyl units with one glucosyl unit at the end of a chain (Niness, 1999). The non-digestibility of inulin is the reason for the reduced caloric value of this natural polysaccharide.

Inulin is frequently used as an additive in functional food articles, especially as substitute for lipid compounds and supplement for sugar. It can also be used in products with increased dietary fibre content, e.g. bread or food product, with a bifidogenic effect.

The main challenge of food industry is to comply with consumers' expectations that hold high standards for the foods they consume. They demand foods that taste great, are fat- and/or calorie-reduced, and they are interested in foods that provide added health benefits. These foods must be convenient and affordable (Niness, 1999; Brennan *et al*., 2004; Roberfroid, 1999; Van Loo *et al*., 1995).

In the collaboration with a chocolate industry we developed a new functional product – chocolate with inulin, in which inulin and fructose were used instead of sucrose. We prepared suitable recipe and with many organoleptic tests determined suitable rate between fructose and inulin. Both new ingredients have the influence on technological process; therefore we had to correct it and made it suitable for their use. It was an exacting piece of work accompanied with numerous sensory analyses, measuring the viscosity and physico-chemical analyses. The results of our research were three types of chocolate (milk, hazelnut and rice) from this chocolate mass. Then we studied the influence of inulin on sensory, physical, chemical and nutritional properties of new types of chocolate.

In this article the results of sensory evaluation are presented. Our purpose was to establish the acceptability of chocolates, to find out if differences between ordinary chocolates and new ones exist, and finally assess these differences by a sensory panel.

MATERIAL AND METHODS

Samples

The research included six samples of chocolate, namely three basic types of chocolate: milk chocolate (MCs), hazelnut chocolate (HCs) and rice chocolate (RCs), and three chocolates in which sucrose was replaced by fructose and inulin: milk chocolate (MCi), hazelnut (HCi) and rice chocolate (RCi).

Sensory analyses

Questionnaire: Eighty diabetics and fifty-two random consumers were presented with 2 chocolate samples (milk chocolate with sucrose – MCs and milk chocolate with inulin – MCi) in a random order. They were asked to taste the chocolates and fulfil the question form.

Consumer test: Hedonic rating using 7-point scale was performed with sixty-five children aged between 11 and 13 years. They were treated as random consumers and they had to assess their liking.

Three difference tests were achieved with the undergraduate students at the Biotechnical Faculty in Ljubljana with the intention to determine whether there is a sensory difference between the chocolate with sucrose and the chocolate with inulin:

Paired comparison test, exactly a two-sided preference (a version of paired comparison test) (ISO, 1983), with the question: “Of these two samples, which one do you prefer?” was carried out with fifty-six students from the first year of study.

Duo-trio test (ISO, 1991) was performed in two combinations, depending which chocolate was served as the reference sample (ordinary chocolate with sucrose or chocolate with inulin). Fifty students from the second year of study performed the test.

Triangular test (ISO, 1983) was taken out with sixty-six students from the third year of study. Samples were prepared in eleven sets of the six possible sequences of chocolates, two of which were identical. They were randomly served to assessors who had to identify the odd sample and denote sensory defects.

An option of »forced choice« at all difference tests was used.

Analytical sensory test: Chocolates were evaluated using descriptive analysis procedures (ISO 6658, 1985a; ISO 6564, 1985b) by a sensory panel of seven assessors, who had been selected and trained according to guidelines in ISO 8586-1 (1993). The quantitative characterization of eight sensory attributes: appearance (smoothness and gloss of the surface, crumbliness of the margins, colour), breakage, distribution of the supplements (hazelnut, rice), solubility, sweetness, mouthfeel (grained, stickiness, thickness in mouth), aroma and aftertaste (off flavour, bitterness) were evaluated on a 1 to 5 scores non-structural linear scale with grade 1 defined as too weakly or too strong expressed sensory attribute, and grade 5 defined as an optimal expressed sensory attribute.

The results were statistically treated by GLM procedure (SAS, 1990).

With a consensus between the panellists for each assessed properties an importance factor, F=1 to F=4, was considered, where F=1 was used for the less important attribute, like breakage, F=2 for appearance, distribution of the supplements and aftertaste, F=3 for solubility, sweetness and mouthfeel, and F=4 for aroma, the most important attribute. There were two exceptions in the milk chocolate, where F = 3 for the appearance and F = 2 for breakage were considered, because in this type of chocolate the distribution of the

supplements was not evaluated. The multiplying scores and importance factors gave us total estimations, from 20 to 100 scores, which make possible to compare studied chocolates.

