Contents available at ISC and SID
Journal homepage: www.rangeland.ir

Research and Full Length Article:

Forage Nutritive Values of *Cymbopogon olivieri* before and after Essential Oil Extraction in Khuzestan Province's Rangelands, Iran

Azadeh Afrigan[A], Hossein Azarnivand[B]*, Fatemeh Sefikon[C], Mohammad Jafari[B], Mohammad Ali Zare Chahouki[B]
[A] PhD Student, Department of Range Management Science and Science and Research Branch, Islamic Azad University, Tehran, Iran
[B] Professor, Department of Reclamation of Arid and Mountainous Regions, Faculty of Natural Resources, College of Agriculture & Natural Resources, University of Tehran, Karaj, Iran, *(Corresponding Author), Email: azarnivad@ut.ac.ir
[C] Professor, Department of Rehabilitation of Arid and Mountainous Regions, Natural Resources Faculty, University of Tehran

Received on: 08/04/2018
Accepted on: 05/07/2020

Abstract. This study was performed to evaluate the forage nutritive value of *Cymbopogon olivieri* before and after conducting the essential oil extraction in rangelands of Khuzestan province, Iran. In this study, the aerial parts of *Cymbopogon olivieri* were collected in flowering stage from 10 natural regions located in Khuzestan province in 2016. Regions included ChalGandali, TalkhabKalat, Bardmar, Morad Abad, Tembi, Dezful, Indika, Lali, Shoushtar, and Izeh. Essential oil composition was analyzed by GC/MS. The forage quality traits including Crude Protein (CP), Dry Matter Digestibility (DMD), Water Soluble Carbohydrates (WSC), Crude Fiber (CF), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), and total Ash were measured. After normalizing the gathered data, the means of the traits were compared by Duncan's multiple range test ($P<0.05$) in SAS software. The 21 components were identified in the essential oil of the plant species. The result showed that the highest mean values of CP, DMD, WSC, CF, ADF, NDF, and total Ash were obtained as 4.83%, 48.03%, 14.9%, 76.63%, 50.12%, 84.59%, and 3.98%, respectively. The result showed that phenological stage had significant effects on forage quality. The higher amounts of NDF, ADF, and CF were observed after essential oil extraction stage, but higher amounts of CP, WSC, and DMD were observed before essential oil extraction. So, it was concluded that since the essential oil extraction led to the decreased forage quality. Therefore, it was suggested that grazing *C. olivieri* by livestock prior to essential oil extraction had more benefits for dairy and meat production.

Key words: *Cymbopogon olivieri*, Essential oil, Chemical composition, Forage quality

Introduction

The genus *Cymbopogon spreng* is an important aromatic grass belonging to the Poaceae family, which is widely distributed and cultivated in tropical and subtropical regions in the world especially in the southeast of Asia (Nair, 1982). The genus *Cymbopogon* comprises two perennial species in flora of Iran that are *C. olivieri* (Boiss.) Bor and *C. parkeri* Stapf. distributed in tropical regions of Iran like the southern parts of Fars, Kerman, Hormozgan, Khuzestan, Bushehr, and Baluchestan provinces (Sonboli *et al*., 2010).

Essential oils of the *Cymbopogon* spp. are mainly composed of cyclic and acyclic monoterpenes like citral (3,7-dimethyl-2, 6-octadienal; a mixture of two isomer geranial and neral), geraniol, citronellol, citronellal, linalool, elemol, 1, δ-cineole, limonene, β-carophyllene, methyl heptenone, geranyl acetate, and geranyl formate (Ito and Honda, 2007). It is well known that yield and yield components of plants are determined by a series of factors including plant genetics (Pirbalouti *et al*., 2013), climate, soil, elevation, and topography (Loziene and Venskutonis, 2005) and also an interaction of various factors (Basu *et al*., 2009). Ozguven and Tansi (1998) reported that the altitude should be considered as a major factor influencing the physiological and chemical characteristics of plants. They found a high correlation between the altitude where aromatic plants grow and their essential oil yield (Ozguven and Tansi, 1998). However, altitude seems to affect the essential oil content of only oil-rich and oil-intermediate aromatic plants and it does not seem to influence oil-poor plants (Kokkini *et al*., 1997). In an investigation done on the effect of environmental factors on *C. olivieri* (Boiss.) Bor (Poaceae) in four regions of Sarbaz, Jiruft, Dezfool, and Masjid Soleiman, Mirjalili and Omidbeigi (2005) concluded that the nearby altitudes of 300-600 m above sea level in the regions of Masjid Soleiman and Jiruft had a greater effect on the function of the essential oil in the lemongrass (Mirjalili and Omidbeigi, 2005). It was demonstrated by Yazdani *et al.* (2002) that the percentage of essential oil of *Mentha piperitone* Stokes (Lamiaceae) from six growing areas depended on the environmental conditions and varied from 1.45% to 3.2%, and was influenced by different environmental factors such as altitude and the daylight period (Yazdani *et al*., 2002). Yavari *et al.* (2010) reported that essential oil yield of *Thymus migricus* was fairly strongly related to the concentrations of Ca^{++} and K^{+}, organic matter, altitude, temperature, and soil texture (Yavari *et al*., 2010).

