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Chemical, Bioactive and antioxidant properties of Alhydwan (*Boerhavia elegana Choisy*) Seeds- A review

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Abstract: In recent years, consumers have turned to natural foods, but this is not the case. Since synthetic preservatives are harmful to health, consumers demand partial or complete replacement of synthetic preservatives. Because of this, there is an increasing demand for the development of more natural alternatives to improve food shelf life and safety. Strategies for natural protection are gaining popularity in food mapping. New preservation methods focus on using environmentally friendly organic plants with antioxidant and antimicrobial properties to extend the safety and shelf-life of food. Since ancient times, medicinal plants have been used in almost all cultures to treat many ailments around the world. The genus *Boerhavia* is found around the world in tropical, subtropical in nature and temperate climates, including Mexico, as well as the United States, Africa, Asia, Indian Ocean islands, Pacific islands, and Australia. *Boerhavia* plants are widely used by locals and physicians to treat hepatitis, urinary tract disorders, gastrointestinal disorders, inflammation, skin problems, infectious diseases and asthma. This review focuses on the bioactive compounds of *Boerhavia elegana Choisy*.

Keywords: *Boerhavia elegana Choisy*, chemical content, Antioxidant compounds.

الخصائص الكيميائية والحيوية والمضادة للأكسدة لبذور الحيدوان *Boerhavia elegana Choisy* - مراجعة

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المستخلص: في السنوات الأخيرة، تحول المستهلكون إلى الأطعمة الطبيعية، نظرًا لأن المواد الحافظة الصناعية ضارة بالصحة، فإن المستهلكين يطالبون باستبدال جزئي أو كامل للمواد الحافظة الصناعية. أدت هذه الحقيقة إلى اهتمام متزايد بتطوير المزيد من البدائل الطبيعية لإطالة مدة صلاحية الطعام وسلامته. تركز طرق الحفظ الجديدة على استخدام نباتات عضوية صديقة للبيئة ذات خصائص مضادة للأكسدة ومضادة للميكروبات لتحسين العمر الافتراضي للأطعمة وسلامتها. منذ العصور القديمة، استخدمت النباتات الطبية في جميع الثقافات تقريبًا لعلاج العديد من الأمراض في جميع أنحاء العالم. ينتشر جنس *Boerhavia* على نطاق واسع في المناطق الاستوائية وشبه الاستوائية والمعتدلة في العالم، بما في ذلك المكسيك وأمريكا وأفريقيا وآسيا وجزر المحيط الهندي وجزر المحيط الهادئ وأستراليا. يستخدم السكان المحليون والأطباء نباتات *Boerhavia* على نطاق واسع لعلاج التهاب الكبد واضطرابات المسالك البولية واضطرابات الجهاز الهضمي والالتهابات ومشاكل الجلد والأمراض المعدية والربو. تركز هذه المراجعة على المركبات النشطة بيولوجيًا للحيدوان.

الكلمات المفتاحية: بذور الحيدوان، المحتوى الكيميائي، المركبات المضادة للأكسدة.

Introduction:

The primary purpose of food consumption is to provide essential nutrients to the body. However, a recent trend has emerged in the development of functional foods that possess additional properties that contribute positively to health (Brown *et al.*, 2018, Ra *et al.*, 2019). This trend has been accompanied by increased demand and preference for functional foods among consumers. The advantages of functional foods are numerous, including the enhancement of the immune system, improvements in the gastrointestinal system, and the prevention of various diseases and disorders such as lactose intolerance, gluten intolerance, diabetes, and hypercholesterolemia (Terpou *et al.,* 2019).

Nowadays, there is an increasing demand by consumers for functional food characterized by its health-promoting activities. Functional foods are designed to be taken as part of a regular diet and contain components with biological activity that have the potential to improve health or lower the risk of serious illnesses. This increasing demand resulted from a deep understanding of the relationship between food, nutrition, and health. Most of the food consumers require contains bioactive components such as polyphenols, antioxidants, prebiotics and probiotics (Lourens-Hattingh and Viljoen, 2001). These active components can be provided from materials such as plants, especially seeds, as well as food processing waste, especially dairy factories. Those functional properties can contribute to microbial safety or other one or more organoleptic, technological or nutritional and health advantages to the food (Beltrán-Barrientos *et al.*, 2016) . However, there is increasing focus on plant seed sources that have been shown to confer health and nutritional benefits to consumers in some way (Su et al., 2014). In recent years, promising plant species have been increasingly used as sources of edible or specialty oils (Jelassi et al., 2014).

