Journal of Agricultural Sciences
Vol. 60, No. 3, 2015
Pages 369-380

DOI: 10.2298/JAS1503369G
UDC: 633.93:582.749.1(55)
Preliminary communication

THE POSSIBILITY OF CROP CULTIVATION AND UTILIZATION OF EDIBLE GUM FROM HERB (*DOREMA AMMONIACUM* D. DON) IN DRYLAND FARMING

Barat Ali Gholami and Mahdi Faravani*

Agricultural and Natural Resources Research Center of Mashhad,
P.O. Box 91735-488, Mashhad, Iran

Abstract: Gum ammoniacum (*Dorema ammoniacum* D. Don) is one of the most important food, industrial and medicinal plants of Iran which is mainly distributed in semi-arid and desert areas**.** It is endangered due to superfluous and unsustainable harvesting methods. The objective of this study was to evaluate the possibility of crop cultivation in terms of dryland farming and the best operation method for collecting gum resin. For this purpose, the effects of different scarification methods (traditional, concave and staircase) and cut-off frequencies (5, 10 and 13 times) on gum yield of the five-year-old plants were studied at Toroq farm in Mashhad. The treatments were studied under a split plot structure in time experiment which was arranged in a completely randomized design with three replications. The rate of the root gum production and the rate of plant survival in the years after the withdrawal were measured, and finally the data were analyzed. Results showed no significant differences among cutting methods at $p<0.05$. The yield of gum was affected by times of harvesting and the highest yield was observed ($p<0.01$) in 13 cut-off times with 31.67 g/plant. The lowest gum yields were seen in 5 cut-off times with 5.84 g/plant. The traditional cutting method destroyed crown buds and caused the death of the plant ($p<0.01$). Reasonable gum yields and plant regeneration rates were obtained with the use of stairs method which is an easy method to be applied by the farmers or beneficiaries.

Key words: ammoniacum, gum, crop cultivation.

Introduction

Gums and resins, forming an important group of non-wood products of forest and medicinal plant products, are considered as the byproducts or end products of certain metabolic pathways. Gum is produced by a large number of plants of Apiaceae family such as asafetida, galbanum and ammonicum (Iranshahi, 2007).

*Corresponding author: e-mail: mfaravani@gmail.com

Its allelopathic properties may suppress subsequent crop growth (Azizi et al., 2009).

The genus Dorema (Apiaceae) is represented in the flora of Iran with seven species among which *Dorema glabrum* Fisch. C.A. Mey, *D. aucheri* Boiss and *D. ammonicum* D. Don are endemic (Rajani et al., 2002; Mozaffarian, 2003). *D. ammonicum* D. Don is a perennial species growing up to 2.5 m in some locations in semi-arid and desert areas of Iran**.** It is distributed in the provinces Kerman, Isfahan, Tehran, Sistan Baluchestan, Khorasan and Semnan (Mozaffarian, 2012). Mohamadabad Ghaen is one of the main and most important natural habitats of *Dorema ammoniacum* for resin production in South Khorasan in Iran (Figure 1).

Figure 1. One of the main habitats of *Dorema ammoniacum* D. Don in Mohamadabad Ghaen, South Khorasan.

Gum ammoniacum with hermaphrodite and self-fertile flowers prefers loamy, acid neutral or alkaline soils. Furthermore, it can grow in semi-shade conditions. Twenty-nine compounds were identified and quantified in ripe fruits of *D. ammoniacum*, representing 95.1% of the total oil. (Z)-Ocimenone (22.3%) and (E)-ocimenone (18.1%) were the main components of the oil. The extract of ammoniacum gum shows antimicrobial activities. It is known as an aromatic gum resin (Iranshahi et al., 2007; Rajani et al., 2002), produced when the plant is stung by a beetle. They are present either in the intercellular space (ducts or cavities) of the root and crown parts or as exudates produced due to injury. The cavities formed

due to injury are called traumatic ducts/cavities. The amount of volatile oil Ammoniacum (0.1-0.3%) is less than the amount either asafoetida (6-17%) or galbanum (10.6-32.8%) contains (Ghannadi and Amree, 2002; Khajeh et al., 2005). Its gum resin, being bitter, nauseous, and acrid, is used in the traditional medicine and is widely used in food, cosmetic and detergent industries (Pereira, 1854; Flannery, 1969).