Also, nutritional quality is affected by abiotic and biotic environmental factors including soil type, climatic regime, botanical composition and soil improvement practices (Corona *et al*., 1998). The evaluation of feed quality is important for the prediction of animal performance (Seven and Cerci, 2006). Herbage evaluation implies the description of feedstuffs with respect to their capacity to ensure diverse kinds and levels of production (Juárez *et al*., 2004). From a ruminant nutrition perspective, Metabolizable Energy (ME), dry matter digestibility (DMD), and crude protein (CP) contents are three of the most important components of herbage quality (Malau-Aduli, 2007). Thus, in order to improve the quality of the herbage consumed by grazing animals, it is necessary to obtain information about its chemical composition, which could be related to its capacity to satisfy the requirements of the grazing animals.

Naseri *et al*. (2017) indicated that DMD, CP, WSC, Ash, and ME had a positive and significant correlation with

each other and all of them were negatively correlated with ADF, NDF, and CF. Mountousis *et al.* (2011) studied altitudinal and seasonal variations in herbage composition and ME, and a CP of grasslands in Greece; then, they reported that CP decreased from 106.65 to 72.03 g/kg dry matter (DM) in the lowlands from 133.95 to 80.38 g/kg DM in the middle zone and from 127.13 to 74.47 g/kg DM in sub-alpine grasslands. Metabolizable energy (ME) content of the herbage decreased as the growing season progressed about 19%, 32% and 23% in the lower, middle, and upper altitudinal zones, respectively (Mountousis *et al*., 2011). In addition to environmental factors, phenology has affected forage quality. Dehghani Bidgoli *et al*. (2013) showed chemical composition variations of six plant species in the rangelands that phenological stages were the most important factor on forage quality. Shadnoush (2014) concluded that in the early stage of plant growth, the quality of forage in range species is adequate for livestock requirements, but during that stage, the greatest problem is its lower quantity. By progress of the vegetation stage, the nutritive value of all species decreased; thus, grazing animals oppose to nutrient deficiencies.

The essential oil composition in these plants is different along the growing stage so that most of them had been connected to high forage quality. *C. olivieri* is known as a forage and medicinal plant. So, this is necessary to identify the stage of plant harvesting besides maintaining essential oil composition and forage quality. This research will be an effective step to cultivate and produce this plant species that lets to decrease grazing pressure in the rangelands. So, the aim of this study was to investigate the effect of essential oil extraction (before and after oil extraction) on forage quality of *C. olivieri* in 10 rangelands/regions of Khuzestan province, Iran.

Material and Methods

Study Area

In the present study, we analyzed the forage quality in several rangelands of Khuzestan Province within latitudes of 48˚ 29' 10" to 49˚ 45' 02" and longitudes of 32˚ 43' 04" to 31˚ 48' 05" (Fig. 1). The dominant plant types are *Astragalus sp-Salvia compressa- Stipa capensis-Cymbopogon*, and *Stipa capensis* that produce 290 Kg/ha per year and the share of the dominant species of *Stipa capensis* is ±100 Kg/ha, the canopy cover is 35% and the base number is 25.

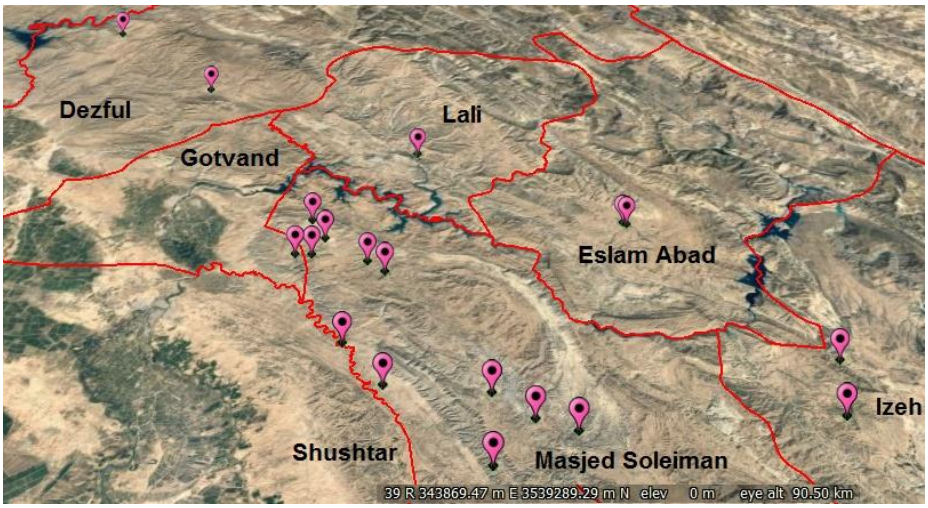

Fig. 1. The location of study area and samples coloration in Khuzestan province, Iran

Plant collection and essential oil extraction

The experimental work was conducted during 2015 and 2016. In this study, the aerial parts of *C. olivieri* were collected from 10 rangelands/regions (located in Khuzestan Province) with three replications, overall 60 samples from 1st till 13th June 2017.

