



RESEARCH PAPER

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Storage period effects on the qualitative characteristics of scented tea

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Abstract

An experiment was conducted with three types of essence. Chemical and organoleptical changes in tea quality were evaluated during one-year storage time. The trial was conducted as a Factorial experiment with two factors and three replications. The essences were distributed in four levels including: without essence, cardamom essence, bergamot essence and earl grey essence whereas the period of storage was: 0, 2, 4, 6, 8, 10 and 12 month storage. Desirability of the tea samples was assessed using a group of university students. Data were analyzed using SAS statistical software. The results showed that increase of moisture amount in bergamot tea was further/greater than other ones (6.06%). The Tea without essence has a lower rank of the total color and sensory scores. Thearubigin, TF/TR ratio and sensory scores were significantly decreased with over-time the storage ($p \leq 0.01$). The whole essence contents had decreased in all samples after one year storage period.

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Introduction

A way to increase the marketability of food products is to create diversity in their sensory properties. Today, natural and edible additives are widely utilized in the food industries. Diversification for consumers, who drink tea in a day and sometimes as the first beverage in the morning and the last one in the evening, is considered a main step to increase the marketability of this product (Gill, 1992). Natural and plant flavorant and aromatic materials utilizing could cause superior utility in black tea. Using natural essential oils to create a variety has always been considered by manufacturers but the impact of these compounds has not been studied on the utility and sensory properties of tea. Another important problem is essential oils' stability during storage and shelf life. Shelf life duration of black tea packs may take up more than a year. Flavor characteristics maintenance is an important item of tea utility in the shelf life (Sedaghatoor and Shokrgozar, 2008).

Flavor of tea has a complex composition. Carbonyl compounds are the dominant for flavor formation in black tea, however, alcohols, acids, terpenoids, esters and pyrolytic compounds are considered as tea flavor constituents, too. In addition, many unknown compounds are present in trace amounts and play an important role in taste of tea. Taste compounds may vary depending on the different types of teas (Roofigari Haghghat, 2002). Study on tea aroma changes through tea production process revealed that there is fluctuation in aromatic compound precursors, so the main composition of essential oils were Linalool and geraniol in withering stage. But the main compounds of tea were α -farnesene and β -bisabolane in dried tea (Nasrollahzadeh *et al.*, 2006).

One of the factors causing variation in tea is aromatic substances which have been most successful as well. Earl grey tea is one of the most popular types of scented tea; a quarter of the world sale is allocated to earl grey tea. This type of tea was produced through oil bergamot mixing to tea leaves in China since 1830. Lemon, apple, grape, black grape, mandarin and

other fruits are popular flavorant of black tea (Gill, 1992).

Bergamot essence extracted from the aromatic skin of the sour bergamot (*Citrus bergamia*) fruit is used to flavor the earl grey tea. Bergamot essential oil contains about 40% ester linalyl acetate and its specific gravity is 0.87-0.88. The bergamot essential oil is used in perfumeries. It has antiseptic, gastrointestinal antispasmodic and anti-parasitic effects (Momeni and Shahrokhi, 1998).

Bergamot essential oils are used in food industry as a fragrant. It is widely used in earl grey tea production. This compound is insoluble in water but dissolved readily in oils and alcohol (Whittemore, 2010). Traditionally, the "Earl Grey" has been applied only to black teas that contain oil of bergamot as a flavoring. Today, this name is used for the teas containing bergamot or other fruit flavorants. 'Twining company' reformulated their Earl Grey tea in 2011, claiming to have added "an extra hint of bergamot and citrus" (Anon, 2012).

Cardamom essential oil is colorless or pale yellow oil with a spicy flavor that is obtained from the distillation of cardamom seeds and contains limonene, 1,8-cineole and terpineol. Its specific gravity is 0.917-0.94 and soluble in alcohol. Fruit and essential oil of cardamom is consumed as a carminative, tonic and flavoring substance (Momeni and Shahrokhi, 1998). In a study on the production process in Iranian fragrant tea, cardamom essential oil is used as a flavoring agent in different concentrations. The production efficiency was low and tea quality was undesirable in the sensory tests. The authors believed that low quality was due to high temperatures during drying process (Nikghalb Ashoory, 2004).

Sedaghatoor and Shokrgozar (2008) reported that adding Qare-Qat (*Vaccinium arctostaphylos*) fruit to black tea causes the increase of theaflavin, theaflavin to thearubigin ratio and brightness of blend tea. The application of this fruit did not show any advantage to

pure tea. In addition to flavor evaluation, the stability of aroma is also important in comparison with scented teas. It has been found that when the aroma oils are introduced manually, ethereal components tend to react with O₂. To avoid this reaction, the aroma component was sprayed in an essentially O₂-free atmosphere, and the leaves were then packed in an essentially O₂-free atmosphere. The atmosphere and the propellant gas are preferably N₂ or CO₂ (Schmitt, 1981).

