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Research Article

Effects of different types of herbs on colour and texture properties of Kashar cheese

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ABSTRACT

In this study, six types of Kashar cheese, five with added herbs and one without any additives, which is determined as a control sample were produced. *Urtica dioica* L. (nettle), *Petroselinum crispum* (parsley), *Mentha piperita* (mint) and *Eruca vesicaria* (arugula), *Chaerophyllum byzantinum* Boiss. (mendek) were added to cheese clot in proportion as 0.1% amounting to 0.1-0.3 cm split particles depending on the milk used. Then, all the cheeses were vacuum-packed and ripened at 7 ±1°C for 3 months, and their *L**, *a**, *b** colour values and textural parameters including resilience, hardness, elasticity, gumminess, cohesiveness, adhesiveness, and chewiness were determined using texture profile analyses (TPA). It was observed that neither cohesiveness, adhesiveness and elastic parameters of texture profile differed in terms of cheese type, nor important statistical difference was identified (P>0.10), differences regarding the ripening process found out though (P<0.05).

Keywords: Kashar cheese, Herb, Colour, Texture

Introduction

Cheese is consumed almost all over the World the main production steps include; Different types of milk get coagulated including cow, sheep, goat and buffalo. Then, whey is removed from the curd, which can be treated in various ways such as scalding, fermentation, salting etc. Finally, cheese is consumed either fresh or ripened. It has been reported that around 4000 varieties of cheese are produced in the world and many of these cheeses are reported to have little or no economic value due to their similarities. It is stated that the number of cheese produced in Tukey is around 200 types (Hayaloğlu and Fox, 2008). Kashar cheese, which is a semi-hard cheese, is one of the most important cheese varieties manufactured in Turkey. After the ripening period, it has a unique flavour, taste and aroma (Agboola and Radovanovic-Tesic, 2002). Cheeses similar to this type are extensively manufactured in Balkan countries known as Kashkaval cheese and Kasseri cheese (Keceli et al., 2006). Proteolysis affects the level of intact casein, which is a major determinant of the firmness and fracture properties of cheese (Tarakçı and Küçüköner, 2006). The herbs are added on the curd weight. The herbs commonly used in cheese are as follows, *Allium* sp., *Chaerophyllum macropodum, Antriscus nemorosa, Silene vulgaris, Ferula* sp., *Prangos* sp., *Tymus* sp. and *Mentha* sp. They are added to cheese at different ratios (Tarakçi et al., 2005). These plants give the cheese its flavor and aid for the preservation of the cheese (Tarakçı and Akyüz, 2009). Tarakçi et al. (2004) indicated that more proteolysis and lipolysis occurred in the cheese samples made from raw milk and herb than the cheese samples made from pasteurized and cultured milk. The increase of the herb ratio (*Allium* sp.) in Van herby cheese caused more proteolysis and lipolysis. It has been reported that *Prangos* sp., *Ferula* sp., and *Chaerophyllum* sp., herbs affect the WSN, TCA-SN/TN and PTA-SN/TN ratios of cheeses (Tarakçı and Temiz, 2009). Proteolysis in cheese involves a complex and dynamic series of events. In order to better understand the development of proteolysis in cheeses, it is necessary to investigate the nitrogen fractions formed during ripening (Tarakçı et al., 2011). Semi-hard cheeses typically matured in less than three months, including natural herbs such as lemon blueberry (*Backhousia citrodora*), natural mint (*Prosanthera incisa*) and bush tomato (*Solanum centrale*) in some factories in Australia are produced (Ahmed and Johnson, 2000). In this study, it was aimed to determine the change that occurred during ripening by adding nettle, parsley, mint, arugula, and mendek on colour values and textural profile analyses of Kashar cheese.

Materials and Methods

Cow milk was obtained from a local dairy plant in Ordu, Turkey. Commercial rennet (1/16000) was obtained from Mayasan Company®, Istanbul. All spices were products of Bağdat Baharat Company (Kahramanmaraş, Turkey) and purchased from local markets.