The use of chemical tapping methods like ethephon (2 chloroelhyl phosphonic acid), a plant growth regulator, increases exudation of gum/gum resin in certain plants such as *Acacia nilotica*. Such methods have been suggested for the sustainable yield, regeneration and survival of the tapped trees (Raj, 2014).

The optimum temperature for this plant was observed at 30^{o}C, and an increase in the temperature decreased the germination percentages of the seed. Besides, the lowest germination percentage (0%) was recorded at 15^{o}C (Ghasemi Arian et al., 2009).

Millions of people worldwide, especially in the developing countries, depend on the collection of gums, resins and latex as a means for their livelihood. Over-tapping leads to the death of the tapped plants and erratic supply of these products in the market (Nair, 2000). In Iran, commercial tapping of gum and resin is done by blazing or making deep cuts on the crown and root of some plants such as *Ferula assa-foetidam, Dorema amoniacum* and *Ferula gummosa* (Askarzadeh, 2000; Behpour et al., 2011).

A study of the effect of different methods of cutting on gum yield and *Ferula assa-foetida* survival showed that sap rate was changed from 19.6 to 62.9 g per plant by different cutting methods and times of cutting (Omidbeygi and Pirmoradei, 2006). Shad (1995) reported that four cuts at harvesting period and a 6-day interval between cutting and collection is the best collection method with 5.28 g/plant gum yield. Salar et al. (2006) mentioned that the best harvesting age for this plant is when the plant is 5 years old or older. Regarding gum yield, Askarzadeh (2000) observed a non-significant difference between different cutting methods in gum yield. Habitats of this species are seriously disturbed by conversion of natural ecosystems to rain-fed farms. Domestication and recovery of natural habitats by seed planting can be a suitable strategy to conserve and regenerate the valuable endangered medicinal plant where the wild source plant is not enough to provide the gum for consumers and additional incomes for local farmers (Cronk et al., 2001). The aim of this study was to evaluate the possibility of crop cultivation in terms of dry land farming and the best operation method for collecting gum resin.

Material and Methods

The main habitats of *Gum ammoniacum* were identified in August according to the latest researches and field work in South Khorasan province. The sample

plants were selected in Mohmadabad area in Ghaen for the field studies.

A field experiment was conducted under dry farming conditions with the factor of scarification methods (traditional, staircase and concave) based on a completely randomized design with three replications (Figure 2). Times of cutting (5, 10 and 13 times) were applied for resin harvesting on each selected plant. A split in time experiment was performed to analyze the effect of scarification methods at three different times during the growing season.

Seeds were planted at soil depth of 1-2 cm in the plot with an area of 4 x 2 m^2 with row-spacing of 50 cm, plant spacing of 40 cm in mid-December after determining the germination test in the laboratory.

Figure 2. Field of *Gum ammoniacum* in dry farming system.

Plants were thinned at two-leaf stage in mid-April. In the fifth year after planting, there was the possibility of harvesting the gum. In order to study the effects of treatments, plants were selected randomly and marked in the plots. Some growth characteristics such as number of leaves, plant canopy and collar diameters were measured before applying the harvest treatments. A wooden cover was laid above the hole after carving out around the crown or root of the plant to avoid evaporation from cut parts. Then, the scarification treatments were applied on the five-year-old plants (Figure 3).

The gum resin was harvested 3-4 days after cutting. The harvest gum and its cumulative amount of product were measured every time in each plant. The regeneration of the plants was checked and recorded in the following years.

Figure 3. A wooden cover was laid above the hole after carving out around the crown to avoid evaporation from cut parts.

Results and Discussion

The results of the analysis of variance (ANOVA) showed a significant ($p \leq 0.01$) effect between the times of cutting ($p \leq 0.01$) on gum yield and a non-significant ($p < .05$) effect between different scarification methods (traditional, staircase and concave).

