Correction of nutrition for the identified violations of bioelements at an early stage will allow for the prevention of overweight and thus have a social effect: prevention of cardiovascular, oncological and endocrine diseases and, as a consequence, an increase in life expectancy.

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THE INFLUENCE OF STORAGE AND SOLVENT ON THE TOTAL PHENOL, FLAVONOID AND ANTIOXIDANT ACTIVITIES OF SAGE (*SALVIA FRUTICOSA* L.)

ВЛИЯНИЕ ХРАНЕНИЯ И РАСТВОРИТЕЛЯ НА ОБЩУЮ ФЕНОЛЬНУЮ, ФЛАВОНОИДНУЮ И АНТИОКСИДАНТНУЮ АКТИВНОСТЬ ШАЛФЕЯ (*SALVİA FRUTİCOSA* L.)

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The total phenol contents of methanol extract change between 875.14 and 784.39 mg GAE/ 100 g. In addition, total phenol contents of methanolic extracts stored at +4 °C changed between 987.46 (2th month) and 819.57 mg GAE/100 g. So, while antioxidant values of methanol extracts depending on storage are determine between 795.61 and 711.47, antioxidant activity values of ethanol extracts changed between 744.83 and 668.51. With respect to flavonoid contents of extracts, these values for methanol extracts were found between 44.13 (1th month) and 20.43 (12th month). These values obtained from extracts of *S. fruticosa* stored at refrigeroter (+4 ºC) were found higher then those of results kept stored room temperature. Also, antioxidant activities of methanol extracts kept at +4 ºC changed between 857.41 and 746.84 mg/ml.

Общее содержание фенола в метанольном экстракте изменяется от 875,14 до 784,39 мг ЭГК/100 г. Кроме того, общее содержание фенола в метанольных экстрактах, хранящихся при +4 ºС, изменялось между 987,46 (2-й месяц) и 819,57 мг ЭГК/100 г. Таким образом, в то время как антиоксидантные значения метанольных экстрактов, в зависимости от хранения, определяются между 795,61 и 711,47, антиоксидантные активности этанольных экстрактов изменяются в пределах 744,83 и 668,51. Что касается содержания экстрактов флавоноидов, эти значения для экстрактов метанола найдены между 44,13 (1-й месяц) и 20,43 (12-й месяц). Показатели, полученные по экстракту *S. fruticosa*, хранившемуся в холодильнике (+4 ºС), оказались выше, чем результаты, полученные при комнатной температуре. Кроме того, антиоксидантная активность метанольных экстрактов, хранившихся при + 4 °С, изменялась между 857,41 и 746,84 мг/мл.

Keywords: total phenol actıvıtıes, flavonoıd actıvıtıes, antıoxıdant actıvıtıes, sage, GAE.

Ключевые слова: общая фенольная активность, флавоноидная активность, антиоксидантная активность, шалфей, ЭГК.

The genus *Salvia* is the largest member of the Lamiaceae family with nearly 1000 species spread throughout the various regions of the World mainly central and south America, western Asia (especially Turkey, Oran, Russia) and eastern Asia. Recently, 99 species of the genus *Salvia* have been identified in Turkey and 52 (52 %) of them are endemic to Turkey. Some members of the *Salvia* genus are commercially important and used for flavouring agents in foods as well as cosmetics, perfumery and the pharmaceutical industries with its biological activities.

Sage (*Salvia* spp) is a common herbal plant widely grown in various in the world, and especially in Mediterranean region (Pop *et al.,* 2015). It is an endemic in Turkey.

Salvia has a tonic, carminative, antiseptic, spasmolytic, astringent, haemostatic and diuretic affect in traditional medicine (Alimpic *et al.,* 2014). The leaves contain carnosolic acid, salvigenin, genkwanin, hispidulin, luteolin, rosmarinic, caffeic, labiatic.