An average of 60 samples was taken in the regions including ChalGandali, Talkhab e Kalat, Bardmar, Morad Abad, Tembi, Dezful, Indika, Lali, Shoushtar, and Izeh. Some basic characteristics of region including latitude, longitude, altitudes, slope, average annual temperature, annual rainfall and evaporation were determined (Table 1). The aerial parts of plants were harvested and dried after being cleaned in the laboratory (Omidbeigi, 2005). The essential oil content was extracted from samples (90 g) using Clevenger apparatus through water distillation for 3 h on 24th June 2017. The essential oil was dried with sodium sulfate (Merck Co. Germany), and kept in a dark glass (4 °C) until the test steps were carried out (Omidbeigi, 2005). The essential oil content was determined using the formula described by Rao *et al*. (2005) as: Y= (A/B)*100

Where:

Y: essential oil concentration (%),

A: amount of essential oil recovered (g), and

B: amount of crop biomass distilled (g).

The essential oil extract and its compound identification were performed, respectively using GC-FID and GC/MS devices.

The following forage quality traits were measured:

- Nitrogen (N) was determined on the basis of Kjeldahl technique,
- Crude Protein (CP) was calculated as CP = N% × 6.25 (Jones, 1981).
- Neutral detergent fiber (NDF), acid detergent fiber (ADF), and crude fiber (CF) were analyzed by the method of Association of the Official Analytical Chemists (AOAC, 2000).
- Dry matter digestibility (DMD) was estimated as DMD=83.58-0.824ADF+2.626N, (Arzani *et al*., 2006).
- Water Soluble Carbohydrate (WSC) and Total Ash were measured using Near Infrared Reflectance Spectroscopy (NIR) (Jafari *et al*., 2003).

Statistical analysis

The collected data on forage quality were analyzed using two-way Analysis of Variance (ANOVA) for two factors of essential oil extraction and regions and their interactions. Means comparison was performed according to Duncan's method ($P<0.05$). The data were statistically analyzed using SAS software.

Table 1. Some basic characteristics of region of the present study

Region	Latitude	Longitude	Altitudes (m)	Slope%	Average Annual Temperature (C˚)	Annual Rainfall (mm)	Annual Evaporation (mm)
Chalgandali	48˚ 06' 24.18"	32˚ 07' 28.84"	328	20	24	350	62
Talkhab e Kalat	49˚ 08' 0.67"	32˚ 06 17.90"	301	20	24	340	62
Bardmar	49˚ 01' 48.14"	32˚ 08' 11.46"	394	55	23	350	63
Morad Abad	49˚ 22' 55.93"	31˚ 52' 05.97"	359	5	23	490	62
Tembi	49˚ 16' 53.50"	31˚ 55' 0.03"	208	45	24	440	64
Dezful	48˚ 48' 16.08"	32˚ 29' 24.93"	461	5	23	600	58
Indika	49˚ 27' 25.98"	32˚ 11' 18.84"	724	5	22	600	53
Lali	49˚ 09' 19.03"	32˚ 20' 0.59"	323	25	23	570	55
Shushtar	49˚ 52' 08.90"	31˚ 59' 35.48"	148	20	24	290	66
Izeh	49˚ 41' 58.49"	31˚ 57' 55.40"	768	12	21	630	53

Result

Essential oil composition

The essential oil analysis showed a high variation for quality and quantity of the essential oil compounds with maximum (93.6%) and minimum (86.30%) yield (w/w) in Lali and Bardmar regions, respectively. In total, 21 compounds were identified in the essential oil. The *piperitone* and δ-2-carene had the highest mean values in the regions (Table 2).