Boerhavia elegana Choisy (familiar name: Alhydwan) is a nutritious herbaceous member of the Nyctaginaceae family native to southerly Yemen (Boulos, 1988). It is commonly used by indigenous tribes in the traditional cuisine of southern Yemen and is one of the key ingredients in making porridge. Where Alhydwan seeds are ground, added to the wheat flour, mixed with water and salt, and the mixture is cooked with continuous stirring until the porridge is formed. The porridge is poured into a bowl with the possibility of adding broth or butter or ghee and honey to the surface of the porridge. Also, alhydwan flour was used as an addition to bread and cake mixes and is characterized by its good taste and which increases the nutritional value, improves the dough properties and aroma of the product (Ammar et al., 2020), as well as an ingredient in desserts and savory products. However, some species of the genus *Boerhavia* are widely used in traditional medicine in many countries (Olaleye et al., 2010) (Fig. 1).

Figure .1. Alhydwan seeds (A); alhydwan flour (B)

Boerhavia (Nyctaginaceae)

The genus has around forty species, virtually all of which are found in tropical and subtropical climates on gravelly plains or rocky slopes (Fosberg, 1978; Spellenberg, 2012). In Iran, three species are found: *Boerhavia repens*, *Boerhavia diffusa*, and *Boerhavia elegana*, which grow in warmer portions of the country's east and southeast at elevations of up to 2000 meters (Zargari, 1987; Ghahraman, 2004). The *Boerhavia* genus comprises approximately forty species, predominantly found in tropical and subtropical regions on gravelly plains or rocky slopes (Fosberg, 1978; Spellenberg, 2012). Although the antimalarial effects of *Boerhavia elegana* have been published by Ramazani et al. in 2010, other biological properties of these species have not been recorded in the literature.

Therefore, this study is the first to evaluate the antioxidant activity of the plant and determine the phenolic content of its various extracts (Fosberg, 1978).

Boerhaivia elegana description:

Boerhaivia elegana is a perennial, erect, bare shrub to 1 m in height with a robust rhizome. Its fleshy stem is woody towards the base, dark green, frequently sanguine-red, rough to pubescent, raying substantially from the base with abdominal bumps. Leaves broadly ovate-lanceolate or linear-lanceolate, gray-green above, gray-white below pubescent, petiole 1 cm long or absent; peduncle or short stalk (Ghahraman, 1996**;** Chen et al., 2007; Ramazani et al., 2010**;** Mahesh et al., 2012). Flowers solitary or in pairs, 2.5-3.5 mm long, with long peduncles, cetacean, glabrous. The fruit of this herbaceous plant is characterized by: oblong, club-shaped, pentagonal, hairy, and grooved (Parsa, 1980). In addition, the fruits of this species are high in mucilage when wet (Spellenberg, 2012). The native range of this species is Niger to Arabian Peninsula, Iran to India. It is a subshrub or shrub and grows primarily in the desert or dry shrubland biome (Fig.2).

Figure .2. Plants of Boerhavia elegans Choisy

Chemical content:

Al-Hayadawan seeds are considered a good source of calories. We all know that calories are a measure of energy, they can be used incontinently or stored after use, food also contains calories. Food serves as a primary source of energy for the body, as it is broken down during the process of digestion. This energy is then utilized by cells to carry out various functions, such as the synthesis of proteins and other essential substances required by the body. (Duyff and Ada, 2011). In a study conducted by Al-Farga et al. (2015 and 2016), they were determined the proximate composition of Al-Hayadawan seeds (Table 1). They explained in their study that the moisture content was 6.12%, while the crude protein, crude fat, fiber, ash and carbohydrates were found to be 14.6%, 11.49%, 36.13%, 6.88% and 30.77%, respectively. Their study has clarified that protein content was higher than that of cereal crops and eggs. Also they found that Al-Hayadawan seeds have higher fat and ash content. The percentage of fat in the seeds was higher than that contained in both corn and millet. While the high ash content reflects the presence of large quantities of minerals, and it is higher than cereals and animal meat. Additionally, Al-Hayadawan seeds have almost all the essential amino acids except tryptophan and amino acid concentration is similar to that found in whole wheat flour Farga et al. (2016) (Tabte 2). For minerals, Farga et al. (2016) found that seeds were an incredible natural source for calcium and potassium, seeds had higher content of these minerals (Table (3)). These minerals can be used for supplementation of pregnant and lactating women, as well as for children and elderly people (Farga et al., 2016). Also zinc and iron found to be the most highly concentrated trace elements. From the above it is clear that how nutritionally important of Al-Hayadawan seeds are, as they contain important minerals for the body's vital activity.