Kashar Cheese Making

Raw milk was pasteurized at 75°C for 30 seconds and cooled to 32°C. Then milk was coagulated with rennet for 75 min. After coagulation, the curd was cut into 8-10 mm cubes with a wire knife and pressed for 120 min. While the sample cheese for control was produced without adding any herb, the others were processed to cheese by adding nettle (G1), parsley (G2), mendek (G3), mint (G4), and arugula (G5) powder as 0.1% according to the milk used. The Kashar cheese samples were salted with dry salt (the amount of dry salt used was 3% of cheese weight) and held 24h inside the salt. The cheese samples were vacuum-packed and ripened at 7±1°Cfor 90 days. Two replicates of cheese samples were prepared for each cheese type.

Color analyses: Colour measurements were performed using a colorimeter (Minolta Chroma Meter, CR-400, and Osaka, Japan). The L^*, a^* and b^* colour measurements were determined according to the CIE Lab colour space system. The L^* value is an indicator of luminosity (the degree of lightness from black to white). The a^* value is an indicator of green (–) and red (+), whereas b* is an indicator of blue (–) and yellow (+). Three readings were taken for each sample and arithmetic means were calculated.

Texture profile analyses: For the texture analysis, the temperature of the cheeses was adjusted to 20 ±2°C. The cheeses were cut into cubes with the dimensions of 20x20x20 mm with a cutting wire. Texture profile analyses (hardness, springiness, gumminess, cohesiveness, adhesiveness, resilience and chewiness) of cheese samples were performed using TA-XT2 (Stable Micro Systems Ltd., Surrey, UK). Analysis conditions: P/36 aluminum cylinder probe (36 mm diameter, AACC) and cell strength 25 kg weight, test speed 0.4 mm/s, initial test speed 1.0 mm/sec, print 40 %, hold time 5 sec. (Everard et al., 2006).

Results and Discussion

Colour Changes in Cheese

*L**, *a**, *b** values given by the three-dimensional coordinate system. The value called *L** in this coordinate system is on the vertical axis; While a brightness (100) indicates going to darkness (0), + *a** indicates redness, -*a** greenness, + *b** yellowness, and –*b** refers to blueness (Luo, 2006). As can be seen in Table 1, the cheese with the lowest *L** value among the herb supplemented cheese varieties was mint added one (75.15 ±7.75) on the 30th day, while Kashar cheese with arugula herb had the highest value on the 90th day as 91.23 ±1.08. As can be seen, it was found that there was no statistically significant difference between nettle, mendek and mint added cheeses (P<0.01). It was also found that there is no difference between parsley cheese and arugula cheese. There was a significant difference at P<0.01 level between *L** values of Kashar cheeses and a decrease at P<0.01 level between periods with prolongation of ripening. Similar results were also obtained by Öksüz et al. (2001) and researchers such as Fırat (2006) and Gülter (2011) stated that Kashar cheese *L** values entered a deceleration during ripening.

There is a tendency towards green in terms of taking negative values of herb supplemented cheese varieties (Table 1). When observed during the ripening period, the lowest was 30th day with mint added cheese with *a** value of -0.90 ±0.49; It was determined that the highest value was nettle cheese with -3.26 ±0.20 on the 60th day. When the average *a** values of all herb supplemented Kashar cheese varieties were compared, mendek (G3) had the highest value of 2.51 ±0.17 while mint-added (G4) Kashar cheese had the lowest value of -1.34 ±0.34 (data not shown). When herb-added cheeses compared to control cheese, it observed that the tendency towards green was lower. The reason for this is that due to the dehydration of the color pigments and the loss of water with the drying of the herbs. The green color becomes a little brownish and this somewhat prevents it from becoming fully green. When these findings are interpreted, the interaction of cheese type and ripening time was statistically significant at the level of (P<0.01). However, herbal supplement cheeses showed similar tendencies. There was statistically a significant difference in a^* value among nettle, parsley and arugula cheeses. According to the multiple comparison test data of Kashar cheese, the lowest value is in control cheese (-3.46 on 60th day) and the highest values is in mint cheese (-0.90 on 30th day). Fırat (2006) and Gülter (2011) observed in their study that a decrease in rates occurred in Kashar cheese during ripening. As it is seen from the table below, it is understood that the cheese with the lowest *a** value is the control group cheese and with this value, it is the cheese with the greenest color. The herbs added to the cheese have non-enzymatic browning depending on factors such as moisture loss, light, temperature and time due to drying, and as a result, the cheese has a color effect (Tarakçı and Deveci, 2019).