Table 2. Essential oil composition of *Cymbopogon olivieri*

Oil composition	Regions										Mean
	Indika	Talkhabe	Tembi	Moradabad	Chalgandali	Lali	Izeh	Bardmar	Dezful	Shushtar	
elemol	0.9	1.6	1.0	1.0	1.0		0.4	1.4	0.8	1	0.91
7-epi-α-selinene	0.0	0.2	0.2	0.2	0.1				0.2	0.2	0.11
β-selinene	0	0.	0.1	0.1	0.1				0.1		0.04
valencene	0.2	0.5	0.4	0.4	0.4		0.2	0.2	0.3	0.3	0.29
germacrene D	0	0.2									0.02
piperitone	**62.6**	**57.5**	**59.7**	**58.1**	**58.9**	**66.6**	**66.5**	**59.2**	**58.2**	**59.9**	**60.72**
α-terpineol	0.3	0.2	0.2	0.3		0.3	0.8	0.2			0.23
p-cymen- δ-01	0.2	0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.18
p-methyl-acetophenone	0.9	0.9	0.9	0.8	0.8	1.0	1.0	0.8	0.9	1	0.90
p-mentha-1, 5-dien-8-01	0.5	0.4	0.6	0.5	0.6	0.6	0.5	0.7	0.6	0.8	0.58
trans-p-menth-2-en-1-01	0.6	0.4	0.5	0.6	0.6	0.4	0.4	0.6	0.6	0.6	0.53
cis-p-memth-2,δ-dien-1-01	0.3	0.3	0.4	0.3	0.2	0.3	0.4	0.3	0.3	0.3	0.31
cis-p-menth-2-en-1-01	0.1	0.1	0.2	0.2		0.2	0.2	0.2	0	0.2	0.14
p-cymenene	0.5	0.4	0.5	0.5	0.5	0.6	0.5	0.5	0.5	0.5	0.50
limonene	2	2.2	2.5	2.4	2.4	2.3	2.2	0.2	2.8	2.6	2.16
p-cymene	0.2	0.2	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.4	0.29
δ-2-carene	**20**	**21.3**	**22.3**	**24.3**	**23.3**	**19.9**	**18.5**	**20.3**	**24**	**22.2**	**21.61**
1,δ-dihydrocineole	0.1	0.1	0.1		0.3	0.2	0.1	0.2	0.2	0.2	0.15
Verbenene	1.0	0.8	1.0	1.1	1.2	0.7	1.0	1.0	1.20	1.0	1.00
Total	90.4	87.8	91.1	91.2	90.7	93.6	93.2	86.3	91.3	91.3	90.96

Forage Quality traits

The result of means comparison of forage quality traits between two essential oil extraction stages showed that there was a significant difference between two growth stages for WSC, NDF, CF and total ash. The higher WSC, DMD, CP, and total ash were obtained before essential oil extraction and higher values of NDF, and CF were obtained after oil extraction and in other words, the forage quality was decreased by essential oil extraction (Table 3).

The means of forage quality traits before and after oil extraction for some regions were different (Table 4). The overall result for each trait was as follows:

Crude protein (CP): Results showed that CP content was higher before extraction stage than after stage (Table 4). In ChalGandali, Bardmar, Tembi, and Izeh, the CP content was high before extraction and in TalkhabKalat, Dezful, and Lali, the CP content was lower before extraction. The highest (4.83 to 4.42%) and lowest (0.88 to 0.81%) CP content was obtained in Shushtar, and Indika in both stages, respectively.

Water Soluble Carbohydrates (WSC): Results showed that the highest and lowest WSC content before (14.9%) and after (4.6%) extraction was belonging to Shushtar region. WSC content was higher before essential oil extraction stage except in Talkhab Kalat, and Lali regions ($P<0.05$) (Table 4).

Acid detergent fiber (ADF): The essential oil extraction had a significant effect on the ADF exception Izeh region ($P<0.05$). The amount of ADF was low in Morad

Abad, Tembi, Dezful, Indika, and Shushtar regions before the stage of extraction. Chalgandali with an average value of 50.12% had the highest ADF before extraction and Indika (30.45%) had the lowest ADF before stage extraction. (Table 4).

Neutral detergent fiber (NDF): The stage of essential oil extraction had a significant effect on NDF content in all regions (P<0.05). The amount of NDF was low in all regions before extraction except for Lali, and TalkhabKalat regions. The highest NDF (average 84.59%) was obtained in Tembi after oil extraction stage and the lowest value (average 56.09%) was observed in Shushtar region after oil extraction stage (Table 4).

Crude fiber (CF): The essential oil extraction stages had a significant effect on CF content (P<0.05). The amount of CF was lower in all regions before essential oil extraction stage except for Lali and TalkhabKalat regions. The highest and lowest CF (with a value of 76.63% and 48.16%) was observed in Chalgandali after oil extraction stage and in Tembi before stage extraction, respectively.

Total ash: There were significant differences between the two stages of essential oil extraction (P<0.05) except for Bardmar, Morad Abad, Shushtar, and Izeh regions. Talkhabkalat and Lali regions had the lowest total ash before stage and the other regions had the highest total ash after extraction. The highest value (3.98%) was obtained before oil extraction stage in Chalgandali and the lowest (2.09%) was obtained before extraction stage in Lali.

DMD: There were significant differences between the two stages of oil extraction (P<0.05) except in TalkhahbKalat, Moradabad, and Izeh regions (P<0.05). Bardmar, Shushtar, and Lali regions had the lowest DMD before oil extraction stage and the other regions with the highest DMD after essential oil extraction stage. The highest DMD content was obtained before oil extraction stage (48.03%) in Dezful and the lowest value (42.64%) was obtained before stage in Izeh region.

