Influence of the surface tension of teas on the temperature and addition of common thyme and summer savory essential oils

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Abstract. Common thyme (*Thymus serpyllum* L.) and summer savory (*Satureja hortensis* L.) are a plants belonging to the Lamiaceae family. Their essential oils widely used in different foods as flavorings and preservatives agents. The surface tension of black tea with the addition of common thyme essential oil and of chamomile tea with the addition of summer savory essential oil were obtained. The quantity of essential oils varying with amounts of 0.01, 0.02, and 0.03%. The surface tension was measured at different temperatures (between 30 and 80°C) and often used in food products and hot drinks. The teas with the addition of 0.03% common thyme and summer savory essential oils are more stable at both low and higher temperatures in terms of taste and aroma protection.

1 Introduction

Common thyme (*Thymus serpyllum* L.) is widespread in countries in Europe, Central Asia, North Africa, and North America. The oil is light to reddish-brown liquid with a smell of thyme and a light lemon note. The main compounds are: carvacrol (5-45%), thymol (1-17%), linalool and linalyl acetate (22-54%), *p*-cymene (up to 22%), *etc*. [1-4].

Summer savory (*Satureja hortensis L.*) is found and cultivated in many countries of Europe, North America and the United States. The essential oil is a yellow liquid with a spiceful, characteristic of savory smell and a weak-tempered spice taste. The main compounds are presented by authors [1-5].

Essential oils of common thyme and summer savory are used in the foods as flavorings and preservatives [1-3]. However, there is no evidence in the literature on their direct addition to teas.

The physicochemical indicator surface tension is important in the storage of essential oils and their transportation, in the application in food products.

A number of authors have determined the surface tension of different essential oils [6-9].

The influence of temperature on the variation of the surface tension of teas with garden savory essential oil and common thyme is the subject of the study, The data obtained are an

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indication of the stability of the resulting solutions, the protection of the aroma and taste of the oils during consumption of the hot drinks.

2 Materials and methods

2.1 Essential oils

Commercial samples of essential oils and teas were used. The essential oil presented following compounds: thymol (29.74%), *β*-linalool (19.96%), *p*-cymene (7.88%), geraniol (7.82%), *β*-caryophyllene (3.82%), *β*-bisabolene (3.40%), and borneol (3.10%) [10].

The main compounds of the commercial summer savory essential oil were: carvacrol (63.71%), *γ*-terpinene (20.47%), and *p*-cymene (5.08%) [11].

2.2 Determination of surface tension

Surface tension is determined by Yankova et al. [12] at different temperatures between 30, and 80°C.

2.3 Statistical analysis

All analyses *were carried out up to three times, with the tables and figures presenting the mean values with the corresponding standard deviation,*

3 Results and discussion

3.1 Black tea with common thyme essential oil

According to our preliminary unpublished research, black tea has been selected, whose neutral taste and aroma are best complemented with both ordinary common thyme and its essential oil.

The results of the determination of the surface tension of black tea with and without the addition of essential oil of common thyme are presented in Table 1.

The data showed that:

- the control sample at temperature 30°C had less tension than the water 72.75 mN/m [13, 14]. At a temperature of 80°C the tension is about 12% lower compared to that at 30°C.

Table 1. Surface tension of black tea (control sample) and black tea with the addition of common thyme essential oil.

Temperature, °C	Surface tension, mN/m			
	Black tea (control sample)	Addition of essential oil		
		0.01% (v/v)	0.02% (v/v)	0.03% (v/v)
30	70.32 ± 0.70	64.49±0.63	58.17±0.57	55.80±0.54
40	68.60 ± 0.67	61.18±0.60	57.74±0.56	54.16±0.53
50	65.46 ± 0.64	59.55±0.58	55.02±0.54	52.04±0.50
60	64.03 ± 0.63	57.42±0.56	54.59±0.53	51.02±0.50
70	62.31 ± 0.61	53.17±0.52	53.16±0.52	50.30±0.49
80	61.59 ± 0.60	51.45± 0.50	50.45±0.49	49.59±0.48

- the teas at a temperature of 30°C have a surface tension value that is lower by about 8% when adding 0.01% essential oil, by about 10% - at 0.02% essential oil and by about 13% - at 0.03% essential oil. With increasing temperature, the value of the surface tension begins to decrease, the dependence being linear.