Changes in aromatic substances were used to develop a suitable package during storage of mint tea. Analysis of essential oil at the end of storage time showed that essential oil content in bulk tea was increased from first to third months and then decreased along with other teas until 6th month. Essential oil content of control samples continued to decline until the end of storage. 12 months storage caused substantial changes in composition of essential oil in all types of packages. Maximum quantity of essential oil was found in the bulk tea (Bagdasarova *et al.*, 1989).

Microencapsulation of aromatic substances can increase aroma stability to two years using gelatin capsules with uniform distribution throughout the tea (Berseneva *et al.*, 1990). Iranian tea needs to increase quality. Using natural essential oils to create a variety is a suitable manner to achieve this purpose. Another important problem is stored teas' stability during storage. The present study investigated the use of essential oils on black tea quality and its stability during 12 months storage.

Materials and methods

This study was carried out as factorial experiment with two factors based on a completely randomized design with three replications. The first factor was the type of essential oil in four levels: a₁: pure black tea, a₂: cardamom essential oil, a₃: Bergamot essential oil and a₄: Earl grey essential oil. The second factor i.e. the storage period was applied in 7 levels (0, 2, 4, 6, 8, 10 and 12 months).

Materials

Orthodox black tea was obtained from tea research institute of Iran. Cardamom, bergamot and earl grey essential oils were purchased from Robertet and Shahsavand companies with product code TA5142-N, PO614282 and 1008933 respectively.

Methods

Adding of essential oils and packaging: Cardamom, bergamot and earl grey essential oils were sprayed to black tea manually (respectively, %1, %2, and %2 v/w). Treated black teas (tea leaves) were stored separately in two wrapper packages for two weeks. Then packaging was carried out by packaging unit in three layered packages and 100 g weights.

Storage

Samples were stored in ambient temperatures at 20-25°C and 70% relative humidity for 12 months. Sampling was accomplished at two months intervals during this period. Moisture content, Theaflavin (TF), Thearubigin (TR), total color, brightness, and organoleptical characteristics of tea were investigated at the beginning of trial and during storage period. Samples were evaluated to determine the stability of essential oils using a GC-MS at beginning and the end of storage period.

Determination of the moisture content: 5 g of the test sample was weighed and placed in the oven at 103±2 °C for 6 h. The hitting was repeated, when necessary, until the difference between two successive weightings does not exceed 0.005 g (ISIRI, 1992).

Spectrophotometric estimation of TF, TR, total color and brightness: A sample (9g) of black tea was infused in 375 ml of boiling water over a water bath for 10 min and then cooled. 20 ml were mixed with 20 ml of 1% (w/v) disodium hydrogen phosphate and TF was extracted from 20 ml of ethyl acetate, by shaking slowly for 10 min. The following solutions were prepared: 2 ml of the extract are diluted with methanol to 25 ml (E1), 1 ml tea infusion + 9 ml water + 15 ml methanol (E2), 1 ml tea infusion + 1 ml of oxalic acid (10% w/v) + 8 ml water +15 ml methanol

(E3). The absorbance was measured at 380 and 460 nm (Mahanta and Barouah, 1992).

Sensory characteristics

2.6 g tea was weighed into pot and boiled water was poured over it. The pot was then covered with a lid and the tea was infused for 6 minutes. Liquor was poured out into a cup. The color and evenness of the infusion, as also its nose, are an index to the intrinsic value of the brew. The scrutiny of the leaf and infusing over, the taster turns his attention to the liquor and takes a sip from the cup, rolls it in his mouth and spits it out. In that split second, the palate registers the taste. Flavor, briskness, strength and all faults and flaws are recorded (ISIRI, 2001).

Tea aroma analysis by GC: Analysis of tea aromatic compounds was accomplished by using hydro distillation method. 100 grams of sample was added to distilled water in a flask. Flask was heated on electric stove and Clevenger apparatus was connected to it. The collected oil was removed after 4 hours. Sodium sulfate was added to absorb water. Resulting extract was injected to gas chromatography system (Sefidkon, Dabiri and Alamshahi, 2002).

Statistical analysis

The data were analyzed based on completely randomized design with four treatments and three replicates, using SAS software and statistical comparison was performed using LSD test. Graph drawing was performed using EXCEL software.

Results

Qualitative traits

Changes of moisture content, Theaflavin (TF), Thearubigin (TR), total color, brightness, TF/TR ratio and organoleptical characteristics of black tea, are shown in table 1 during the storage time. Time increasing caused a significant decrease in total sensory scores. After two and four storage months, TF and TR were at its highest level, respectively. Moisture content, total color, brightness and TF/TR ratio had no clear trend.

