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EFFECT OF ADDED RAPE HONEY ON CHOSEN PHYSICOCHEMICAL AND TEXTURAL PROPERTIES AND ANTIOXIDANT ACTIVITY OF YOGURTS DURING STORAGE

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ABSTRACT

This study evaluated chosen physicochemical properties, antioxidant activity and textural properties of yogurts during refrigerated storage. The yogurts were divided into four groups as follows: control group without any additions of honey (K) and yogurts samples with the different addition 1, 3 and 5 % (w/v) of rape honey (A, B and C). These samples were analysed during fourteen days of storage at cooling temperature (6 ±1 °C). Yogurt samples were analyzed for dry matter content, fat content, pH values, lactic acid percentage, antioxidant activity and textural properties (firmness and cohesiveness). Dry matter content increased gradually with increased addition of honey. On the contrary, the rising addition of honey caused a decrease of fat content. The pH values of yogurt samples decreased during storage. The lowest firmness and cohesiveness was observed in the sample with highest addition of rape honey.

Keywords: yogurt, honey, physicochemical parameters, antioxidant activity, textural properties

INTRODUCTION

Yogurt is milk fermented with symbiotic starter cultures of lactic acid bacteria *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subs. *bulgaricus*, which shall be in a viable state, active and still present in the product through the end of shelf life **(Yilmaz and Gökmen, 2017)**. The pH value decreased to the level 4.6 – 4.7 by fermentation with lactic acid bacteria, which convert lactose into lactic acid **(Sert *et al*., 2017)**. Yogurt is renowned for its health benefits, nutritional value and digestibility. It contains protein, B vitamins and calcium **(O´Sullivan *et al*., 2016; Nguyen *et al*., 2017)**. Yogurt is gel that is composed of denatured protein and milk fat globule. The fat content in yogurts influences the firmness of gel network structure. The low fat content can leads to less desirable textural properties, flavour and aroma **(Yu *et al*., 2016)**.
Yogurt has its own peculiar flavour. The flavour of yogurts has played an important role in their acceptance by consumer. Sweeteners, flavourings and other ingredients are added to modify the taste and aroma of yogurts. Also there has been an interest in fortification of yogurt to improve its nutritional value and health benefits. The ambition to provide tasty and also nutritive rich food increased with the development of technologies and the growing competition **(Routray and Mishra, 2011; Singh *et al*., 2012)**.
Honey has been used in foods and drinks as sweetener and flavouring agent. Its main producers are China, Turkey, Argentina, Ukraine and other. Yogurts with honey are not widely available in trade network **(Meo *et al*., 2017)**. Blossom honey and honeydew honey are the main honey types in term of its origin. There are unifloral and multifloral types of blossom honey. Unifloral honey is obtained from profuse crops, for example *Brasicca napus*. This type of honey is called rape honey **(Kňazovická *et al*., 2015)**. According to Codex Alimentarius "Honey is the natural sweet substance produced by honey bees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in the honey comb to ripen and mature" **(Codex Stan, 2001)**. Honey is popular because of its high nutritive value and due to its beneficial effects on human health. It has antioxidant, bacteriostatic, anti-inflammatory and antimicrobial properties. Honey contains approximately 80 % of carbohydrates, glucose and fructose are the main contributors, 15 – 17 % of water, 0.1 – 0.4 % of proteins, ash, amino acids, vitamins, minerals, enzymes, organic acids and phenolic compounds **(Kasprzyk *et al*., 2018)**.
The objective of our study was to evaluate chosen physicochemical and textural properties of yogurts with the different additions of rape honey and compare them with a control samples without any addition of honey.

MATERIAL AND METHODS

Yogurts production

Yogurts were made and assessed in Department of Evaluation and Processing of Animal Products, Slovak University of Agriculture in Nitra. Semi-skimmed milk obtained from trade network was used for yogurts production. The milk was heated on 40 – 42 °C, mixed with skimmed milk powder and again heated to 80 – 82 °C for two minutes. Yogurt culture (Laktoflora®, Milcom a. s., Czech Republic) was added into the cooled milk and inoculated milk was dosed into sealable glasses. This product was marked as control sample (K). To all experimental samples (A, B and C) was added rape honey. These experimental samples of yogurts were divided to three groups: first group of samples (A) additionally contain of 1 % (w/v) of honey, second groups of samples (B) additionally contain of 3 % (w/v) of honey and third groups of samples (C) additionally contain of 5 % (w/v) of honey. The fermentation of milk was set at 42 – 43 °C during four hours. The final products were stored at 6 ±1 °C during 14 days. Each experiment was evaluated at least three times and the given results are represented as the mean values.