Based on the Duncan's new multiple range test (MRT), no differences for the yield of gum between traditional scarification (12.95 g/plant) methods, concave (10.89 g/plant) and staircase (10.78 g/plant) methods were observed.

The traditional methods, causing more damage to the layers of plant root in the time of cutting, affect the opening of the urethra and the increased secretion of gum up from the root after each cutting (Figure 4). However, the cumulative gum yield was not significantly different ($p < 0.01$) from other harvesting methods. The following pictures show the situation of the gum under the status of the different scarification methods (Figures 5-7).

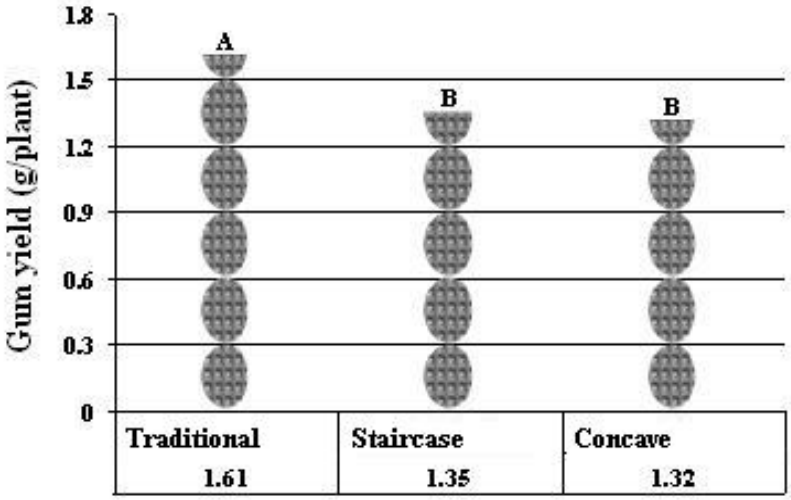

Figure 4. Gum resin yield of Gum ammoniacum using different cutting methods compared by the Duncan's new multiple range test (MRT).

Figure 5. The situation of secretion of gum from the root in June-July by the traditional method.

Figure 6. The situation of secretion of gum from the root in June-July by the concave method.

Figure 7. The situation of secretion of gum from the root in June-July by the concave method. There is lack of damage to the growing bud and crown when using the concave scarification method for gum harvesting.

Times of scarification

Times of cutting and cut-off frequency influence the amount of damage to plant roots, secretion of gum, gum harvesting and finally plant survival (Gholami and Faravani, 2014). The results of this study showed a significant difference ($p<0.05$) between various cut-off frequencies (5, 10 and 13 times) on the gum yield. With an increase in the frequency of the cut-offs, the harvested cumulative gum was raised from 5.84 g/plant in 5 cut-off times to 16.67 g/plant in 13 cut-off times (Figure 8).

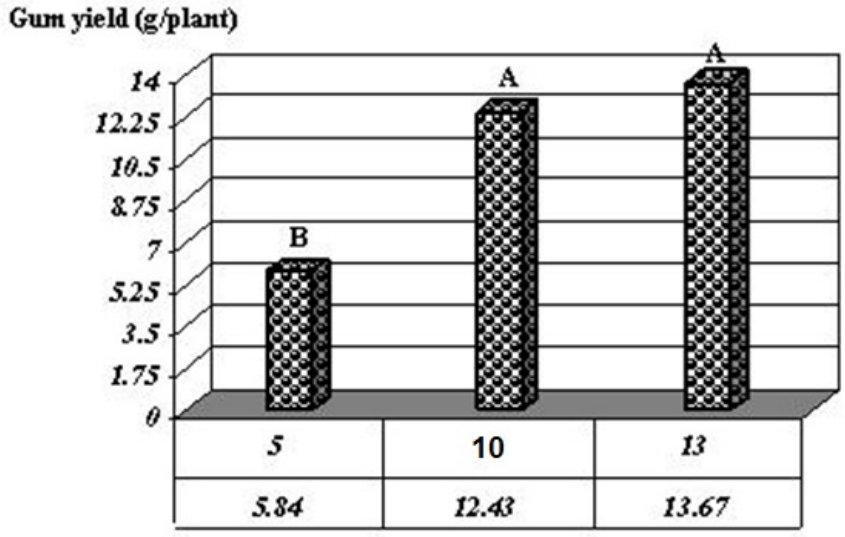

Figure 8. Effect of different cut-off frequencies (5, 10 and 13 times) on gum yield of plant during an annual harvesting period.