Over a year, moisture content of tea with bergamot was more than other types of teas (Table 2). Pure black tea had the lowest content of total color and organoleptical score. Figures 1 to 3 show a decreasing trend in the amount of TF, TR and total sensory scores in all type of teas. But difference between different samples did not show different behaviors.

Table 1. Tea qualitative characteristics during storage period ($P \leq 0.05$)

Time (month)	Moisture (%)	Theaflavin (%)	Thearubigin (%)	Total Color (%)	Brightness (%)	TF/TR	Total Sensory Score
0	5.545	0.411	12.894	2.580	13.022	0.0318	19.50
2	5.780	0.433	12.522	2.554	13.876	0.0346	19.48
4	5.402	0.368	13.366	2.602	10.035	0.0275	19.51
6	5.508	0.370	11.071	2.595	15.003	0.0335	18.50
8	5.310	0.313	11.495	2.712	12.216	0.0273	18.01
10	5.776	0.317	10.981	2.536	12.679	0.0288	17.23
12	6.048	0.350	11.447	2.789	13.499	0.0307	17.25
LSD	0.112	0.021	0.241	0.068	1.128	0.002	0.086

Analysis of GC/MS (essential oils stability)

GC/MS analysis of tea samples, before and after of storage, are given in Table 3. Terpeneol and Linalool are found in all types of tea at the beginning of storage. Cineole and Carene were observed just in tea with cardamom, and limonene was found in both teas with bergamot and earl grey. After one year storage,

the content of tea essential oils reduced about to 0.02%, 0.03%, 0.12% and 0.1% respectively, for pure black tea, black tea with cardamom, black tea with bergamot and black tea with earl grey. While some aromatic components like linalool and terpeneol had increased some types of teas after one year storage.

Table 2. Tea qualitative characteristics in different teas ($P \leq 0.05$)

Type of Tea	Moisture (%)	Total Color (%)	Total Sensory Score
a ₁	5.279	2.524	18.39
a ₂	5.304	2.671	18.52
a ₃	6.061	2.641	18.59
a ₄	5.854	2.660	18.48
LSD	0.0847	0.0516	0.0653

a₁: pure black tea, a₂, a₃ and a₄ (respectively): black tea with cardamom essential oil, Bergamot essential oil and Earl grey essential oil.

Table 3. GC-MS analysis of tea samples.

Type of tea	Time (month)	Yield of Essential oil (%)	GC-MS results (peak Area %)						
			Limonene	Cineole	Linalool	Terpineol	Linalyl acetate	Carene	Citral
a ₁	0	0.03	-	-	0.9	1.4	-	-	-
	12	0.01	-	-	-	-	-	-	-
a ₂	0	0.08	-	6.0	4.4	3.8	2.1	52.0	-
	12	0.05	3.7	15.6	7.0	7.1	-	41.9	-
a ₃	0	1.12	6.0	-	49.0	22.7	-	-	-
	12	1.00	0.5	-	64.2	27.9	-	-	-
a ₄	0	0.70	8.6	-	24.3	5.9	14.0	-	0.2
	12	0.6	-	-	70.7	23.8	-	-	-

Discussion

Moisture content

The results show that the maximum moisture content of tea samples was 6.05% after one year storage, which is 0.5% more than the initial moisture content. While the acceptable level of moisture in packed tea is 7% based on Iranian national standards, so 0.5% moisture increasing is acceptable and it shows that the packing materials had created appropriate barrier to moisture penetration in the tea samples. Previous research has shown paperboard packaging with a liner and cover is the best kind of tea packaging and it can prevent moisture penetration inside the tea packages for one year storage in humid conditions such as in Guilan province (Roofigari Haghghat and Saburi, 2007).

The average of moisture content in tea with bergamot and earl grey was higher than other samples. It is possible that increase of moisture content was because of determination method (sample drying in 103°C). Volatile compounds including essential oils

are evaporated from the sample and this amount is added to moisture percent in tea mass loss calculation. Also the amount bergamot and earl grey added to tea was two times more than that of cardamom oil. Essential oil contents comparison at the beginning of storage (Table 3) also showed a greater volume of oil in tea samples with bergamot and earl grey. So adding of essential oils did not increase the moisture of tea during storage and no changes were observed in tea humidity under compliance of storage principle.

TF, TR and sensory properties: The reduction of TF, TR and sensory properties was shown during storage for all samples. The decrease in the percentage of TF during the early months until the end of storage was 0.12%, while TR has been reduced by 1 to 3 percent between the first and second 6 maintenance months. It is because of the continuous oxidation in tea packages due to presence of air, which leads to loss quality characteristics of tea during long storage periods (Roofigari Haghghat and Saburi, 2007).