Traditionally, the leaves of the sage are used as herbal tea by infusing it into hot boiled water for 3–5 min. Recently, it has been marketed in tea bags and has also potential for processing into instant herbal tea but the extraction process of the sage is the main issue for the potential herbal tea products. From an engineering point of view, understanding of mass transfer phenomenon at the solid–liquid interface in sage extraction is important for optimizing process, scaling up to pilot, consequently development of industrial application.

Today, it is well known that free radicals cause many diseases. Antioxidants have great importance in the fight against free radicals, which can damage biological molecules with different mechanisms of action and the interest in the usage of antioxidants in the food, pharmaceutical and cosmetic industries is constantly increasing. Nowadays, synthetic antioxidants such as butylated hydroxyanisole (BHA), Butylated hydroxytoluene (BHT) and natural antioxidants are used as preservatives in many industries, especially in food industry. However, the concerns about the safety and toxicity of synthetic antioxidants have not been overcome yet. Therefore, the need for new and safer antioxidant sources is still maintained.

Total antioxidant capacity of plant material depends not only on the content and composition of phenolics, but also on the contents of other antioxidants. Antioxidants such as β, carotene, ascorbic acid, and alfa-tocopherol are proved to prevent oxidations of free radicals by *in vitro* and *in vivo* studies.

As one of the plants used as natural antioxidant source is the genus *Salvia* and the antioxidant activities of *Salvia* extracts have been associated mainly with their total phenolic contents. Plants with phenolic content are used especially in oily food because of their significant functions such as dealing with undesirable fragrances, prolonging thier shelf life, delaying the formation of toxic oxidation products, increasing nutritional value and preventing microbial growth. Phenolic compounds are known to be extremely beneficial in terms of human nutrition, cosmetic and pharmacological.

Several studies were conducted on antioxidant, antimicrobial, antiviral, antitumor effects of different aromatic plants (Özcan *et al.,* 2009; Alimpic *et al.,* 2014). Sage is used as a herbal tea for many years in Turkey. It is estimated a reduction at the bioactive components during the storage of plant tea. There is limited study on storage of herbal teas.

The objective of this study was to determine the total phenol, total flavonoid and antioxidant activities of methanol and ethanol extracts of *Salvia fruticosa* stored in dark at room temperature and +4 ºC for one year.

Aerial parts of *Salvia fruticosa* Mill. were collected at the early vegetative stage on May 2015. About 10 g ground sample was extracted 100 ml mixture of 90 % methanol+9 % water+1 % acetic acid and 90 % ethanol+9 % water+1 % acetic acid, respectively at 28 ºC for 48 h in a shaker. After filtration, the filtrate was evaporated under vacuum by a rotary evaporator apparatus.

The total phenol content was determined with Folin-Ciocalteu colorimetric method according to Singleton and Rossi (1965). The results were given as mg GAE/100 g.

Total flavonoids content was estimated according to Dewanto *et al.* (2002). The flavonoid content of extract was stated as mg CE/100 g dry-weight.

Antioxidant activity values of methanol and ethanol extracts of *S. fruticosa* were determined by using 2,2-diphenyl-1-picrilhidrazil (DPPH) method modified by Odriozola-Serrano *et al.,* 2008).

All results were mean±standard deviation (MSTAT C) of independent plant parts (Püskülcü, Ikiz, 1989).

