Technological and sensory characteristics of honey based candy

Anastasia Yankova-Nikolova[1*], *Raina* Hadjikinova[2], *Gabriela* Opalchenova[2], and *Desislava* Vlahova-Vangelova[1]

[1] Meat and Fish Technology, Technological faculty, University of Food Technologies, Plovdiv, Bulgaria
[2] Department of Tobacco, Sugar, Vegetable and Essential Oils, Technological faculty, University of Food Technologies, Plovdiv, Bulgaria

Abstract. The aim of the present work was to investigate the possibilities of sugar replacing with honey in candies processing. Four candy samples were examined. Honey based groups - 10% (M_{10}), 15% (M_{15}) and 20% (M_{20}) honey and sugar substitute - isomalt, compared to the control (sample K) obtained according to a classic recipe, with crystal sugar and glucose syrup. The color intensity, the hygroscopicity in candies and the spreadability of the candy mass increase linear with the honey content. The highest compressive strength after direct compression was found in the control (K). In the experimental samples (M_{10}, M_{15}, M_{20}) the breaking force was over 250 N, while for the control it was 144.74 N. The honey taste decreased in the following order: M_{20}> M_{15}> M_{10}> K. Replacing sugar with honey gives a caramel flavor in the candies. Stickiness significantly increased in M_{15} and M_{20}, which was assessed as a product disadvantage. At the same time as the stickiness increases, the brittleness of the candies decreases. The energy value decreases by 39% in sample M_{10} and by 37% and 36% in samples M_{15} and M_{20}, respectively, which gives an opportunity honey-based candies to be classified with the nutritional claim "Food with reduced energy content".

1 Introduction

Hard candies, known as boiled candies, are one of the popular products among confectionery consumers all over the world. They are obtained after boiling sugar-glucose syrup to a candy mass with a concentration of dry matter of 97-99% [1].

Typical for the group of the hard candies is the large variety determined by taste-aromatic characteristics and also by the structure of their constituent parts. In this regard, hard candies are divided into two main groups: hard candies without filling (made entirely of candy mass); hard candies with a filling consisting of a shell and a filling (of different composition).

The processing of hard candies includes the following technological operations: preparation on the raw materials; obtaining sugar-glucose syrup; boiling the syrup to candy mass; processing on the candy mass (coloring, flavoring and acidification); forming on the candies; cooling; wrapping and packing [2].

The main ingredients for the production of this group of candies are crystal sugar, glucose syrup and additives for the food industry (acids, colorings and flavorings) [3].

It has been established that excessive consumption of foods with high content on sucrose is one of the reasons for so called "diseases on civilization" such as obesity, diabetes, heart disease, tooth decay, etc. [4, 5]. This fact has an impact on the development trends of the hard candy market and especially on the sugar-free and energy-reduced candies segment. With their functional properties such as low metabolic energy value, not causing dental caries, non-insulin-dependent metabolism, polyols (sugar alcohols) they are suitable sugar-substitutes in the production of hard candies. As additives for the food industry, except as sweeteners, polyols are used as texturizers and humectants [6]. Polyols also have the property of extending the shelf life of sweet-tasting products by delaying their aging and microbial spoilage [7].

According to [3] of all polyols, isomalt is the ideal sugar substitute in hard candy production.

The present study aims to establish the quality of hard candies obtained by substitution of sugar with isomalt and honey as honey was added in different ratios.

2 Materials and methods

2.1 Materials

For the purposes of the study were used crystal isomalt with the trade name "C* IsoMaltidex 16502" from the company "Cargill", crystal sugar from "Zaharni zavodi" AD, G. Oryahovitsa, glucose syrup from the company "Roquette" and honey from the company "Royal-Bees" EOOD, Saedinenie, Municipality of Plovdiv.

The recipe composition of the individual samples and their designation are shown in table 1.

2.2. Experimental design

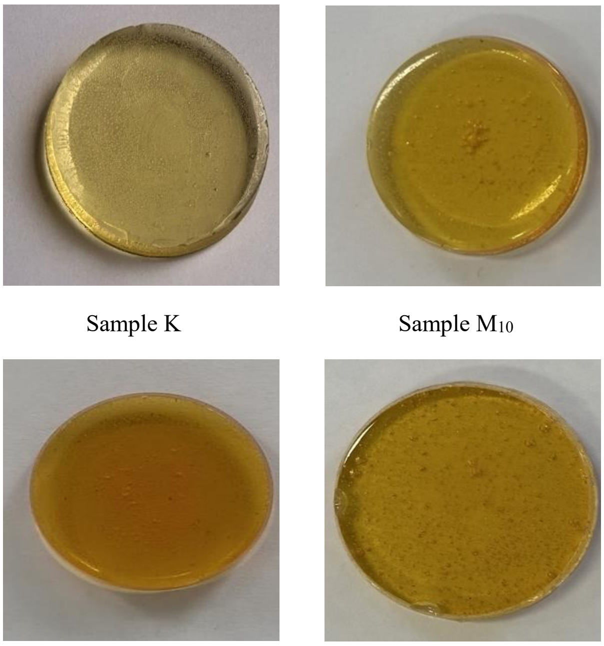
To carry out a complete comparative characteristic, a control (sample K) – candy mass obtained according to a classic recipe, with crystal sugar and glucose syrup, was analyzed. Hard candies are boiled in laboratory conditions. The samples substituted with honey are obtained by mixing isomalt with water in an amount of 0.25 relative to its mass and heating. After the complete dissolution of the isomalt, honey was added and the candy mass was boiled to a temperature of 150°C. The control