RESULTS AND DISCUSSION

The results of the questionnaire about the acceptability of chocolate with inulin achieved by 80 diabetics and 52 randomly questioned consumers showed that the chocolate with inulin was well accepted (Table 1). The individuals were well aware of its nutritional quality and functional value, but many of them didn′t agree with higher price of this product.

Table 1. The questionnaire about the acceptability of chocolate with inulin achieved by diabetics and random consumers

Question	Number of answers					
	Yes		No		No answer	
	Diab.	Cons.	Diab.	Cons.	Diab.	Cons.
Is the chocolate sweet enough?	79	45	1	5	0	2
Is the taste of the chocolate pleasant?	79	45	0	4	1	3
Would you buy this chocolate another time?	77	47	2	4	1	1
Would be consuming the chocolate beneficial to your health?	64	40	12	8	4	4
Do you find it important that the chocolate you've eaten has lower energy value?	73	43	6	9	1	0
Are you willing to pay more for this chocolate (20 % more than for usual chocolates)?	53	36	19	15	8	1

n of Diab. (diabetics) = 80; n of Cons. (consumers) = 52

Results of the consumer test

The participants had to indicate the degree of liking on seven points labelled scale. The results of this test presented in Figure 1 showed that in the case of all three types of chocolate: milk, hazelnut or rice, the participants preferred the chocolate with sucrose to the chocolate with inulin. In general both rice chocolates, RCs and RCi were evaluated better than milk and hazelnut chocolates. 98 % of children decided to denote RCs chocolate and 91 % of children decided to denote RCi as "good", very good" or "extremely good". Less perceived sweetness was mentioned as the greatest deficiency of the chocolates with inulin.

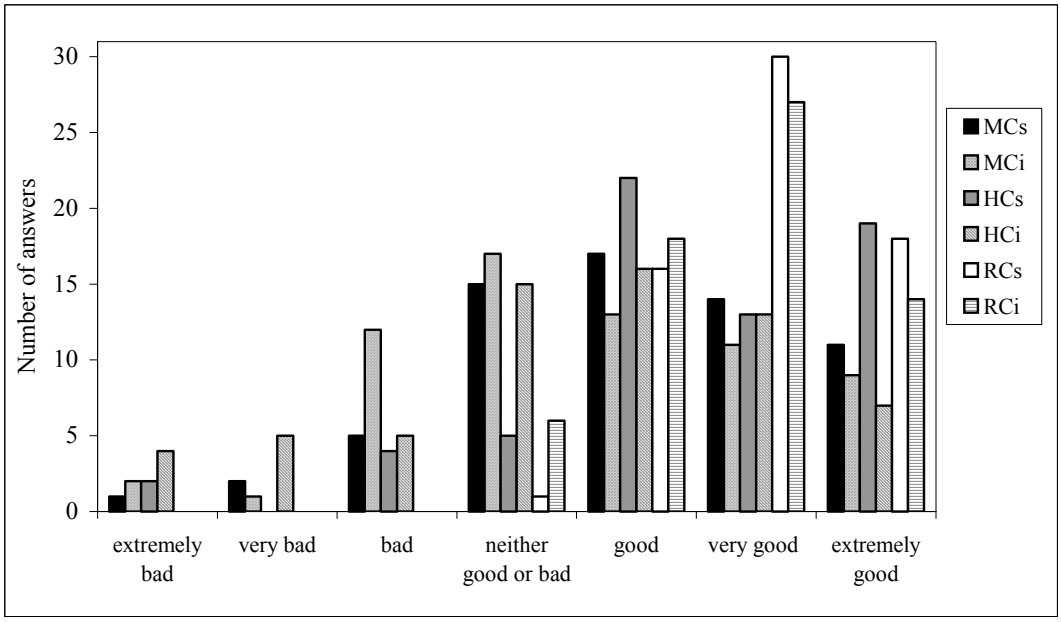

Figure 1: Results of the consumer test for chocolates with sucrose and chocolates with inulin

Results of difference tests

To determine whether there is a sensory difference between two chocolates (with sucrose or inulin) we used three difference tests: paired comparison, duo-trio and triangular test. Altogether 150 of students were included in these tests; each test was performed with the students of one year of study at Biotechnical faculty in Department of food science and technology. They had no experience in sensory tests.