Total phenol, flavonoid and antioxidant activity values of methanol and ethanol extracts of *Salvia fruticosa* stored in dark at room temperature and +4 ºC for one year are presented in Table 1. While the total phenol contents of methanol extract change between 875.14 and 784.39 mg GAE/100 g, the total phenol contents of ethanol extract were found between 799.21 and 601.84 mg GAE/100 g. As a parallel with antioxidant values of both extracts, antioxidant values decreased when compared with total phenol values of extracts. So, while antioxidant values of methanol extracts depending on storage are determined between 795.61 and 711.47 mg/ml, antioxidant activity values of ethanol extracts changed between 744.83 and 668.51 mg/ml. With respect to flavonoid contents of extracts, these values for methanol extracts were found between 44.13 (1th month) and 20.43 (12th month). In addition, total flavonoid contents changed between 39.54 and 18.67. These values obtained from extracts of *S. fruticosa* stored (kept) at refrigerator (+4 ºC) were found higher then those of results kept stored room temperature. Total phenol contents of methanolic extracts kept at +4 ºC changed between 987.46 (2th month) and 819.57 mg GAE/100 g. In addition, total phenol contents of ethanol extracts were found between 846.14 and 642.39 mg GAE/100 g. Also, antioxidant activities of methanol extracts kept at +4 ˚C changed between 857.41 and 746.84 mg/ml. Total flavonoid contents of methanol extract kept at +4 ºC were determined between 57.84 and 31.11 mg CE/100 g. The total phenol, total flavonoid contents and antioxidant activity values of sage depending on storage periods

in both storage conditions were significant at $p < 0.05$. Generally, total phenol, total flavonoid and antioxidant activity values of methanol extract were found partly high compared with results of ethanol extract.

Table 1 – Total phenol, total flavonoid and antioxidant activities of methanol and ethanol extracts of S.fruticosa stored room and refrigerator conditions

Storage (Month)	Solvents	Room Conditions		
		Total phenol (mg GAE/100 g)	Total flavonoid (mg CE/100 g)	Antioxidant activity (µg/ml)
1	2	3	4	5
2	methanol	875.14±12.43*a	44.13±2.26a	795.61±13.46a
	ethanol	799.21±17.28b**	39.54±1.17b	744.83±10.52b
4	methanol	861.56±13.62a	41.74±2.13a	784.17±11.49a
	ethanol	784.33±21.56b	36.41±1.39b	734.66±17.43b
6	methanol	848.42±9.89a	35.63±1.56a	771.48±15.49a
	ethanol	767.18±15.24b	32.78±2.34b	721.83±14.86b
8	methanol	830.27±11.67a	28.56±3.28a	752.93±14.27a
	ethanol	736.13±10.55b	27.51±1.57b	709.58±13.49b
10	methanol	807.41±8.37a	23.14±1.89a	738.23±11.88a
	ethanol	720.49±9.23b	20.46±1.13b	688.76±13.21b
12	methanol	784.39±7.61a	20.43±1.46a	711.47±12.54a
	ethanol	601.84±8.38b	18.67±1.29b	668.51±10.83b

Continuation of table 1

Storage (Month)	Solvents	Refrigerator (+4 ºC)		
		Total phenol (mg GAE/100 g)	Total flavonoid (mg CE/100 g)	Antioxidant activity (µg/ml)
1	2	6	7	8
2	methanol	987.46±18.77a	57.84±2.39a	857.41±11.43a
	ethanol	846.14±15.39b	47.62±1.71b	758.18±10.37b
4	methanol	886.55±11.54a	55.84±1.21a	837.48±11.28a
	ethanol	829.11±12.27b	49.76±2.45b	768.29±13.72b
6	methanol	887.21±16.38a	51.54±3.28a	847.76±11.63a
	ethanol	791.34±10.89b	44.81±1.67b	769.27±14.38b
8	methanol	844.61±11.65a	39.87±1.51b	798.44±14.46a
	ethanol	762.17±12.49b	41.33±2.48a	728.67±11.39b
10	methanol	844.15±13.67a	36.43±2.33a	767.56±10.53a
	ethanol	748.14±15.29b	29.66±1.19b	718.41±11.39b
12	methanol	819.57±14.37a	31.11±1.23a	746.84±17.36a
	ethanol	642.39±13.62b	29.48±1.47b	697.56±15.28b

Note: * *– mean±standard deviation,* ** *– Values within each colomn followed by different letters are significantly different ($p < 0.05$).*