Table 3. Means comparison between essential oil extraction stages average over locations

Essential oil extraction stage	CP	WSC	DMD	ADF	NDF	CF	ASH
Before oil extraction	3.31a	11.99 a	46.03a	40.29a	66.38b	57.36b	3.17a
After oil extraction	3.19a	8.17 b	45.57a	40.54a	77.01a	63.64a	2.91b

Means of column followed by same letters has no significant differences based on Duncan method (P<0.05)

Table 4. Means comparison between essential oil extraction stages in each areas

Areas	Extraction stage	CP	WSC	DMD	ADF	NDF	CF	ASH
ChalGandali	Before	3.90 b	11.8 d	44.25 f	50.12 a	69.90 e	66.76 c	3.98 a
	After	3.38 d	9.3 f	43.00 g	42.87 b	78.16 c	76.63 a	2.15 g
TalkhabKalat	Before	3.54 bc	9.4 f	47.00 bc	39.00 cd	74.89 d	55.23 e	2.98 de
	After	4.74 a	10.6 de	46.34 cd	38.41 cd	63.01 f	50.38 fg	3.87 ab
Bardmar	Before	4.46 a	12.7 cd	45.83 d	40.21 bc	69.29 e	54.41 e	2.78 ef
	After	3.97 b	10.2 ef	47.44 ab	30.60 e	79.94 bc	62.96 cd	2.46 fg
Morad Abad	Before	2.87 e	11.9 d	45.25 de	40.40 bc	62.76 f	62.44 cd	3.64 b
	After	2.91 e	5.9 gh	44.83 ef	43.75 b	83.89 a	73.51 b	3.52 bc
Tembi	Before	2.31 f	12.0 d	47.08 bc	38.01 d	62.27 f	48.16 g	3.83 ab
	After	1.03 g	8.2 g	44.75 ef	43.00 b	84.59 a	64.73 c	3.09 d
Dezful	Before	3.09 de	13.8 b	48.03 a	37.82 d	60.58 f	49.50 g	3.38 c
	After	3.22 d	7.3 g	44.58 ef	43.81 b	83.18 a	65.40 c	2.10 g
Indika	Before	0.88 g	14.3 ab	46.89 bc	30.45 e	60.29 f	53.00 ef	2.50 f
	After	0.81 g	7.3 g	44.95 e	40.58 bc	74.47 d	60.19 d	2.20 g
Lali	Before	3.77 b	5.8 gh	42.64 g	49.00 a	82.93 ab	65.25 c	2.09 g
	After	4.78 a	10.0 ef	45.39 de	40.95 bc	63.68 f	51.29 ef	3.74 ab
Shushtar	Before	4.83 a	14.9 a	45.78 de	38.12 cd	56.09 g	55.00 e	3.03 cd
	After	4.42 a	4.6 h	47.04 bc	42.28 bc	80.98 bc	63.28 cd	2.87 d
Izeh	Before	3.35 cd	13.3 bc	47.56 ab	39.73 cd	64.72 f	63.81 cd	3.44 c
	After	2.62 ef	8.32 fg	47.33 ab	39.13 cd	78.14 c	68.00 bc	3.10 cd

Means of column followed by same letters has no significant differences based on Duncan method (P<0.05)

Discussion

According to the result, *Cymbopogon olivieri* plant species are valuable sources as medicinal care for human and livestock forage. The 21 components were identified in the essential oil of the aerial parts of this plant species and high forage quality.

Results showed that there was a significant difference between before and after extraction stage ($P<0.05$), and the highest CP was observed before extraction. The highest and lowest CP content was observed in Shushtar and Indika samples with average values of 4.83% and 0.81%, respectively. Indika located in the highlands (altitude 725m) with low slope (5%) and high rainfall (600mm) while Shushtar located in lowlands (148m) with high slope (20%), and low rainfall (290mm). So, the amount of CP was affected by an environmental factor that had an effect on the essential oil amount. This result is according to that stated by Arzani *et al.* (2001) who reported that locations had significant effects on forage quality in their research because of differences in ecological characteristics. Özgüven and Tansi (1998) stated the altitude can also be considered as a major factor influencing the physiological and chemical responses of plants. As Mountousis *et al*. (2011) stated, CP of the herbage decreased as the growing season progressed due to environmental factors. In this order, Marshal *et al.* (2005) showed that CP was positively associated with forage growth ($P < 0.001$), and rainfall ($P \leq 0.025$). In the highlands (Indika), growing season occurred sooner than lowlands (Shushtar) and played a role in reducing the CP content.

The same as CP, WSC content before stage of essential oil extraction was nearly 2% higher. WSC content was different between Shushtar after stage with Lali, and Morad Abad but it was similar between Shushtar and Indika and between Lali and Morad Abad that there is the same annual average temperature between them and difference in elevation. Ahmadi Beni *et al*. (2014) investigated on temperature and elevation effect on forage quality and found that impact of plant maturity is most serious about forage quality which is related to plant environment including temperature.