The *b** color value indicates yellow and blue colors. + *b** values indicate that yellow is present in the environment, -*b** values indicate that blue is present in the environment (Voss, 1992).While the highest *b** value was 22.99 ±0.43 on the 3rd day in the control cheese (K), the lowest one was observed in the mint cheese on 90th day (12.96 ±1.80). This shows that herb addition reduced its orientation to yellow color. According to the results of the multiple comparison test of the *b** values of cheese varieties (Tarakçı and Deveci, 2019), it observed that there was no statistical difference between the herbs supplemented cheeses, compared to the control group cheese. In addition, it was found that the control group cheese was the highest in terms of yellow color.

Textural Properties

In the textural evaluation of cheese, texture profile analysis (TPA) is a frequently used instrumental analysis and is associated with sensory features. Resilience, hardness, elasticity, gumminess, cohesiveness, adhesiveness structures are the parametric features used to determine the texture of cheeses with TPA device (Gunasekaran and Ak, 2003). Many factors affect the hardness of cheese; these are proteolysis rate and depth, acidity, dry matter and salt amount. The hardness values of the cheeses matured for 90 days using different herbs are shown in Table 2. As can be seen from the table, the highest hardness value of 13.65 ±1.36 kg was determined in the control cheese on the 3rd day while the lowest value was in the parsley cheese on 90th day (4.38 ±0.71). When herb-added cheese compared to the control group cheese, it was seen that the control group cheese was higher than other additive cheeses, except for cheese with added mendek. In this regard, it can be said that the addition of herbs affects the hardness values of Kashar cheese. Statistical study also shows that cheese type and ripening time has a significant effect on the hardness value. It is seen that the hardness decreases during ripening in Kashar cheeses.

Table 1. Changes in color values during ripening of Kashar cheese samples

	Cheese Types	Ripening Times (Days)			
		3	30	60	90
*L**	K	83.06 ±0.98$^{b, A}$	85.47 ±0.40$^{b, A}$	90.27 ±0.76$^{a, A}$	89.55 ±1.90$^{a, A}$
	G1	78.38 ±3.88$^{a, A}$	78.70 ±5.55$^{a, A}$	81.17 ±2.05$^{a, A}$	84.64 ±7.61$^{a, A}$
	G2	77.38 ±3.88$^{a, A}$	83.99 ±1.60$^{a, A}$	87.90 ±3.38$^{a, A}$	87.32 ±2.96$^{a, A}$
	G3	80.66 ±0.57$^{ab, A}$	75.56 ±3.17$^{b, A}$	83.98 ±3.29$^{a, A}$	83.79 ±3.04$^{a, A}$
	G4	78.45 ±6.43$^{a, A}$	75.15 ±7.75$^{a, A}$	81.69 ±6.61$^{a, A}$	81.45 ±5.09$^{a, A}$
	G5	80.20 ±3.69$^{b, A}$	75.74 ±3.12$^{b, A}$	88.15 ±3.41$^{a, A}$	91.23 ±1.08$^{a, A}$
*a**	K	-2.51 ±0.04$^{a, BC}$	-2.47 ±0.42$^{a, C}$	-3.46 ±0.29$^{b, C}$	-3.05 ±0.39$^{a, B}$
	G1	-2.09 ±0.20$^{ab, AB}$	-1.31 ±0.40$^{a, AB}$	-3.26 ±0.20$^{b, C}$	-3.13 ±0.69$^{b, B}$
	G2	-2.70 ±0.16$^{b, C}$	-1.86 ±0.39$^{a, ABC}$	-2.57 ±0.29$^{ab, B}$	-2.45 ±0.30$^{ab, AB}$
	G3	-2.54 ±0.03$^{ab, BC}$	-2.09 ±0.15$^{a, BC}$	-2.69 ±0.31$^{b, AB}$	-2.73 ±0.20$^{b, AB}$
	G4	-1.59 ±0.27$^{ab, A}$	-0.90 ±0.49$^{a, A}$	-1.09 ±0.49$^{b, A}$	-1.76 ±0.11$^{b, A}$
	G5	-2.05 ±0.26$^{a, AB}$	-2.38 ±0.18$^{a, C}$	-2.18 ±0.28$^{a, B}$	-2.60 ±0.43$^{a, AB}$
*b**	K	22.99 ±0.43$^{a, A}$	22.41 ±0.19$^{a, A}$	19.15 ±0.23$^{b, AB}$	18.07 ±0.23$^{c, A}$
	G1	19.08 ±1.59$^{a, B}$	19.08 ±1.59$^{a, A}$	18.42 ±2.24$^{a, AB}$	16.53 ±3.86$^{a, AB}$
	G2	16.19 ±0.75$^{b, B}$	20.72 ±0.61$^{a, A}$	14.20 ±2.18$^{b, B}$	13.40 ±0.22$^{b, AB}$
	G3	18.44 ±0.22$^{ab, B}$	21.30 ±2.69$^{a, A}$	16.19 ±1.42$^{bc, A}$	14.44 ±0.25$^{c, AB}$
	G4	19.17 ±1.89$^{a, B}$	18.20 ±2.32$^{ab, A}$	16.98 ±2.65$^{ab, AB}$	12.96 ±1.80$^{b, B}$
	G5	19.30 ±1.84$^{ab, B}$	22.87 ±3.76$^{a, A}$	16.41 ±0.75$^{b, AB}$	13.99 ±1.11$^{b, AB}$