- the teas at a temperature of 80°C have a lower surface tension value than at 30°C, the dependence is inversely proportional to the amount of essential oil added: for tea with 0.01% the decrease is about 20%, for tea with 0.02% – by about 13% and for tea with 0.03% – by about 8%.

- the teas with the addition of 0.03% essential oil have the lowest values of surface tension, which is an indication that they are more stable at both low and higher temperature in terms of taste and aroma protection.

The comparative analysis of the values of the surface tensions of thymol, which is the main component of the essential oil of common thyme [15], of the four samples of black tea – the control and the three teas with the addition of essential oil and essential oil can be seen on Fig. 1 [10].

The surface tension values are lowest at the main component thymol. It is a solid, therefore the measurements were made in the form of solutions with 70 and 80% ethanol, which, however, has a low surface tension and this has an impact on the data obtained.

The surface tension values of the control and the teas with the addition of oil had the highest values.

The surface tension of the essential oil is the lowest, as it contains compounds with different functional groups – hydrocarbons and their oxygen components, which affect this physicochemical indicator.

- the teas at a temperature of 30°C have a surface tension value that is lower by about 8% when adding 0.01% essential oil, by about 10% - at 0.02% essential oil and by about 13% - at 0.03% essential oil. With increasing temperature, the value of the surface tension begins to decrease, the dependence being linear.

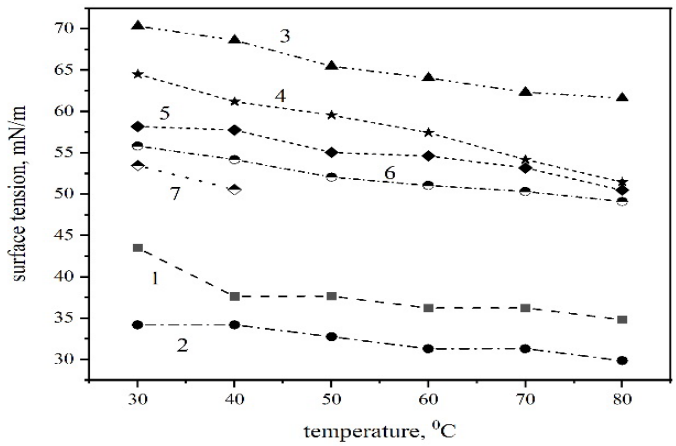

Fig. 1. Comparison of thymol surface tension, black tea samples with the addition of common thyme essential oil and common thyme essential oil.
1 – solution of thymol with 70% ethanol; 2 – solution of thymol with 80% ethanol; 3 – black tea (control sample); 4 – black tea with 0.01% essential oil; 5 – black tea with 0.02% essential oil; 6 – black tea with 0.03% essential oil; 7 – common thyme essential oil.

- the teas at a temperature of 80°C have a lower surface tension value than at 30°C, the dependence is inversely proportional to the amount of essential oil added: for tea with 0.01% the decrease is about 20%, for tea with 0.02% – by about 13% and for tea with 0.03% – by about 8%.

- the teas with the addition of 0.03% essential oil have the lowest values of surface tension, which is an indication that they are more stable at both low and higher temperature in terms of taste and aroma protection.

Data exist in the literature on surface tension measured at different temperatures, but for solutions of linalool in ethanol, propanol and water [16, 17], as well as for linalool and linalyl acetate in ethanol and water [18]. It is difficult to make a comparison with these data, as the substances studied with different structures.

3.2 Chamomile tea with summer savory essential oil

According to our preliminary unpublished studies, chamomile tea has been selected, whose specific taste and aroma are best complemented with both summer savory and its essential oil.