According to Table 4, essential oil extraction led to 20% increasing in NDF specially in Morad Abad, Tembi, Dezful, Indika, and Shushtar. These regions are located in low elevation (380m), low slope (16%), high rainfall (484mm), and high evaporation (60.6mm). These environmental factors, especially altitude had effects on maturity time; also, the fiber concentration increases as the plants mature, which is the most important factor affecting DMD. These increases are due to increasing the herbage cell wall contents with maturity compared to cell content (Skapetas *et al*., 2004).

Essential oil extraction had a significant effect on the CF ($P<0.05$), and this treatment led to 13% increasing in CF content. Chalgandali (after oil extraction stage), and Tembi (before oil extraction stage) showed the highest (76.63%) and lowest (48.16) means of CF, respectively. The environmental factors are different, especially low elevation (208m) and high rainfall (440mm) in Tembi. So, the maturity stage of plant is sooner than Chalgandli and this emphasizes the result of Skapetas *et al*. (2004).

There were significant differences in Ash content before and after essential oil extraction ($P<0.05$). Generally, essential oil extraction led to 12% reduction in ash the same as CP and WSC. Also, Chagandali and Bardmar showed the highest (3.98%) and lowest (2.1%) means, respectively. This is similar to finding of other researchers such as Arzani *et al*. (2006) and Mountousis *et al*. (2011). They reported that elevation and slope had a main effect on forage quality.

There was a significant difference in DMD before and after essential oil extraction ($P<0.05$) so that there was high DMD before oil extraction stage. DMD

content decreased from 48.03 (max value) in Dezful to 42.64% (min value) in Lali before oil extraction stage extraction. Dezful located in the in the highlands with high rainfall and low slope aspect that affected DMD content.

Conclusion

According to the results, it was found that essential oil extraction had significant effects on forage quality traits. Also, there were significant differences between areas. Altitude has effects on maturity time; so, chemical components change according to growth stages.

The result showed that the stage of essential oil extraction is an effective factor in forage quality and the higher amounts of NDF, ADF, and CF were observed after oil extraction, but the higher amounts of CP, WSC, and DMD were observed before oil extraction. So, we can conclude that essential oil extraction led to low forage quality. This result is opposite of the other studies indicating that essential oil is a decreasing factor on palatability of some plants. For example, Azarnivand *et al*. (2009) explained that high essential oil in fresh (2.7% with 18 chemical compositions) led to low palatability than dry (0.4% with 17 chemical compositions) in *Diplotaenia cachrydifolia* Boiss. They stated that high essential oil and some chemical compositions are known as anti-quality factors. The result of present research is according to Budavari (2005) showing that some essential oils have no negative effect on forage quality e.g. Sis-beta-Osimen and Trans-beta-Osimen, but others can make diarrhea (Budavari, 2005).

Also, we must pay attention that different regions have effects on essential oil and then forage quality. There was a significant difference between Lali and Talkhab e Kalat regions with others. It seems that according to Skapetas *et al*. (2004), environmental factors affect forage quality. Özguven and Tansi (1998) stated that there is a correlation between the elevation where aromatic plants occur and their yield in essential oils. The elevation led to decrease forage quality in some parameters (e.g. CP, WSC, and total Ash). So, we can conclude that forage quality depends on either essential oil extraction or environmental factors such as elevation, rainfall, etc. According to Freidooni *et al*. (2012), the forage quality of a *Prangos ferulacea* was higher in low elevation and high rainfall, and the forage quality of *Cymbopogon olivieri* was high in Shushtar, Chalgandali, and Dezful regions than others before stage of essential oil extraction. In this research, grazing livestock before essential oil extraction was suggested especially in these regions with average elevation 312m above sea level, 15% slope aspect, 23.6°C, 413 mm annual rainfall, and 62 mm annual evaporation. Although this plant with the proper distribution has multi-uses in rangelands of Khuzestan province as a livestock forage, it is proposed to plant and develop it in the farmlands and pharmaceutical industries like antibacterial uses based on the existing organic compounds.

References

Ahmadi Beni, M., Niknahad Gharmakher, H., Sadat Azimi, M., Maramaei, M.G., 2014. Investigation of forage quality of *Vetiveria zizanioides* in Semi-Steppe region of Maraveh-Tappeh, Golestan Province, Iran. Journal of Rangeland Science, 4: 287-297.

AOAC. 2000. Official methods of analysis of association of agricultural chemists. Virginia, D.C. V: 1213.

Arzani, H., Basiri, M., Khatibi, F., Ghorbani, G., 2006. Nutritive value of some Zagros mountain rangeland species. Journal of Small Ruminant Research, 65: 128-135.

Arzani, H., Torkan, J., Jafari, M., Jalili, A., Nikkhah, A., 2001. Investigation on effects of phenological stages and environmental factors (soil and climate) on forage quality of some important range species. Journal of Agricultural Sciences, 32: 385-397.