abc indicate differences (P<0.05) among rows. ABC indicate differences (P<0.05) between columns.
Mean values ± Standard deviation. **K:** control **G1:** nettle, **G2:** parsley, **G3:** mendek, **G4:** mint, and **G5:** arugula.

The ratio of the resistence in the second compression to the first compression is defined as cohesiveness of food (Koca and Metin, 2004). It is also expressed as the power between the inner bonds that make up the product structure. When the cohesiveness values analyzed in Table 2, the highest rate among herbal additives was arugula additive cheese on the 3rd day of ripening, while the lowest value was nettle added cheese on the 90th day. In addition, when the average of cohesiveness values of herb supplemented cheeses and control cheeses compared, it was observed that the values were close to each other. When we consider maturation, it was seen that the cohesiveness decreased. As seen from the table, it was observed that the addition of herbs had no effect on the cohesiveness of Kashar cheese and no statistically significant difference found (P>0.10). During the ripening period of Kashar cheeses, it was determined that there was a slight decrease in the cohesiveness values, albeit a small amount. In addition, there was a similarity in cohesiveness values occurring in Kashar cheeses. Another researcher Yaşar and Güzeler (2011) and Çakır (2018), who are working on Kashar cheese, found that the cohesiveness of Kashar cheese decreased during the maturation period.

Adhesiveness is expressed as the negative force field of the product after the first compression (Antoniou et al., 2000). As seen in Table 2, the adhesiveness data during ripening was between -36.06 ±23.74 g.sn and -104.72 ±38.22 g.sn. Compared to the herb-supplemented cheese, the control cheese samples was found to have higher adhesiveness compared to other herb additive cheeses, except for the cheese with the tincture. As cheese loses moisture, its stickiness decreases (Emmons et al., 1980). In addition, the increase in adhesiveness observed in cheeses was attributed to high protease speed (Antoniou et al., 2000).

Table 2 shows that there is no difference in the resilience values of Kashar cheese samples, but significant at the level of P<0.05 in terms of maturation. According to this, while the highest value among the herb supplemented cheese samples was the cheese on the 3rd day of ripening with a ratio of 0.44 ±0.04 mm (aragula), the lowest value found on the 90th day with cheese with a value of 0.28 ±0.02 mm (arugula). It was stated that because calcium has the ability to bind casein molecules, it limits the resilience of cheese (Sood et al., 1979; Cavalier-Salou and Cheftel, 1991). This is because; the ratio of calcium ions in cheese, solubility of casein and interactions of casein with other components affect the resilience of cheese. As the calcium ions increase in the cheese system, the interactions created by casein decreases and the elasticity values of the cheeses become low. The strength of the existing molecular bonds in the cheese structure increases the resilience values (Tarakçı et al., 2011).