Duncan's new multiple range test (MRT) has been done on the data to get more details. Results revealed that the highest gum production could be increased by times of cut-off frequencies up to 4-6. However, the secretion of gum gradually decreased in the plant root system in 12-13 cut-off times (Figure 9).

The highest plant survival and regeneration percentages of plant after the fifth year were observed in the control concave, and staircase cutting methods, respectively (Figure 10). The lowest regeneration (0-8.3%) was observed in the traditional cutting method with 13 times of cutting. Based on the obtained results, the traditional method was mostly applied by local people to provide high gum yield. In addition, this method not only destroys the crown buds of the plant but

also hinders the plant survival in the next year. The best harvesting method which provides a considerable yield and also gives a chance to plants for regeneration and surviving is concave or staircase harvesting method with 5-6 cutting times. Gum production is influenced by tapping intensity, rainfall, and minimum and maximum temperatures at tapping time (Ballal et al., 2005; Raj, 2014).

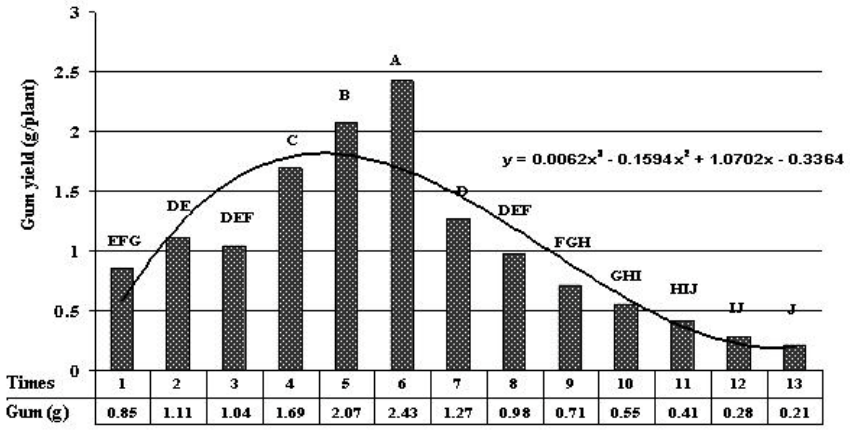

Figure 9. The best cut-off frequencies for gum production (g/plant).

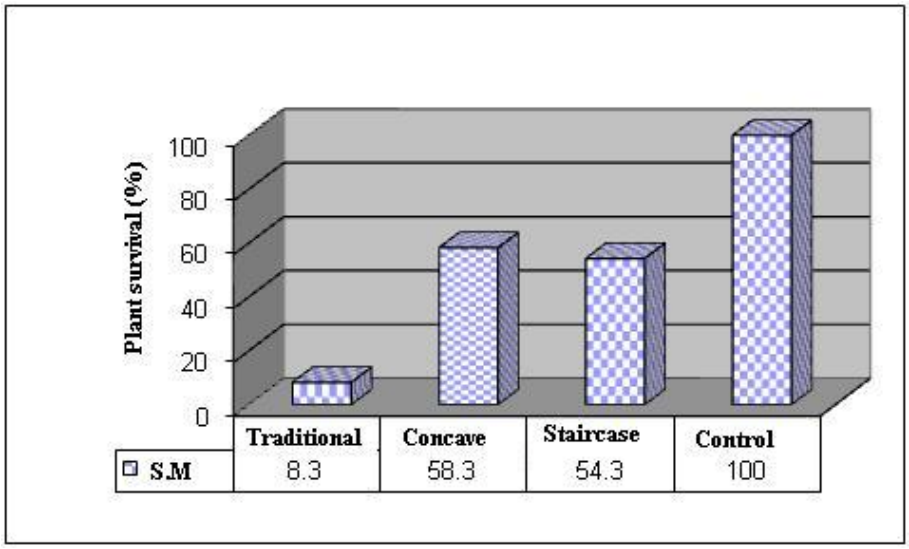

Figure 10. Effect of different cutting methods on plant survival (%).