Table 1: The chemical composition of Al-Haydawan seeds (Farga et al., 2016).

	chemical composition (%)					
	moisture	protein	fat	fiber	ash	carbohydrates
Al-Hayadawan seeds	6.12	14.60	11.49	36.13	6.88	30.77

Table 2: Essential amino acid composition of Al-Haydawan seeds (g/100 g protein). (Farga et al., 2016).

	Essential amino acid							
	Histidine	Threonine	Valine	Methionine	Phenylalanine	Isoleucine	Leucine	Lysine
Al-Hayadawan seeds	0.33	0.46	0.58	0.15	0.49	0.45	0.75	0.55

Table 3: Minerals contents of Al-Haydawan seeds (mg/100 g). (Farga et al., 2016).

	Minerals							
	Calcium	Potassium	Magnesium	Iron	Manganese	Copper	Zinc	Sodium
Al-Hayadawan seeds	655.0	595.0	109.5	3.8	0.73	0.44	1.72	26.15

Farga et al. (2016) reported how the importance of Al-Hayadawan seeds as a source of water-soluble vitamins such as thiamin (B1), riboflavin (B2) and niacin (B3) (Table 4). They reported that Al-Hayadawan seeds have higher contents of thiamin and riboflavin if compared with legumes and wheat. While niacin was equal or slightly lower. Carbohydrates contents of Al-Hayadawan seeds are presented in Table 5. Study of Farga et al. (2016) stated that Al-Hayadawan seeds had mono and disaccharides such as sucrose, fructose, maltose, glucose, xylose, galactose and arabinose. The most abundant sugar was glucose (71.3%) and the lowest was arabinose (2.00%) (Table 5).

Table 4: B vitamin contents of Al-Haydawan seeds (mg/100 g). (Farga et al., 2016).

	B vitamin		
	Thiamin	Riboflavin	Niacin
Al-Hayadawan seeds	19.3	8.2	2.3

Table 5: The carbohydrate contents of Al-Hayadawan seeds (Farga et al., 2016).

	Mono and disaccharides Portion in total (%)						
	Sucrose	Fructose	Maltose	Glucose	Xylose	Galactose	Arabinose
Al-Hayadawan seeds	71.3	9.93	6.5	50.5	2.76	2.42	2.00

Farga et al. (2015) analyzed *B. elegana* for oil (11.49%), organic matter (6.88%), and dietary fiber (36.13%). The ether-extracted oil from the leaves of *B. elegana* was found to contain a significant amount of oleic acid (57.77%), palmitic acid (18.65%), and linoleic acid (12.88%).

Antioxidants:

Antioxidants are crucial in safeguarding individuals against both infectious and degenerative ailments. These antioxidants can be classified into two main categories: natural and synthetic. Certain synthetic antioxidants, such as butylated hydroxyanisole and hydroxytoluene, are readily accessible in the market and are utilized in food products at concentrations ranging from 50-200 ppm. They have many side effects such as: B. Oncogenic mutagenicity in humans (Ebrahimzadeh et al., 2008; Ghanbari et al., 2006). Natural antioxidants are safe and biologically active. Phenolic compounds are a class of natural antioxidants that possess the ability to neutralize oxygen free radicals by donating hydrogen atoms or electrons to these radicals. These compounds also exhibit anti-inflammatory, anticancer, and atherosclerotic properties, as reported by Sonboli et al. (2010) and Huang et al. (2009). Consequently, there has been a surge in research aimed at identifying plants with potent antioxidant activities that can be utilized in the treatment of diverse human ailments, as highlighted by Jayavelu et al. (2013). Figure (3) shows examples of some extracted bioactive compounds by various solvents (Kumar et al., 2019). While table 6 and 7 show the antioxidant activity using different solvents and the total phenolic content in different parts of Al-Hayadawan plant as illustrated by Sadeghi et al. (2015).