* Corresponding author: a.yankova@gmail.com

was obtained from crystal sugar and glucose syrup in a ratio of 1.0: 0.5 and water 0.3 relative to the mass of sugar. The candies are formed by pouring the candy masses into molds. The resulting candies are shown in Figure 1.

Table 1. Prescription composition

Raw materials, %	Type of sample			
	K	**M_{10}**	**M_{15}**	**M_{20}**
Crystal sugar	66.7	-	-	-
Glucose syrup	33.3	-	-	-
Isomalt	-	90	85	80
Honey	-	10	15	20
Total	100	100	100	100



Sample K Sample M_{10}

Sample M_{15} Sample M_{20}

Fig. 1. Photos of the obtained candies

2.3. Physicochemical parameters

The values of the main physicochemical parameters such as dry matter content, total sugar content, reducing substances and titratable acidity were analyzed according to [8].

The colour of the candies was determined spectrophotometrically on 10% solutions of the samples at λ=440 nm.

The sorption properties of the samples were analyzed according to the methodology described in [8] at a relative humidity of 68% and 75% at room temperature. Saturated solutions of $CuCl_2$ and NaCl, respectively, were used to maintain a constant relative humidity.

The spillability of the candy masses was determined, which is characterized by the so-called spillability coefficient, determined by the formula:

$$K=S/g \quad (1)$$

Where: K – spillability coefficient, cm^2/g;
S – area of the candy mass, cm^2;
g – mass of the candy mass, g.

The energy value of the obtained candies was calculated depending on the content of macronutrients in their composition and by using conversion factors defined in [9].

2.4. Texture properties

Texture properties were determined by a direct compression using a TX-700 texture analyzer (LAMY RHEOLOGY, France) equipped with a flat probe of 50 mm. The breaking force was determined using a cleaver probe (CP25 at 60° angle). A crossed speed of 1 mm/sec with a 5 kg compression load cell to 40% of the original height of the candy at pre-test speed: 2 mm/s; test speed: 1.0 mm/s and post-test speed: 1 mm/s was used. The analysis was carried out at ambient temperature (25°C). Each sample was measured five times and average value ± SD was reported for each parameter.

2.5. Sensory profile

The sensory evaluation of the candies was performed by a panel group of nine trained tasters, people aged between 23 and 45 years with experience in candy tasting as described by [10] with slight modifications. Sensory analysis was performed in the tasting room. Global satisfaction degree evaluation was established by measuring the pleasant or unpleasant sensations produced by the sample using a 9-point hedonic scale. When evaluating the aroma and taste, criteria for honey or caramel presence were used. Textural characteristics were determined by stickiness, brittleness, hardness, and smoothness in honey-based candies.

2.6. Statistical analysis

The method of single-factor variance analysis of variables (ANOVA: Single Factor) was used to evaluated the significance of the results. In this manner, a significant effect of different percent honey was determined at a significance level of $p \leq 0.05$ [11]. Data is presented as Mean ± SD (standard deviation). A, B, C and D indicate significant differences ($p \leq 0.05$). The number of replicates is n=5, and the used statistical software is Microsoft Office Professional Plus 2019.

3 Results and discussion

The values of the determined physicochemical parameters of the obtained hard candies are shown in Table 2.

The significant differences between the samples are observed in the indicators of total sugar content, reducing substances and color. Sample K is distinguished by significantly higher values of the indicator total sugar, which is about 87% higher than sample M_{10}. In the samples with honey, with higher amount of honey the content of total sugar increases. This is due to the glucose and fructose content in honey.

The samples obtained with honey are more intensely colored than the control. The most strongly colored is the one with the highest content of honey (M_{20}), which is about three times more intensely colored than sample K.

Similar results were obtained by [12] and the reason was higher mineral content in the honey compared to sugar.