Results of paired comparison test – test for preference

The paired samples were presented simultaneously in the equal number of the combinations AB and BA. According to the "forced choice" technique (ISO, 1983) the assessors were obligated to indicate which chocolate they preferred to the other. The majority of them decided for the chocolates with sucrose: 53 % of assessors in the test at milk chocolate, 72 % at hazelnut chocolate and 67 % at rice chocolate (Figure 2). The results were evaluated statistically according to "Table 2 – Two sided test" in ISO 4120 (1983), where the minimal number of regular answers at 56 assessors and significance of $P \leq 0.05$ has to be 36 (64 %). Therefore we can conclude that the participants gave priority to hazelnut and rice chocolates with sucrose while between the milk chocolate with sucrose and inulin, respectively, the differences were not perceived.

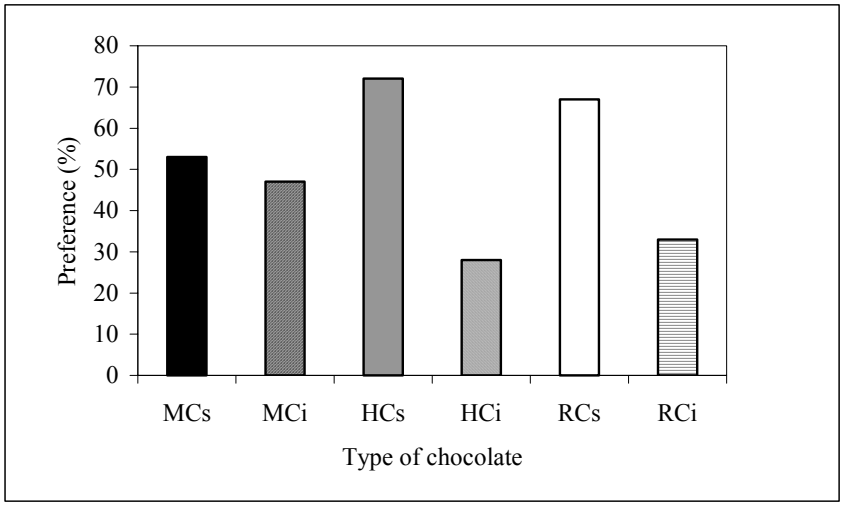

Figure 2: Results of paired comparison test

Results of duo-trio test

The results of the duo-trio test presented in Fig. 3 are an average of two combinations. Each assessor was presented with the identified reference sample, in the first combination it was ordinary chocolate and in the second it was chocolate with inulin. That was followed by two coded samples, one of which was identical to the reference sample. Fifty assessors were asked to determine which one of these two samples was identical to the reference sample. The number of assessors was statistically evaluated according to "Table 1" in ISO 10399 (1991).

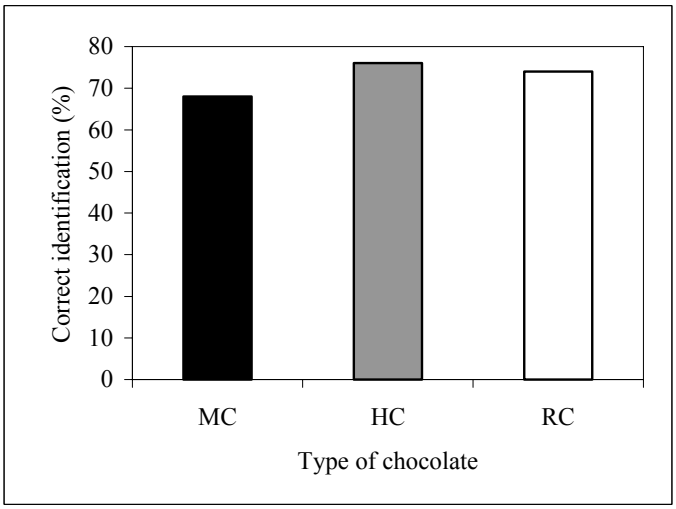

Figure 3: Results of duo-trio test

The results showed that the differences between chocolate with sucrose and that with inulin existed; the required number of positive answers 32 was achieved in all three cases (34 answers (68 %) for milk chocolate, 38 (76 %) for hazelnut chocolate and 37 (74 %) for rice chocolate).