In previous study, while antioxidant activity values of of *Salvia fruticosa* extracts, change between 287.57 and 450.51 µmol TE/100 g, total phenol and flavonoid contents of *Salvia fruticosa* extracts were determined between 488.70 and 1170.18 mg GAE/100 g and 664.03 and 1943.89 mg CE/100 g, respectively (Erdoğan *et al.,* 2014). Tawaha *et al.,* (2007) reported that the total phenolic content of *S. fruticosa* was 24.1 mg GAE/g. Papageorgiou *et al.,* (2008) have reported that the total phenolic content of leaves of *S. fruticosa* in different year and season ranged between 63.7 (determined in May) and 144 mg GAE g^{-1} DW (determined in August). These differences can be related with plant parts and storage conditions before analysis and they stored their samples under nitrogen. Also, extraction methods employed, geographical coordinates, climate, UV radiation, soil characteristics, and other ecological conditions may also cause such differences in total phenolic content (Papageorgiou *et al.,* 2008; Kallithraka *et al.,* 2009). Our results suggest that *S. fruticosa* is a strong antioxidant activity due to its total phenol contents in in vitro study. So it can be used as natural antioxidant source in the protection and preservation of certain foods and nutraceuticals.

Antioxidant activity as well as flavonoids total phenols of *S. fruticosa* extracts obtained by two different solvents were studied. Consequently, it is believed that storage in refrigerator for a long time is a convenient storage compared with storage at room due to bioactive constituents. In further research, it will be conducted on the correlation between the antioxidant capacity and the chemical composition of the sage plants.

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ANTIOXIDANT EFFECT OF POWDER AND EXTRACTS OF THE DATE SEED BY-PRODUCTS THAT CAUSE ENVIRONMENTAL PROBLEMS ON THE OXIDATIVE STABILITY OF SESAME OIL

АНТИОКСИДАНТНОЕ ВЛИЯНИЕ ПОРОШКА И ЭКСТРАКТА ФИНИКОВ КАК ПРИЧИНА ЭКОЛОГИЧЕСКИХ ПРОБЛЕМ В ОКИСЛИТЕЛЬНОЙ СТАБИЛЬНОСТИ КУНЖУТНОГО МАСЛА

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Antioxidant effects of the date powder and extracts on the oxidative stability of sesame oil stored at 70 °C were investigated. For this purpose, the date powder (at the concentration of 2 %, 6 % and 10 %) and extract (at the concentration of 1 %, 3 % and 5 %) were added into sesame oil. Effects of the date powder and extract on the oxidative stability of sesame oil were assessed as connected with colour (Hunter *L, a* and*b*), viscosity, free fatty acid (FFA%) and peroxide value. The consequences were compared with 0.02% BHA and control sample. All concentrations of the date powder and extracts also showed greater activity than BHA on sesame oil. But the addition of 10 % date powder was shown the greatest effect. The addition of 10 % date powder has been determined to show best impact on peroxide value of sesame oil.

Исследованы антиоксидантное влияние порошка и экстрактов фиников на окислительную стабильность кунжутного масла, хранящегося при температуре 70 °С. Для этой цели порошок (в концентрации 2 %, 6 % и 10 %) и экстракт фиников (в концентрации 1 %, 3 % и 5 %) добавляли в кунжутное масло. Влияние порошка и экстракта фиников на окислительную стабильность кунжутного масла оценили как связанные с цветом (Hunter *L*, *a* andb), вязкостью, величиной свободных жирных кислот (СЖК%) и перекисным числом. Результаты сравнивали с 0,02 % БГА и контрольной пробой. Все концентрации порошка и экстрактов фиников также показали большую активность, чем БГА в кунжутном масле. Добавление 10 % порошка фиников показало наибольший эффект. Установлено, что добавление 10 % порошка фиников наилучшим образом влияет на перекисное число кунжутного масла.

Keywords: date powder, date extract, sesame oil, antioxidan, BHA.