Table 2. Values of basic physicochemical parameters of hard candies

Indicators	Type of sample			
	K	**M_{10}**	**M_{15}**	**M_{20}**
Dry content, %	97.66^{A} ±0.13	97.45^{A} ±0.11	97.13^{A} ±0.15	96.79^{A} ±0.12
Total sugar content, % (as inv. sugar) of dry matter	75.82^{A} ±0.23	9.23^{D} ±0.18	12.03^{C} ±0.10	15.12^{B} ±0.21
Reduc. substances, % (as inv. sugar) of dry matter	16.23^{A} ±0.12	7.18^{D} ±0.16	10.27^{C} ±0.17	14.33^{B} ±0.11
Titratable acidity, grad.	0.38^{B} ±0.01	0.46^{B} ±0.05	0.56^{A} ±0.09	0.61^{A} ±0.04
Color, E	0.055^{C} ±0.004	0.145^{B} ±0.01	0.152^{B} ±0.023	0.182^{A} ±0.021

The hygroscopicity of hard candies depends largely on their composition. On this occasion, the sorption properties of the obtained honey samples were analyzed compared to that of sample K (control) reflected in Fig. 2 and Fig. 3, respectively at relative humidity φ =68% and φ =75%.

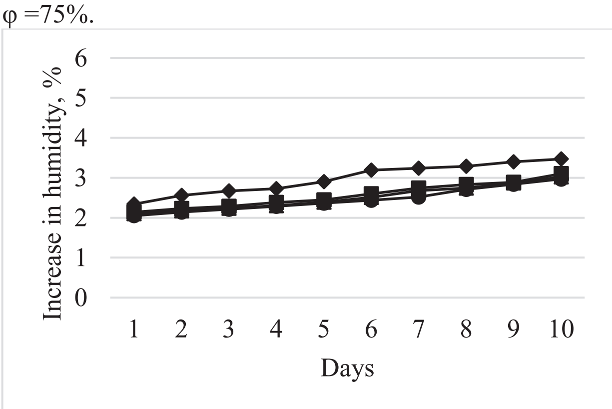


Fig. 2. Kinetics of hard candies depending on their recipe composition at φ=68%, sample type: ●-sample K, ▲-sample M_{10}, ■-sample M_{15} and ♦-sample M_{20}

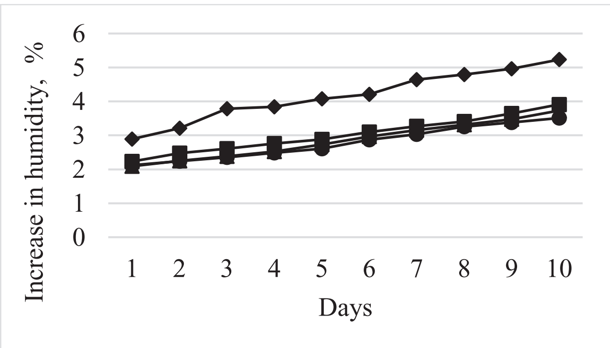


Fig. 3. Kinetics of hard candies depending on their recipe composition at φ =75%, sample type: ●-sample K, ▲- sample M_{10}, ■-sample M_{15} and ♦-sample M_{20}

From the graphically expressed dependencies (Fig. 2 and Fig. 3) it is clear that the sample obtained with the largest amount of honey (M_{20}) has the highest hygroscopicity. On the tenth day, the moisture content of sample M_{20} increased by about 33% more compared to the first day at φ=68% and by about 55% at φ=75%. The control and sample M_{10} are distinguished by the lowest hygroscopic properties at both analyzed values of relative humidity.

Table 3 shows the so-called spillability coefficient of the obtained candy masses. The spreadability of the candy mass is an indirect characteristic of its viscosity and to a certain extent depends on its recipe composition. From the data in Table 3 it is evident that the control has the lowest spillability coefficient. In the rest of the samples with increasing the amount of honey the spillability of the candy masses increases. Samples M_{10} and M_{15} have about 23% to 24% higher spillability coefficient value than the control

Table 3. Spillability factor and textural characteristics of candies

Indicator	Type of sample			
	K	**M_{10}**	**M_{15}**	**M_{20}**
K, coefficient of spillability, cm^2/g	1.24^{B}	1.62^{A}	1.63^{A}	1.68^{A}
Direct compression, N	8.36^{A} ± 1.98	5.69^{C} ± 0.57	5.48^{C} ± 0.38	5.14^{C} ± 0.05
Breaking strength, N	144.74^{B} ±13.00	$>250^{A}$	$>250^{A}$	$>250^{A}$

The calculated energy value of the candies, depending on their composition, is shown in the table. 4.

Table 4. Energy value of hard candies, depending on the composition

Energy value	Type of sample			
	K	**M_{10}**	**M_{15}**	**M_{20}**
kcal /100 g	373	226	232	239
kJ /100 g	1584	944	969	997

It is clear that the control (K) has the highest energy value. Its energy value is about 39% higher than sample M_{10} and about 37% and 36% higher than samples M_{15} and M_{20}, respectively. This allows, in accordance with [13] candies obtained with the participation of honey to be classified with the nutrition claim "Energy-reduced food".