Results of triangular test

The combinations prepared were distributed randomly among the assessors. The results evident from Fig. 4 were evaluated statistically according to Table in ISO 4120 (1983), where the minimal number of regular answers at 66 assessors and significance of $P \leq 0.05$ has to be 29 (44 %). In that case we can conclude that the differences between the chocolate with sucrose and chocolate with inulin were sensory perceived. In our experiment the number of regular answers at milk chocolate was 42, at hazelnut chocolate 41 and 37 at rice chocolate. Probably the great supplement of rice in rice chocolates affected that the differences in these types of chocolate were the least. The assessors included in this test were from the third year of study and had the elementary knowledge from sensory analysis. They were asked to denote which sensory defects perceived in tasted samples. The greater number of their observations related to worse solubility of MCi and rancidity of HCi while in rice chocolate they didn't perceive any defect.

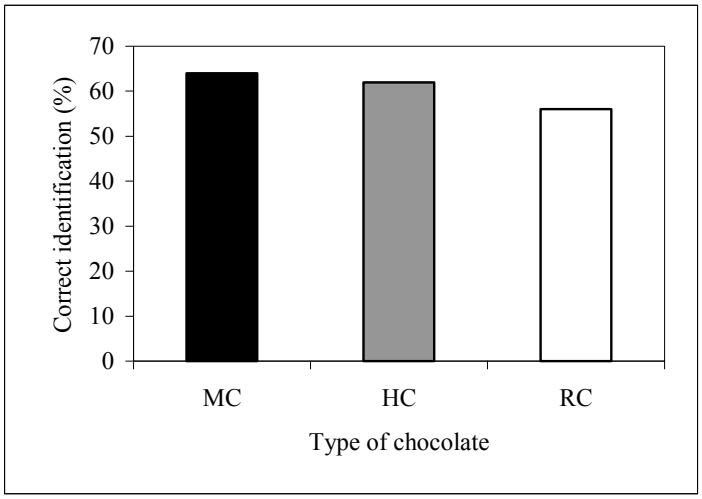

Figure 4: Results of triangular test

Results of descriptive analysis

Results of descriptive analysis presented in Table 2 indicate that the scores for the sensory terms differed significantly across the experimental samples, with the exception of breakage, which was not significantly different. It was assessed well, with the averages from 4.0 in MCs to 4.4 scores in HCi and RCi.

All the assessors gave the highest score for appereance to both rice chocolates, 4.4 scores, and the lowest to hazelnut chocolate with inulin, 3.6 scores, where an inexpressive gloss and porosity were mentioned.

In the chocolates with supplements the distribution of hazelnuts or rice was assessed. In all cases it was evaluated relatively well, from 4.2 to 4.6 scores.

Table 2. Comparison of sensory assessment for the chocolates with sucrose and chocolates with inulin

Sensory attributes	Chocolates					
	MCs	MCi	HCs	HCi	RCs	RCi
appearance	$3.8^{a,b} \pm 0.49$	$4.2^{c} \pm 0.27$	$4.1^{b,c} \pm 0.19$	$3.6^{a} \pm 0.19$	$4.4^{c} \pm 0.38$	$4.4^{c} \pm 0.38$
breakage	$4.0^{a} \pm 0.65$	$4.2^{a} \pm 0.27$	$4.1^{a} \pm 0.19$	$4.4^{a} \pm 0.38$	$4.3^{a} \pm 0.40$	$4.4^{a} \pm 0.53$
distribution of the supplements	-	-	$4.4^{a,b} \pm 0.38$	$4.2^{a} \pm 0.27$	$4.5^{a,b} \pm 0.29$	$4.6^{b} \pm 0.24$
solubility	$4.2^{b,c} \pm 0.27$	$3.5^{a} \pm 0.58$	$4.4^{c} \pm 0.35$	$3.9^{a,b} \pm 0.24$	$4.3^{b,c} \pm 0.49$	$3.9^{a,b} \pm 0.45$
sweetness	$4.6^{b,c} \pm 0.56$	$4.0^{a} \pm 0.41$	$4.4^{a,b,c} \pm 0.45$	$4.2^{a,b} \pm 0.39$	$4.7^{c} \pm 0.39$	$4.8^{c} \pm 0.27$
mouthfeel	$4.1^{b,c} \pm 0.35$	$3.5^{a} \pm 0.41$	$4.1^{b,c} \pm 0.35$	$3.8^{a,b} \pm 0.39$	$4.3^{c} \pm 0.39$	$4.1^{b,c} \pm 0.24$
aroma	$4.2^{a,b,c} \pm 0.27$	$3.9^{a,b} \pm 0.70$	$4.3^{b,c} \pm 0.27$	$3.8^{a} \pm 0.39$	$4.2^{a,b,c} \pm 0.27$	$4.4^{c} \pm 0.35$
aftertaste	$4.5^{b} \pm 0.50$	$4.3^{a,b} \pm 0.86$	$3.8^{a} \pm 0.49$	$4.6^{b} \pm 0.35$	$4.6^{b} \pm 0.38$	$4.6^{b} \pm 0.38$