In texture profile analysis, gumminess is the result of the hardness value multiplied by the cohesiveness value. The gumminess level values of cheese samples during ripening shown in Table 2. When these findings examined, when comparing between herb adding Kashar cheeses, it was observed that the lowest gumminess value was 3.21 ±0.52 kg with the addition of parsley on the 90th day, while the highest value was 10.38 ±0.98 kg with the mendek added cheese on the 3rd day of ripening. Presumably, the decrease in the gumminess level of these cheeses produced was caused by proteolytic, microbial and other enzymatic events occurring in the cheese structure. Similar changes was also observed with the gummyiness values and hardness values (Tarakçı et al., 2011).

According to the results of multiple comparison test, when the chewiness data of Kashar cheese samples were compared, that there was a higher value than other cheeses except for the control group added Kashar cheese. Addition of herbs also reduced the chewiness value. Furthermore, there was a statistically significant difference between nettle and arugula cheeses and other cheeses. The highest chewiness was observed in mendek cheese (8.62 ±0.48 on the 3rd day) while the lowest one was observed in parsley cheese (2.51 ±0.44 on the 90th day). The general average of chewability of all cheeses found as 4.63±0.66 kg mm (data not shown). It was assumed that this decrease in chewability value was due to proteolytic, microbial and other enzymatic events occurring in cheese, and the protein network structure that decreased chewable values during storage.

The elasticity data of Kashar cheese samples during ripening was shown in Table 2. When the elasticity values were examined, it was seen that the data were close to each other and did not much change during maturation (Tarakçı et al., 2011). In the light of obtained data, a statistically significant difference found between the elasticity rates in terms of cheese type (Tarakçı and Deveci, 2019). The highest elasticity was detected in the arugula chees on the 3rd day (0.91 ±0.02) while the lowest one was in the mint cheese on the 30th day (0.79 ±0.03). In addition, the general average of cheeses found to be 0.83 ±0.03 (data not shown). When a comparison made between herb-supplemented cheeses, parsley herb supplemented cheese found on the 3rd day of ripening to the highest elasticity value, while the lowest value was found on the 30th day of ripening.

Conclusion

The nettle, parsley, mendek, mint, and arugula herbs were added to the Kashar curd and a comparison was made with the herb-free sample. In terms of L^*, a^*, and b^* colour values of cheeses, it was determined that the ripening time and cheese variety had an important effect on Kashar cheese. In cheese samples, it was determined that the ripening time and cheese type had an important effect in terms of chewiness, gumminess, and cohesiveness and hardness values. As a result, it is possible to produce Kashar cheese with different kinds of herbal supplements. Because of the production of Kashar cheese with the addition of herbs, it was observed that the addition of herb had positive effects on the colour and textural properties of cheese. Adding herbs to Kashar cheese increases its product range; therefore, it offers an alternative product to the consumer.