The lightest colour is the control candy sample, in the recipe of which sugar is used. The tasting committee found a distinct, darker colour in the three experimental samples with 10, 15 and 20 % honey respectively (M_{10}, M_{15}, M_{20}). According to the studied colour indicator, no statistically significant difference was found in candies M_{10}, M_{15} and M_{20}. The tasting panel did not find any differences (p≥0.05) in the four candies tested (K, M_{10}, M_{15}, M_{20}) according to the opacity criterion.

Table 5. Sensory characteristics of the control and experimental samples of hard candies

Sensory characteristic		K	M_{10}	M_{15}	M_{20}
Appearance	Colour (shades of yellow from light to dark)	3.05 ±0.05	7.10 ^{A} ±0.05	7.00 ^{A} ±0.05	7.00 ^{A} ±0.10
	Opacity	8.90 ^{A} ±0.15	8.95 ^{A} ±0.05	8.90 ^{A} ±0.05	8.95 ^{A} ±0.05
Taste	Sweet	8.95 ^{A} ±0.05	6.00 ^{D} ±0.15	8.00 ^{B} ±0.25	9.00 ^{A} ±0.15
	Sour	0	0	0	0
Aroma	Honey	0	2.00 ^{D} ±0.15	8.00 ^{B} ±0.25	8.90 ^{A} ±0.15
	Caramel	0	1 ^{D} ±0.15	8.95 ^{A} ±0.05	8.95 ^{A} ±0.05
Texture	Hardness	8.90 ^{A} ±0.10	8.00 ^{B} ±0.15	8.00 ^{B} ±0.25	8.00 ^{B} ±0.15
	Fragility	8.95 ^{A} ±0.05	0	0	0
	Smoothness	8.95 ^{A} ±0.05	8.95 ^{A} ±0.05	8.95 ^{A} ±0.05	8.95 ^{A} ±0.05
	Stickiness	0	1.00 ^{D} ±0.15	6.00 ^{B} ±0.20	8.80 ^{A} ±0.10

The most intense sweet taste was obtained in the candies with 20 % honey (M_{20}) and in the control K, followed by M_{15}. The low intensity of the sweet taste was found in candies with 10% honey (M_{10}). No sour taste was detected in all tested samples. According to the indicator aroma, the candies were ranked in the following order: $M_{20} > M_{15} > M_{10} > K$. Replacing sugar with honey gives a caramel flavor to the produced candies. The structural indicators of hardness and smoothness did not differ ($p \geq 0.05$) in the four investigated samples. After using 15% and 20% honey in the candy formulation, the stickiness increases significantly ($p \leq 0.05$). The tasting committee notes this excessive stickiness as a product flaw. At the same time as the stickiness increases, the brittleness of the candies decreases.

4 Conclusion

From the comparative analysis, the influence of honey and isomalt in composition of hard candies was established. It was found that the candies used for control (sample K) had about 87% higher total sugar content than sample M_{10}. The samples obtained with honey are more intensely colored than the control. Candies obtained with the participation of bee honey can, according to food legislation, be classified as energy-reduced food.

References

1. R. Hartel, J. Elbe, R. Hofberger. *Confectionery science and technology* (Springer Cham., p. 536 2018)
2. G. Marshalkin, Food Industry. **445**, 35 (1978)
3. J. Raudonus, J. Bernard, H. Janben, J. Kowalczyk, R. Carle, Food Res. Int. **33**, 41 (2000)
4. M. Rusu, J. Exp. Mol. **10**, 93 (2009)
5. R. Supriyanto, M. Mojiono, Y. Ambarwati, IOP Conf. Series: Environ. Earth Sci., **1182**, (2023)
6. P. Cock, UK- Blackwell Publishing Ltd., 215-240 (2012)
7. S. Bhise, A. Kaur, Int. J. Adv. Sci. Res., i. **3**, v. **1**, 262-272 (2013)
8. I. Lurie, L. Skokan, A. Tsitovich, *Technochemical and microbiological control in confectionery production*, Moscow, Koloss, **415**, (2003),
9. Regulation (EU) No. 1169/2011 of the European Parliament and of the Council of October 25, 2011 on the provision of food information to consumers.
10. L. Pui Yan, N. Yeen Linn, M. Arunasalam, T. Choon Hui, S. Salvamani, Baskaran, J. Cul. Sci. Technol., **21**, 6 (2023)
11. N. Draper, H. Smith, Applied regression analysis, JWS, **326** (1998)
12. J. Juliani, I. Irmayati, *In Proceedings of International Conference on Multidiciplinary Research*, **5**, No. 1, 163-169 (2022)
13. Regulation (EC) No. 1924/2006 of the European Parliament and of the Council of 20 December 2006 on nutrition and health claims for foods