The results confirm the findings of Shad's study (1995), who reported that four cut-offs at harvesting period with a 6-day interval between cutting and harvesting were the best collection method. He indicated that the new method of cutting increased the gum yield per plant from 2.150 g/plant by the conventional method to 3.546 g/plant. Nonetheless, Askarzadeh (2000) observed no significant differences in gum yield between different cutting methods.

Conclusion

This study recommends that 5-6 times of cutting and concave method can be highly useful for plant survival and gum production in order to sustain the production. Further studies are needed to understand how to introduce Gum amoniacum in the cropping systems with more details on the application of organic fertilizer and their interactions with cutting methods, times of cutting and gum yield.

Acknowledgements

We are grateful to Khorasan Agriculture and Natural Resources Research Center for the financial support.

References

Askarzadeh, M.A. (2000): Investigation on destruction effects of harvesting methods on survival and regeneration of *Ferula Gummosa* in Khorassan province. In final reserach report, Khorasan Razavi Agriculture and Natural Resources Reserach Center. Mashhad, Iran, 75 pp.

Azizi, M., Amini, S., Joharchi, M.R., Oroojalian, F., Baghestani, Z. (2009): Genetic resources for allelopathic and medicinal plants from traditional Persian experience. MARCO Symposium (Challenges for Agro-Environmental Research in Monsoon Asia), Tsukuba, Japan.

Ballal, M.E., Siddig, E.A El., Elfadl, M.A., Luukkanen, O. (2005): Relationship between environmental factors, tapping dates, tapping intensity and gum arabic yield of an *Acacia senegal* plantation in Western Sudan. Journal of arid environments 63(2):379-89.

Behpour, M., Ghoreishi, S.M., Khayatkashani, M., Soltani, N. (2011): The effect of two oleo-gum resin exudate from *Ferula assafoetida* and *Dorema ammoniacum* on mild steel corrosion in acidic media. Corrosion Science 53(8):2489-501.

Cronk, Quentin C.B., Fuller, Janice L. (2001): Plant Invaders: The threat to natural ecosystems (people and plants conservation). Earthscan Publications Ltd. California (Simi Valley, CA, U.S.A.), 256 pp.

Flannery, K.V. (1969): Origins and ecological effects of early domestication in Iran and the near East [in not specified]. Gerald Duckworth & Co., London. http://www.cabdirect.org/abstracts/19701602489.html;jsessionid=F922125B248428A0392C67DBC5EB6D3E.

Ghannadi, A., Amree, S. (2002): Volatile oil constituents of *Ferula gummosa* Boiss. from Kashan, Iran. Journal of Essential Oil Research 14:420-421.

Ghasemi Arian, A.R., Izadi, J., Afkham, S., Alshoara M.R, Ejlali R. (2009): Germination

improvement in seeds of gum Ammoniac (*Dorema ammoniacum*). Iranian Journal of Range and Desert Research 15(33):455-63.

Gholami, B.A., Faravani, M. (2014): Effects of different cutting methods and times of cutting on growth performance and gum resin production of *Ferula assa-foetida*. Journal of Agricultural Sciences 59(1):35-44.

Iranshahi, M., Shaki, F., Mashlab, A., Porzel, A., Wessjohann, L.A. (2007): Kopetdaghins a−E, sesquiterpene derivatives from the aerial parts and the roots of *Dorema kopetdaghense*. Journal of Natural Products 70(8):1240-43.

Khajeh, M., Yamini, Y., Bahramifar, N., Sefidkon, F., Pirmoradei, M.R. (2005): Comparison of essential oils compositions of Ferula assa-foetida obtained by supercritical carbon dioxide extraction and hydrodistillation methods. Food Chemistry 91: 639-644.

Mozaffarian, V. (2003): Dictionary of Iranian plant names. Farhang Moaser. Tehran.

Mozaffarian, V. (2012): Knowledge of medicinal and aromatic plants of Iran. (1): Farhang Moaser. Tehran.