The results of the determination of the surface tension of black tea with and without the addition of essential oil of summer savory savory are presented in Table 2. According the data on the table:

- the control sample at temperature 30℃ had less tension than the water 72.75 mN/m [13, 14]. At a temperature of 80°C the surface tension is about 18% lower compared to that at 30°C.
- the teas at a temperature of 30°C have a surface tension value that is lower by about 12% when adding 0.01% essential oil, by about 24% – at 0.02% essential oil and by about 31% – at 0.03% essential oil. With increasing temperature, the value of the surface tension begins to decrease, the dependence being linear.
- the teas at a temperature of 80°C have a lower surface tension value than at 30°C, the dependence is inversely proportional to the amount of essential oil added: for tea with 0.01% the decrease is about 21%, for tea with 0.02% – by about 23% and for tea with 0.03% – by about 29%.
- the teas with the addition of 0.03% essential oil are more stable at both low and higher temperatures in terms of taste and aroma protection.

Table 2. Surface tension of chamomile tea (control sample) and chamomile tea with the addition of summer savory essential oil.

Temperature, ℃	Surface tension, mN/m			
	Chamo-mile tea (control sample)	Addition of essential oil		
		0.01% (v/v)	0.02% (v/v)	0.03% (v/v)
30	63.46 ± 0.62	55.88 ± 0.54	48.31 ± 0.47	43.73 ± 0.42
40	61.74 ± 0.60	53.16 ± 0.52	47.59 ± 0.45	39.16 ± 0.38
50	58.59 ± 0.57	50.74 ± 0.47	44.16 ± 0.43	36.59 ± 0.35
60	56.17 ± 0.55	49.31 ± 0.48	42.73 ± 0.41	34.87 ± 0.33
70	53.45 ± 0.52	47.59 ± 0.46	39.01 ± 0.38	33.44 ± 0.31
80	51.74 ± 0.50	44.15 ± 0.43	37.30 ± 0.36	31.01 ± 0.30

The comparative analysis of the values of surface tension of carcacrol, which is a major component of summer savory essential oil [19, 20], of the four chamomile tea samples – contral and the three teas with the addition of essential oil and essential oil is presented in Fig. 2.

The surface tension values were highest in the control sample. Following are those of the pure component carvacrol, the three teas with the addition of oil.

The pure component carvacrol is in a liquid, therefore the values of the surface tension between it and the essential oil under study are commensurate.

The classical dependence is presented that the surface tension of the essential oil is the lowest, as it contains compounds with different functional groups – hydrocarbons and their oxygen components, which affect this physicochemical indicator.

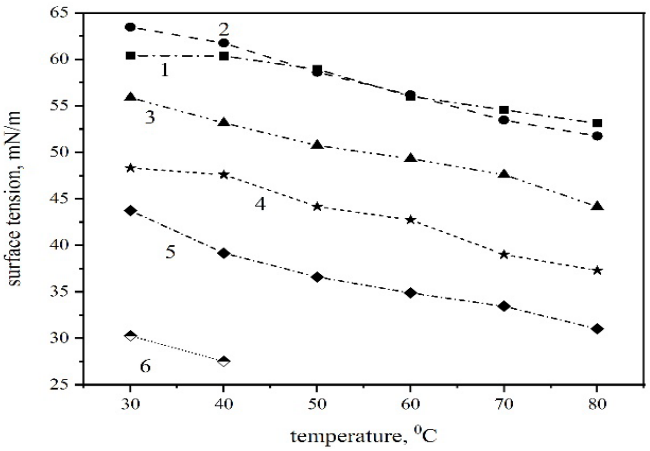

Fig. 2. Comparison of carvacrol surface tension, chamomile tea samples with the addition of summer savory essential oil and summer savory essential oil.
1– carvacrol; 2 – chamomile tea (control sample); 3 – chamomile tea with 0.01% essential oil; 4 – chamomile tea with 0.02% essential oil; 5 – chamomile tea with 0.03% essential oil; 6 – summer savory essential oil.

4 Conclusion

The change of surface tension of teas with the addition of common thyme and summer savory essential oils was studied. Author's formulations of: black tea with common thyme essential oil and chamomile tea with summer savory essential oil have been developed. The variation of the surface tension was studied at six temperatures (30, 40, 50, 60, 70 and 80°C) and at three oil concentrations (0.01; 0.02 and 0.03%), the dependence being linear. Commercial essential oils of common thyme and savory (0.03%) are a suitable addition to teas, preserving their aroma and taste.

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