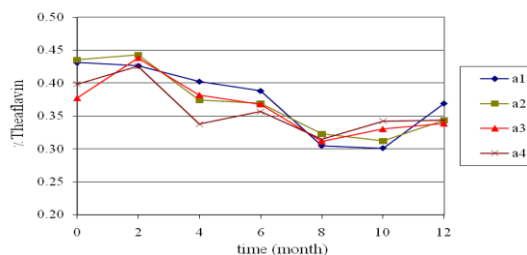


Fig. 1. Change of Theaflavin in the tea samples during storage.

a₁: pure black tea, a₂, a₃ and a₄ (respectively): black tea with cardamom essential oil, Bergamot essential oil and Earl grey essential oil.

Quality characters did not show different behaviors in different samples (Figures 1, 2 and 3). In other words, adding the essential oils did not influence on these compounds in black tea during one year storage period.

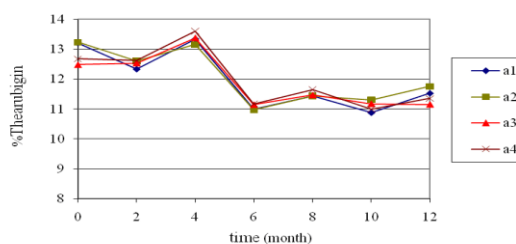


Fig. 2. Change of Thearubigin in the tea samples during storage.

Sensory properties of tea have shown a significant decrease over time (Figure 4). The regression equation that is fitted to the data by $R^2=0.97$ (for polynomial equation) and $r=0.98$ indicates significant relation between decrease of sensory characteristics and time. Figure 3 shows the decline in the sensory characteristics since the second storage month until the tenth month of storage. The changes in theaflavin and thearubigin percent also corroborated this matter. In other words, qualitative traits are changed after 2-4 months storage time. Friedman *et al.* (2009) reported the total amount catechins declines within 6 months storage. But increasing has been observed in these compounds during the intervals of 4 and 6 months. They believed that the reduction of tea

aromatic compounds in long-term storage could be one of the reasons.

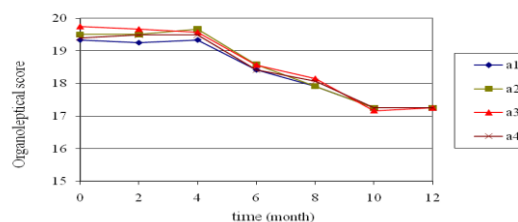


Fig. 3. Change of total sensory scores in the tea samples during storage

a₁: pure black tea, a₂, a₃ and a₄ (respectively): black tea with cardamom essential oil, Bergamot essential oil and Earl grey essential oil.

Organoleptical scores of tea samples demonstrated that desirability of essential oil added tea was higher than that of pure black tea. The appearance of these kinds of tea was better than pure tea in sensory scores. Decrease of total color was also observed in pure tea. Another reason for decline of sensory properties of pure tea was reduction of aromatic compounds more than 60% during storage time (Table 3). Reduction of aromatic compounds leads to flat tea, which is one of the indicators for stored tea (Keegel, 1983).

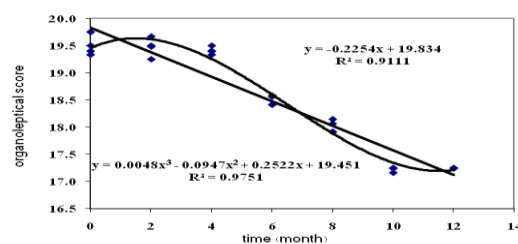


Fig. 4. Distribution of sensory scores data in storing time of tea

Tea with bergamot was rated more sensory score among different trial teas. Bergamot is one of the most popular essential oil that widely consumed to produce earl grey tea since 1830, so a quarter of sales were allocated to it (Gill, 1992). Essence is known today by the name of earl grey, is obtained from formulating bergamot with other citrus oils such as orange and lemon essential oil. According to results of present study, it seems that earl grey can not produce

enough desirable quality and popularity such as bergamot oil.

Essential oil stability

Essence was decreased for three types of tea when cardamom, bergamot and earl grey were 37, 11 and 14 percent, respectively (Table 3). In other words, the stability of bergamot was better than other essential oils. Increase of some aromatic compounds after one year maybe occurred due to reduction of other aromatic compounds which were presented in tea but not analyzed. In fact, these compounds were black tea natural aromas that were decreased more than 60% in pure tea after long term storage. This event increases the peak area percent of aromatic compounds added to teas. In other words, the reduction or elimination of natural tea aroma can cause increase in share of essential oil compounds in the final assessment.

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