Table 2. Textural analysis values of cheese samples

	Cheese Types	Ripening times (days)			
		3	30	60	90
Hardness	**K**	11.52 ±0.51$^{a, AB}$	9.28 ±0.73$^{ab, A}$	7.40 ±0.45$^{bc, A}$	5.27 ±0.47$^{c, B}$
	G1	6.75 ±2.40$^{a, B}$	7.85 ±1.26$^{a, AB}$	7.57 ±0.42$^{a, A}$	7.97 ±1.12$^{a, A}$
	G2	8.53 ±3.26$^{a, AB}$	6.35 ±0.92$^{a, B}$	5.61 ±1.40$^{a, A}$	4.38 ±0.71$^{a, B}$
	G3	13.65 ±1.36$^{a, A}$	9.28 ±0.73$^{b, A}$	7.40 ±0.45^{bc,A}	5.27 ±0.47$^{c, B}$
	G4	8.69 ±0.23$^{a, AB}$	6.54 ±0.45$^{b, B}$	7.70 ±0.59$^{ab, A}$	4.91 ±0.54$^{c, B}$
	G5	9.24 ±1.21$^{a, AB}$	7.63 ±0.36$^{ab, AB}$	6.27 ±0.79$^{bc, A}$	4.94 ±0.09$^{c, B}$
Cohesiveness	**K**	0.75 ±0.03$^{a, A}$	0.75 ±0.01$^{a, A}$	0.71 ±0.04$^{a, A}$	0.72 ±0.05$^{a, A}$
	G1	0.72 ±0.06$^{a, A}$	0.74 ±0.02$^{a, A}$	0.73 ±0.01$^{a, A}$	0.69 ±0.03$^{a, A}$
	G2	0.73 ±0.02$^{a, A}$	0.73 ±0.01$^{a, A}$	0.72 ±0.02$^{a, A}$	0.73 ±0.02$^{a, A}$
	G3	0.76 ±0.01$^{a, A}$	0.75 ±0.01$^{a, A}$	0.71 ±0.04$^{a, A}$	0.72 ±0.05$^{a, A}$
	G4	0.77 ±0.02$^{a, A}$	0.75 ±0.03$^{a, A}$	0.72 ±0.02$^{a, A}$	0.73 ±0.03$^{a, A}$
	G5	0.79 ±0.07$^{a, A}$	0.71 ±0.03$^{a, A}$	0.75 ±0.01$^{a, A}$	0.71 ±0.01$^{a, A}$
Adhesiveness (g.sn)	**K**	-68.01 ±36.15$^{a, A}$	-75.30 ±34.01$^{a, A}$	-77.65 ±30.68$^{a, A}$	-52.49 ±30.34$^{a, A}$
	G1	-50.43 ±49.76$^{a, A}$	-68.21 ±57.86$^{a, A}$	-104.72 ±38.22$^{a, A}$	-96.52 ±23.49$^{a, A}$
	G2	-50.27 ±25.30$^{a, A}$	-73.92 ±39.06$^{a, A}$	-85.48 ±44.04$^{a, A}$	-94.37 ±4.04$^{a, A}$
	G3	-66.17 ±34.33$^{a, A}$	-75.30 ±34.01$^{a, A}$	-77.65 ±30.67$^{a, A}$	-52.49 ±30.35$^{a, A}$
	G4	-61.42 ±27.51$^{a, A}$	-99.81 ±21.37$^{a, A}$	-92.25 ±30.97$^{a, A}$	-103.88 ±4.23$^{a, A}$
	G5	-36.06 ±23.74$^{a, A}$	-102.66 ±4.64$^{a, A}$	-82.63 ±38.36$^{a, A}$	-85.99 ±33.12$^{a, A}$
Resilience (mm)	**K**	0.36 ±0.04$^{a, AB}$	0.32 ±0.01$^{a, A}$	0.31 ±0.02$^{a, A}$	0.31 ±0.02$^{a, A}$
	G1	0.35 ±0.07$^{a, AB}$	0.32 ±0.04$^{ab, A}$	0.30 ±0.01$^{ab, A}$	0.29 ±0.03$^{b, A}$
	G2	0.32 ±0.02$^{a, B}$	0.31 ±0.02$^{a, A}$	0.32 ±0.03$^{a, A}$	0.29 ±0.02$^{a, A}$
	G3	0.38 ±0.00$^{a, AB}$	0.32 ±0.01$^{b, A}$	0.31 ±0.02$^{b, A}$	0.31 ±0.02$^{b, A}$
	G4	0.35 ±0.02$^{a, AB}$	0.33 ±0.03$^{ab, A}$	0.30 ±0.01$^{ab, A}$	0.30 ±0.03$^{b, A}$