Physicochemical analysis

Dry matter content, fat content, pH values and lactic acid percentage of yogurts were determined. The analyses were performed at least in duplicate. Dry matter content and fat content were determined in the 1st day following the yogurts production. The dry matter content was determined with a gravimetric reference method by drying to constant weight at 102 ± 2 °C. The fat content was determined with Gerber´s acidobutyrometric method **(Cvak *et al*., 1992)**. The pH values of the yogurts samples were measured by pH meter Orion Star A211 (Thermo Fisher Scientific, USA). The pH measurement was carried out in the 1st, 7th and 14th day following the yogurts production. Electrophoretic analyser EA 102 (Villa Labeco, Slovak Republic) was used for capillary isotachophoretic determination of lactic acid in yogurt samples. The electrolyte system was created by the leading electrolyte (LE) and the terminating electrolyte (TE). Driving current 250 µA was used for isotachophoretic analysis. Lactic acid percentage was determined in the 1st, 7th and 14th day following the yogurts production.

Antioxidant activity

Antioxidant activity of yogurt samples by 1, 1-diphenyl-2-picrylhydrazyl radical (DPPH) inhibition was determined by an assay modified from **Zainoldin and Baba (2009)**. The decrease in absorbance was monitored at 517 nm until a constant reading was obtained. The readings were compared with the controls which contained distilled water instead of yogurt water extract. The results were expressed as the trolox equivalent antioxidant capacity (TEAC). Antioxidant activity of yogurt samples was determined 7th and 14th day following the yogurts production.

Textural properties

Texture properties were measured on a texture analyser TA.XT Plus (Stable Micro Systems LTD., UK). The texture analyser was used to measure chosen textural properties and that firmness and cohesiveness. The texture analysis was carried out on the 1st, 7th and 14th day following the yogurts production. The test was carried out in a plastic container with 50 mm diameter, using a 35 mm back extrusion disk probe and 5 kg load cell. Temperature of samples was 15 °C. Test speed of probe was 1 mm.s^{-1} and a distance reached in the yogurt sample was 30 mm. The course of measurement was recorded through the curves by Texture Exponent software.

RESULTS AND DISCUSSION

Physicochemical analysis

Dry matter content and fat content in yogurts are shown in table 1. The highest dry matter content was determined in the samples with highest honey addition (C). Dry matter content was increased by the presence of rape honey. **Glušac *et al*. (2015)** showed similar trend for yogurts with same addition of whey protein concentrate and different addition of acacia honey. They caused an increase in dry matter content of yogurts.
The lowest fat content was observed in the yogurt samples with highest addition of honey. The rising addition of honey amount caused a decrease of fat content. These findings are in line with results by **Rashid and Thakur (2012)**, who found that the fat content decreased gradually with increased addition of honey.

Table 1 Dry matter content and fat content in yogurts

Sample	Dry matter content (%)	Fat content (%)
K	15.21	1.48
A	15.52	1.48
B	17.13	1.47
C	18.09	1.45

Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

The highest pH value on the first day of storage was determined in the sample with highest addition of honey (Table 2). On the last day of storage, the sample without any addition of rape honey showed lowest pH value. The pH values of all analysed yogurt samples decreased during storage. These findings are consistent with those of **Varga (2006)**, who reported a decrease in pH values of yogurts with different honey additions during six weeks storage.

Table 2 The pH values in yogurts stored at 6 ± 1 °C during 14 days

Sample	Day of storage		
	1. day	7. day	14. day
K	4.63	4.20	3.95
A	4.59	4.08	3.99
B	4.60	4.20	4.01
C	4.75	4.25	3.97

Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

Yogurt is obtained by lactic acid fermentation and therefore the yogurts contain the different percentage of lactic acid (Table 3). Lactic acid percentage of all samples increased during storage. In all of analysed samples, the highest content of lactic acid was determined after 14 days of storage. Our findings are consistent with those of **Rotar *et al.* (2015)**, who reported a growth of lactic acid percentage in yogurts with the same level of polyfloral honey (3 %) and the different levels of goji berries (3, 5 and 7 %) during 21 days of refrigerated storage. They found that the content of lactic acid increased during storage.
In the study of **Varga (2006)**, acacia honey had no effect on lactic acid levels of the final products. There were no significant differences among control and honey-containing yogurts in lactic acid levels during storage.

Table 3 Lactic acid percentage in yogurts stored at 6 ± 1 °C during 14 days

Sample	Day of storage		
	1. day	7. day	14. day
K	0,91	1,05	1,25
A	1,03	1,03	1,25
B	0,99	1,03	1,27
C	0,91	0,96	1,27

Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

Antioxidant activity

Fermented dairy products are the excellent sources of bioactive peptides. They provide numerous peptides with antioxidant properties **(Rahmawati and Suntornsuk, 2016)**. Honey is rich in antioxidants and the components in honey responsible for its antioxidative effect are phenolic compounds. The composition and antioxidant capacity of honey depend on the floral source used to collect nectar and other factors. The higher antioxidant activity was found for darker honeys **(Lachman *et al*., 2010)**. The rape honey added into the yogurts had antioxidant activity 1,053 mg TEAC.g^{-1}. Antioxidant activity of yogurts (Table 4) depends on the kind of honey, which is added into the yogurt samples. The higher addition of honey led to higher antioxidant activity of yogurt samples. In the samples K, A and B was observed the sharp decline (9,857 – 10,142 µg TEAC.g^{-1}) of antioxidant activity during 7 days. The least decline of antioxidant activity (4,467 µg TEAC.g^{-1}) was determined in the sample with the highest addition of honey. Our findings are comparable with those of **Perna *et al.* (2014)**, who determined a higher antioxidant activity in yogurts with addition of chestnut and sulla honey. Yogurts with chestnut honey addition showed higher antioxidant activity compared to the samples with sulla honey, because total phenolic and flavonoid contents were higher in chestnut honey.

Table 4 Antioxidant activity of yogurts stored at 6 ± 1 °C on the 7th and 14th day of storage

Sample	µg TEAC.g^{-1}	
	7. day	14. day
K	12,095	2,238
A	13,153	3,151
B	14,071	3,929
C	15,954	11,487

Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

Textural properties

Changes in textural properties of yogurts during storage are shown in figure 1, 2 and 3. In the storage period, the lowest firmness and cohesiveness were found in the samples with highest addition of honey. On the last day of storage, the highest firmness and cohesiveness were measured in the control sample without honey addition. Honey addition led to the lower firmness and cohesiveness of yogurts. These results are comparable with those of **Shleykin *et al*. (2015)**, who found that increasing concentrations of honey (10 %, 20 % and 30 %) leading to lower firmness of yogurts.

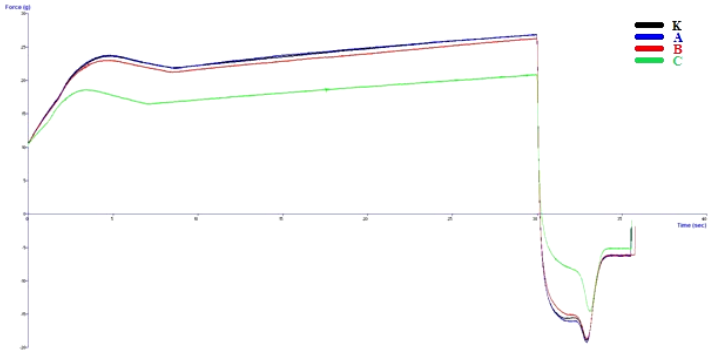

Figure 1 Textural properties of yogurts 1st day of storage
Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

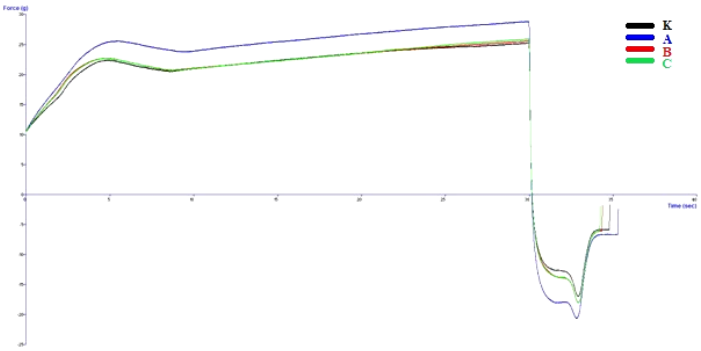

Figure 2 Textural properties of yogurts 7th day of storage
Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

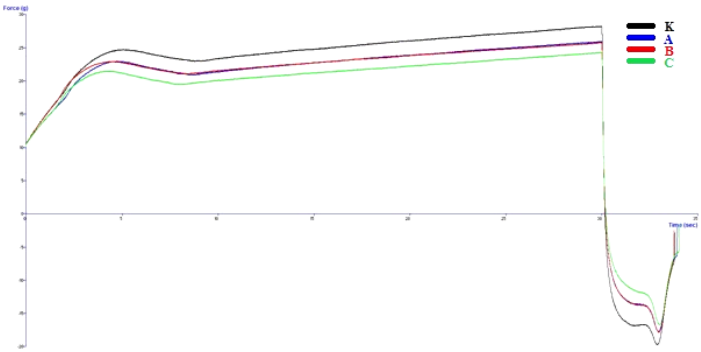

Figure 3 Textural properties of yogurts 14th day of storage
Legend: K – yogurt containing added without rape honey, A – yogurt containing added rape honey at 1 % (w/v), B – yogurt containing added rape honey at 3 % (w/v), C – yogurt containing added rape honey at 5 % (w/v)

CONCLUSION

Rape honey addition into the yogurts leads to higher dry matter content. The honey addition caused a decrease of fat content in final yogurts. The different addition of honey had no significant effect on the pH values of yogurts. The rising addition of rape honey caused less desirable textural properties of yogurts.

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