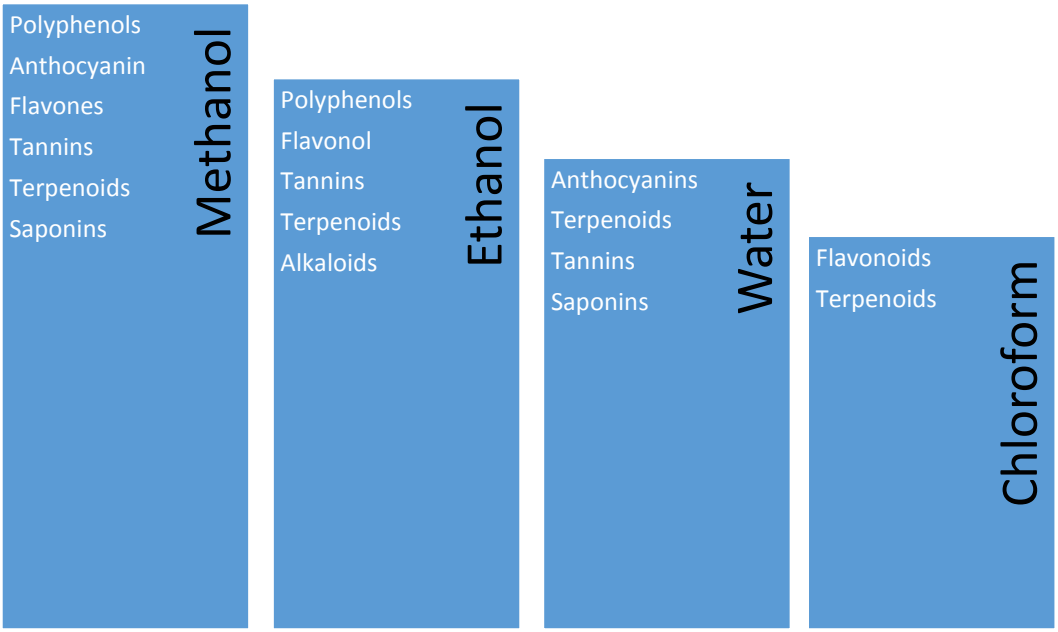

Figure (3): Examples of some bioactive compounds as extracted by various solvents (Kumar et al., 2019).

Table 6: Antioxidant activity as IC50 (µg/mL) for DPPH assay or FE (µg/mL) for FRAP assay of B. elega

Parts of the plant	Extract	DPPH IC50 (µg/ml)	FRAP
leaf	Water	24.76	36.63
	Methanol	6.85	56.18
	EthylAcetate	44.33	24.64
	Chloroform	189.33	15.33
stem	Water	27.12	30.58
	Methanol	9.70	47.79
	EthylAcetate	50.79	24.64
	Chloroform	240	23.65
fruit	Water	26.18	33.50
	Methanol	8.83	50.92
	EthylAcetate	48.17	23.93
	Chloroform	223.60	10.43
seeds	Ethanol	2.42	-

Sadeghi et al., (2015) and Al-Farga et al., (2014).

Table 7: Total phenolic content expressed as mg Gallic Acid/g D.w (dry weight)

Total phenolic contents			
Leaf	Stem	Fruit	seeds
16.41	12.48	14.31	253.9

Sadeghi et al., (2015) and Al-Farga et al., (2014).

Al-Farga et al., (2014) reported that ethanol extracts of *B. elegana* seeds, measured with the Foline- Ciocalteu reagent, had higher phenolic content in terms of Gallic acid equivalent (253.9 ± 0.9 mg/g) and flavonoid content Calculated on the basis of catechol equivalent (23.68 ± 0.6 mg/g). Phenolic content of this plant are important constituent with valuable pharmacological effects. Flavonoids are known to have antioxidant effects that have major implications for human nutrition and health. Seed extract and reference antioxidant (ascorbic acid) promoted inhibition of 2,2-Diphenyl-1-picrylhydrazyl (DPPH) free radicals with increasing concentrations. The ethanol extract of *Boerhavia elegana* seeds had a significant inhibitory effect on DPPH, and at the highest