Nair, B. (2000): Sustainable utilization of gum and resin by improved tapping technique in some species. In harvesting of non-wood, 293. FAO, Italy. http://www.fao.org/docrep/019/y4496e/y4496e.pdf.

Omidbeygi, R., Pirmoradei, M. (2006): A Study of the effect of root diameter and incision time on gum yield in medicinal-Rangeland Asafoetida Plant (*Ferula assa-foetida* L.). Iranian Journal of Natural Resources 59:269-61.

Pereira, J. (1854): The elements of materia medica and therapeutics (2): Blanchard and Lea. http://archive.org/stream/101507665X1.nlm.nih.gov/101507665X1_djvu.txt (Accessible in 2014).

Raj, A. (2014): Effects of temperature and relative humidity on ethephon induced gum exudation in Acacia nilotica. Asian Journal of Multidisciplinary Studies 2(10): 114-16.

Rajani, M., Saxena, N., Ravishankara, M.N., Desai, N., Padh, H. (2002): Evaluation of the antimicrobial activity of Ammoniacum gum from *Dorema ammoniacum*. Pharmaceutical Biology 40(7):534-541.

Salar, N.A., Aldin, H., Taherian, K. (2006): A survey on cultivation and propagation methods of *Ferula gummosa* in Semnan province. Journal of Pajouhesh and Sazandegi 53:90-97.

Shad, G. (1995): Avetochology of *Ferula assa foetida* and an investigation on its harvesting methods in Mohammad Abad region of Chelpo, University of Gorgan. Kashmar, Iran.

Received: November 16, 2014
Accepted: February 09, 2015

MOGUĆNOST UZGAJANJA I ISKORIŠĆAVANJA JESTIVE GUME IZ BILJKE (*DOREMA AMMONIACUM* D. DON) U USLOVIMA SUVOG RATARENJA

Barat Ali Gholami i Mahdi Faravani*

Istraživački centar za poljoprivredne i prirodne resurse u Mešhedu,
P.O. Box 91735-488, Mešhed, Iran

R e z i m e

Guma ammoniacum (*Dorema ammoniacum* D. Don) je jedna od najvažnijih prehrambenih, industrijskih i lekovitih biljaka u Iranu koja je uglavnom rasprostranjena u semiaridnim i pustinjskim regionima**.** Ugrožena je usled neracionalnih mera ubiranja. Cilj ovog istraživanja je bio da se proceni mogućnost uzgajanja ovog useva u uslovima suvog ratarenja i ispitivanja najboljeg metoda rada za sakupljanje smole gume. Stoga su proučavani uticaji različitih metoda skarifikacije - zasecanja (tradicionalni, konkavni, stepenasti) i učestalosti zasecanja (5, 10 i 13 puta) na prinos gume petogodišnjih biljaka na farmi Torok u Mešhedu. Tretmani su ispitivani u eksperimentu postavljenom po planu podeljenih parcela koje su raspoređene po potpuno slučajnom rasporedu u tri ponavljanja.

Mereni su uspešnost proizvodnje gume iz korena i stepen preživljavanja biljaka u godinama posle zasecanja, a dobijeni podaci su analizirani. Rezultati istraživanja nisu pokazali značajne razlike među metodama zasecanja ($p<0,05$). Prinos gume je bio uslovljen učestalošću zasecanja i najviši prinos je dobijen ($p<0,01$) kod 13 zasecanja sa 31,67 g/biljci. Najniži prinosi gume su dobijeni kod 5 zasecanja sa 5,84 g/biljci. Tradicionalan metod zasecanja je uništio pupoljke i izazvao uginuće biljke ($p<0,01$). Odgovarajući prinosi gume i stepen regeneracije biljaka koji su bili postignuti upotrebom metode stepenastog zasecanja, te mogućnost jednostavne primene ovog metoda uzgoja preporučuju ga za poljoprivrednu (farmersku) proizvodnju i ostale korisnike.

Ključne reči: ammoniacum, guma, uzgajanje useva.

Primljeno: 16. novembra 2014.
Odobreno: 9. februara 2015.

*Autor za kontakt: e-mail: mfaravani@gmail.com