Azarnivand, H., Alikhaheasl, M., Arzani, H., Amin, Gh. Jafari, M., Moosavi, S.S., 2009. Investigation of Changes in quality and quantity of *Diplotaenia achrydifolia* Boiss. Plant oils as anti-quality factors of green fodder and dry in two cases. Iranian Journal of Medicinal and Aromatic Plants Research, 25(1): 85-91.

Basu, S., Acharya, S., Bandara, M., Friebel, D., Thomas, J., 2009. Effects of genotype and environment on seed and forage yield in Fenugreek (*Trigonella foenum*-graecum L.) Grown in Western Canada. Australian Journal of Crop Science, 3: 305-313.

Budavari, S., 2005. The Merck Index. 12thed, Merck & Co. INC, USA, 648p.

Corona, M.E.P., De Aldana, B.R.V., Criado, B.G., Ciudad, A.G., 1998. Variations in nutritional quality and biomass production of semiarid grasslands. Journal of Range Management, 51(5): 570-576.

Dehghani Bidgoli, R., Ranjbarforoei, A., Akhzari, D., 2013. Estimation of nutritive values of some range species as indicators for rangelands management. Journal of Rangeland Science, 2(4): 669-676.

Freidooni, M., Amiri, B., Gharadaghi, H., Keshavarz, A., 2012. Quality changes investigating of *Prangos ferulacea* in different phenological stages in two site of Fars province. Journal of Plant Ecophisioloy, 4: 87-96 .

Ito, M., Honda, G., 2007. Geraniol synthases from perilla and their taxonomical significance. Phytochemistry, 68: 446-453.

Jafari, A.V., Connolly, Frolich, A., and Walsh, E.K., 2003. A note on estimation of quality in perennial ryegrass by near infrared spectroscopy. Irish journal of agricultural and food research, 42: 293-299.

Jones, D., 1981. Chemical composition and nutritive value. Sward Measurement Handbook'. (Eds J. Handson, RD Baker, A. Davies, AS Laidlows and JD Leawer.) pp, 243-265.

Juárez, A., Montoya, R., Nevarez, G., Cerrillo, M., 2004. Seasonal variations in chemical composition and dry matter degradability of the forage consumed by goats in a highly deteriorated rangeland of North Mexico. South African Journal of Animal Science, 34: 68-71.

Kokkini, S., Karousou, R., Lanaras, T., 1997. Essential Oils with 1, 2-Epoxy-p-menthane Derivatives from *Mentha spicata* plants growing across the Island of Crete. Journal of Plant Biology, 110: 184-189.

Loziene, K., Venskutonis, P., 2005. Influence of environmental and genetic factors on the stability of essential oil composition of *Thymus pulegioides*. Journal of Biochemical Systematics and Ecology, 33: 517-525.

Malau-Aduli, A.E., 2007. Energy and protein contents in pastures at different times of the year and feeding to meet animal nutrient requirements. Australia 16th Annual Conference, Tasmanian Branch, Launceston, Australia, 16: 39-52

Marshal, J.P., Krausman, P.R., Bleich, V.C., 2005. Rainfall, temperature, and forage dynamics affect nutritional quality of desert mule deer forage. Journal of Rangeland Ecology and Management, 58: 360-365.

Mirjalili, F.T.I.M., Omidbeigi R., 2005. Study of compatibility and evaluation of the essential function in the indigenous biomass of the Iranian lemongrass. Journal of Management Agricultural Sciences, 36: 33-41.

Mountousis, I., Dotas, V., Stanogias, G., Papanikolaou, K., Roukos, C. and Liamadis, D., 2011. Altitudinal and seasonal variation in herbage composition and energy and protein content of grasslands on Mt Varnoudas, NW Greece. Animal feed science and technology, 164(3-4): 174-183.

Nair, E., 1982. Promotional aspects of lemongrass. Cultivation and utilization of aromatic plants/edited by CK Atal and BM Kapur.

Naseri, S., Adibi, M., Kianian, M., 2017. Forage Quality of endangered species of *Astragalus fridae* Rech. F. in Semnan province, Iran. Journal of Rangeland Science, 7(4): 387-399.

Omidbeigi, R., 2005. Production and processing of medicinal plants. Tehran University. 283pp.

Özguven, M., Tansi, S., 1998. Drug yield and essential oil of Thymus vulgaris L. as in influenced by ecological and ontogenetical variation. Turkish Journal of Agriculture and Forestry, 22: 537-542.

Pirbalouti, A.G., Hashemi, M., Ghahfarokhi, F.T., 2013. Essential oil and chemical compositions of wild and cultivated *Thymus daenensis* Celak

and *Thymus vulgaris* L. Journal of Industrial Crops and Products, 48: 43-48.

Rao, B.R., Kaul, P., Syamasundar, K., Ramesh, S., 2005. Chemical profiles of primary and secondary essential oils of palmarosa (*Cymbopogon martinii* (Roxb.) Wats var. MotiaBurk.). Journal of Industrial Crops and Products, 21: 121-127.