	G5	0.44 ±0.04$^{a, A}$	0.33 ±0.02$^{b, A}$	0.33 ±0.01$^{b, A}$	0.28 ±0.02$^{b, A}$
Gumminess (kg)	**K**	8.63 ±2.25$^{a, AB}$	6.92 ±0.57$^{ab, A}$	5.25 ±0.63$^{b, A}$	3.81 ±0.43$^{b, B}$
	G1	4.96 ±2.06$^{a, B}$	5.83 ±0.94$^{a, AB}$	5.51 ±0.28$^{a, A}$	5.48 ±0.92$^{a, A}$
	G2	6.22 ±2.38^{a,AB}	4.64 ±0.63$^{a, B}$	4.23 ±1.08$^{a, A}$	3.21 ±0.52$^{a, B}$
	G3	10.38 ±0.98$^{a, A}$	6.92 ±0.56$^{b, A}$	5.25 ±0.63$^{bc, A}$	3.81 ±0.43$^{c, B}$
	G4	6.70 ±0.03$^{a, AB}$	4.91 ±0.23$^{b, B}$	5.56 ±0.49$^{b, A}$	3.57 ±0.37$^{c, B}$
	G5	7.32 ±1.51$^{a, AB}$	5.43 ±0.17$^{ab, AB}$	4.68 ±0.62$^{b, A}$	3.51 ±0.12$^{b, B}$
Chewiness (g.mm)	**K**	7.22 ±2.06$^{a, AB}$	5.86 ±0.59$^{ab, A}$	4.46 ±0.29$^{ab, A}$	3.26 ±0.42$^{b, AB}$
	G1	4.29 ±2.03$^{a, B}$	4.91 ±0.94$^{a, AB}$	4.53 ±0.34$^{a, A}$	4.40 ±0.78$^{a, A}$
	G2	5.44 ±2.17$^{a, AB}$	3.81 ±0.63$^{a, B}$	3.49 ±0.89$^{a, A}$	2.51 ±0.44$^{a, B}$
	G3	8.62 ±0.48$^{a, A}$	5.86 ±0.59$^{b, A}$	4.46 ±0.29$^{c, A}$	3.26 ±0.42$^{d, AB}$
	G4	5.72 ±0.07$^{a, AB}$	3.89 ±0.19$^{b, B}$	4.57 ±0.35$^{c, A}$	2.88 ±0.32$^{d, B}$
	G5	6.66 ±1.30$^{a, AB}$	4.49 ±0.19$^{b, AB}$	3.93 ±0.51$^{c, A}$	2.80 ±0.07$^{d, B}$
Elasticity	**K**	0.83 ±0.03$^{a, A}$	0.85 ±0.02$^{a, A}$	0.85 ±0.06$^{a, A}$	0.85 ±0.02$^{a, A}$
	G1	0.84 ±0.09$^{a, A}$	0.84 ±0.05$^{a, A}$	0.82 ±0.05$^{a, A}$	0.80 ±0.02$^{a, AB}$
	G2	0.87 ±0.04$^{a, A}$	0.85 ±0.02$^{ab, A}$	0.85 ±0.06$^{ab, A}$	0.85 ±0.02$^{b, B}$
	G3	0.83 ±0.03$^{a, A}$	0.84 ±0.03$^{a, A}$	0.83 ±0.00$^{a, A}$	0.81 ±0.01$^{a, A}$
	G4	0.85 ±0.02$^{a, A}$	0.79 ±0.03$^{b, A}$	0.82 ±0.02$^{ab, A}$	0.80 ±0.02$^{ab, AB}$
	G5	0.91 ±0.02$^{a, A}$	0.82 ±0.01$^{bc, A}$	0.84 ±0.01$^{b, A}$	0.80 ±0.02$^{c, B}$

abc indicate differences ($P<0.05$) among rows. ABC indicate differences ($P<0.05$) between columns.
Mean values ± Standard deviation. **K:** control **G1:** nettle, **G2:** parsley, **G3:** mendek, **G4:** mint, and **G5:** arugula.

Compliance with Ethical Standard

Conflict of interests: The authors declare that for this article they have no actual, potential or perceived the conflict of interests.

Ethics committee approval: Author declare that this study does not include any experiments with human or animal subjects.

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