Data expressed as means ± SD. Means in rows not sharing the same letter are significantly different ($P \leq 0.05$)

The most distinctive differences between ordinary and chocolate with inulin were perceived in solubility. All three chocolates with inulin, milk, hazelnut and rice, were assessed worse than ordinary types. It is known that the supplement of inulin influences on the viscosity and worse solubility of the product (Mičović, 2003).

Regarding the results we have developed a new chocolate where the sweetness was one of the attributes to which we devoted the most attention. Our intention was to make a functional product with sweetness like ordinary one. In that case many combinations of supplements (sucrose, fructose and inulin) had been tested before the final recipe was accepted. Higher sweetness of fructose to sucrose makes a possible relatively great supplement of inulin. As it is seen from Table 3 the sweetness of all studied chocolates was expressed very similar, from an average of 4.0 scores in MCi to 4.8 scores in RCi.

The mouthfeel is considered as a property of great importance for the sensory impression of many foods, especially in sweets and fatty foods. The results of the assessment of this attribute showed that all three types of chocolates with inulin were evaluated worse. The lowest scores, 3.5, were given to MCi where stickiness and mouth loading were perceived.

Aroma as the sensation of senses odour and taste was evaluated as the most important attribute (the highest important factor was given). While milk and hazelnut chocolates with inulin had worse aroma than ordinary type, the aroma in rice chocolate with inulin was assessed better. The assessors stated that the combination of inulin and one of the supplements, hazelnuts or rice, influenced on fullness of aroma. The statistical treatment showed that the aroma difference between hazelnuts chocolates, HCs and HCi, was significant at $P \leq 0.05$.

Table 3. Final estimation of chocolates sensory evaluation

Sensory attributes	F	Chocolates (mean scores · F)					
		MCs	MCi	HCs	HCi	RCs	RCi
appearance	2	11.4*	12.6*	8.2	7.2	8.8	8.8
breakage	1	8.0**	8.4**	4.1	4.4	4.3	4.4
distribution of the supplements	2	-	-	8.8	8.4	9.0	9.2
solubility	3	12.6	10.5	13.2	11.7	12.9	11.7
sweetness	3	13.8	12.0	13.2	12.6	14.1	14.4
mouth feel	3	12.3	10.5	12.3	11.4	12.9	12.3
aroma	4	16.8	15.6	17.2	15.2	16.8	17.6
aftertaste	2	9.0	8.6	7.6	9.2	9.2	9.2
sum of scores	20-100	83.9	78.2	84.6	80.1	88.0	87.6

F - importance factor; *F=3; **F=2

In general chocolates studied didn't have any unpleasant aftertaste, except the ordinary hazelnut chocolate, where rancidness was detected and so this sample was assessed the worst.

According to the request of chocolates producer the panellist had to evaluate their scores with the previous defined importance factors. These data are presented in Table 3. From the sum of all scores we could estimate the general sensory quality of chocolates tested and range them in one of four classes: 81-100 scores as excellent, 61-80 scores as good, 41-60 scores as acceptable and 40 scores and less as unsuitable. Regarding these criteria four chocolates were of an excellent quality. The highest assessment was stated for the rice chocolates, 88.0 scores for RCs and 87.6 scores for RCi. Ordinary hazelnut chocolate achieved 84.6 scores but ordinary milk chocolate 83.9. The worse assessed chocolates were HCi and MCi, with 80.1 and 78.2 scores, respectively.

CONCLUSIONS

The results obtained in this research have shown that the new product – a functional chocolate was accepted quite well among consumers of different age. Despite its differences in worse solubility and sweetness it was evaluated similar to ordinary types of chocolates. The increasing content of fibre, reduction of sugar content for 50 % and energy value for ca 12 % are very important factors to recommend consumption of this product to healthy population and also to diabetics.

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