Seven, P.T., Cerci, I., 2006. Relationships between nutrient composition and feed digestibility determined with enzyme and nylon bag (in situ) techniques in feed sources. Bulgarian Journal of Veterinary Medicine, 9: 107-113.

Shadnoush, G., 2014. Chemical composition and In Vitro digestibility of some range species in rangelands of Chaharmahal and Bakhtiari Province, Iran. Journal of Rangeland Science, 3(4): 343-352.

Skapetas, B., Nitas, D., Karalazos, A., Hatziminaoglou, I., 2004. A study on the herbage mass production and quality for organic grazing sheep in a mountain pasture of northern Greece. Livestock Production Science, 87: 277-281.

Sonboli, A., Mirjalili, M. H., Yousefzadi, M., 2010. Antimicrobial activity and composition of the essential oil of *Cymbopogon Olivieri* (Boiss.) Bor from Iran. Iranian Journal of Pharmaceutical Research, 5(1): 65-68.

Yavari, A., Nazeri, V., Sefidkon, F., Hassani, M.E., 2010. Influence of some environmental factors on the essential oil variability of *Thymus migricus*. Natural product communications, 5: 943-948.

Yazdani, D., Jamshidi, A., Mojab, F., 2002. Comparing the essential amount and the menthole in peppermint planted in different regions of the country. Quart Journal of Iranian Aromatic Herbs, 1: 73-78.

تعیین ارزش علوفه‌ای گیاه کاه‌مکی *Cymbopogon olivieri* قبل و بعد از استخراج اسانس در مراتع استان خوزستان

آزاده آفریجان[الف]، حسین آذرنیوند[ب*]، فاطمه سفیکن[ج]، محمد جعفری[ب]، علی زارع چاهوکی[ب]
[الف]دانشجوی دکتری، دانشکده علوم مدیریت و ریاضی، دانشگاه آزاد اسلامی، تهران، ایران
[ب]پرفسور، بخش احیای مناطق خشک و کوهستانی، دانشکده منابع طبیعی، دانشکده کشاورزی و منابع طبیعی، دانشگاه تهران، کرج، ایران، *(نگارنده مسئول)، پست الکترونیکی: azarnivad@ut.ac.ir
[ج]پرفسور، موسسه تحقیقات جنگل‌ها و مراتع، تهران، ایران

چکیده. این مطالعه جهت برآورد ارزش علوفه‌ای گیاه کاه‌مکی (*Cymbopogon olivieri*) قبل و بعد از استخراج اسانس در اندام جمع‌آوری شده گیاه در مراتع استان خوزستان، انجام شد. در این مطالعه اندام‌های هوایی کاه‌مکی بعد از گلدهی از ده منطقه بومی در سه تکرار در سال ۱۳۹۵ جمع‌آوری شدند. مناطق شامل: چال‌گندلی، تلخاب‌کلات، بردمار، مراد آباد، تمبی، دزفول، اندیکا، لالی، شوشتر و ایذه هستند. ترکیبات شیمیایی موجود در اسانس گیاه با استفاده از دستگاه GC/MS شناسایی شدند. شاخص‌های اندازه‌گیری شده معرف کیفیت علوفه شامل: پروتئین خام (CP)، قابلیت هضم ماده خشک (DMD)، کربوهیدرات‌های محلول در آب (WSC)، الیاف خام (CF)، فیبر نامحلول در شوینده اسید (ADF)، فیبر نامحلول در شوینده خنثی (NDF) و خاکستر کل بودند. پس از حصول اطمینان از نرمال بودن داده‌ها و داشتن شرایط تجزیه و تحلیل، آزمون تجریه واریانس (آزمون دانکن) در سطح ۰/۰۵ استفاده گردید. نتایج نشان داد که ۲۱ ترکیب شیمیایی در اسانس گیاه کاه‌مکی وجود دارد. بالاترین میزان CP، DMD، WSC، CF، ADF، NDF و خاکستر کل به ترتیب ۴/۸۳، ۴۸/۰۳، ۱۴/۹، ۷۶/۶۳، ۵۰/۱۲، ۸۴/۵۹ و ۳/۹۸ درصد بدست آمد. نتایج حاکی از آن بود که استخراج اسانس اثرات معنی‌داری بر شاخص‌های کیفیت علوفه دارد و بیشترین مقدار NDF، ADF و CF بعد از اسانس‌گیری بود در حالیکه بیشترین مقدار CP، WSC و DMD قبل از اسانس‌گیری بود. در نتیجه می‌توان اذعان داشت؛ اسانس‌گیری، کیفیت علوفه را در گیاه کاه‌مکی کاهش می‌دهد. بنابراین در صورت استفاده از آن برای چرای دام پیشنهاد می‌شود این گیاه در قبل از مرحله‌ی اسانس‌گیری توسط دام چرا شود.

کلمات کلیدی:کاه مکی، اسانس، ترکیب شیمیایی، کیفیت علوفه