concentration, the inhibitory effects of the seed extract and the standard antioxidant (ascorbic acid) were as high as 87.00% and 92.3%, respectively. The IC50 of the sample was (2.42), while the IC50 of the control was (1.47). The high phenolic component value of *Boerhavia elegana Choisy* seeds is compatible with a study on the roots of several species of *Boerhavia diffusa* (Khalid et al., 2011). Furthermore, the total phenol level discovered is higher than the findings reported by Rocha-Guzmán et al., (2007), who investigated total phenol content in three distinct types of common bean. Polyphenolic substances are antioxidants that may aid in preventing oxidative stress-related disorders such as atherosclerosis, cancer, and neurological diseases. In 2015, Sadeghi et al. conducted a study on the antioxidant power of various extracts from different parts of a plant. The results indicated that the methanolic extract exhibited the highest activity in both the 2,2-Diphenyl-1-picrylhydrazyl (DPPH) and ferric reduction activity potential (FRAP) assays, followed by the aqueous, ethyl acetate, and chloroform extracts, in decreasing order. The methanolic extract of the leaf also had the highest phenolic content, with an IC50 of 6.85 ppm and 16.41 mg GA/g d w, as determined by the Folin-Ciocalteu method. The study found a positive correlation between total phenolic content and antioxidant capacity in the extracts, with a high correlation coefficient of r=1.00 and a significance level of $p<0.05$.

Table 7. Important plant Seeds in Bioactive Properties Benefits and effective antioxidant

Plant seeds	References
Anise (Pimpinella anisum L.) seeds have different properties such as antioxidant, antibacterial, antiviral, antifungal, and insecticidal.	**Lee, (2005)- Goksen and Ekiz (2021)**
Basil seeds (Ocimum basilicum L.) have important health benefits, including anticancer, antioxidant, antidiabetic, and antimicrobial effects.	**Gahruie et al., (2019)- Gajendiran et al., (2016)**
The main health benefits of coriander (Coriandrum sativum L.) seeds are antioxidant properties, hypolipidemic effects and anti-atherosclerotic.	**Carrubba et al., (2020)- Sahoo and Brijesh, (2020)**
Chamomile (Matricaria chamomilla L.) seeds contain volatile oils, organic acids, coumarins, flavonoids, sterols, and polysaccharides.	**Shahrajabian et al., (2020)- Rafii et al., (2020)**

The scientific community still lacks substantial data in the literature regarding the biological activities of *B. elegana* and the mechanisms underlying its action, despite its extensive therapeutic use. A study conducted by Ramazani et al. in 2010 aimed to investigate the anti-malaria properties of the crude ethanolic extract of *B. elegana* and found promising anti-plasmodial activity. The results showed that *B. elegana* exhibited high activity against *P. falciparum* strains, with IC50 values of less than 20 µg/ml. Additionally, Ramazani et al. screened the ethanolic extract of *B. elegana* against brine shrimp nauplii and found no significant toxicity, with an LC50 value exceeding 1,000 µg/ml. In comparison to Duxorubicin (10µg/ml, 95% inhibition), *B. elegana* (50µg/ml) demonstrated a 15.14% inhibition on the MCF7 cell line.

Conclusion:

The antioxidant properties *of Boerhavia elegana Choisy* seeds have been demonstrated to be of significant interest. The seed extracts exhibited a robust free radical scavenging effect, as determined by DPPH and ABTS tests, and demonstrated good antioxidant activity through various mechanisms of action, including the FRAP test, b-carotene bleaching test, and Fe2+ chelation test. The seed extract is characterized by a high concentration of phenolics and flavonoids, indicating potent antioxidant properties. These findings suggest that *Boerhavia elegana Choisy* seeds can be utilized not only for food consumption but also as a source of healthy compounds for the development of dietary supplements and protection against oxidative stress. Numerous studies have reported that flavonoids are the most important bioactive compounds in this genus, and their numbers appear to be increasing as research progresses.

References:

- AL-Farga, A., Zhang, H. and Azhari, S. (2014). In vitro antioxidant activity and total phenolic and flavonoid contents of Alhydwan (*Boerhavia elegana Choisy*) seeds. *J. Food Nutr.* Res. 2: 215-220.
- Beltrán-Barrientos, L. M., Hernández-Mendoza, A., Torres-Llanez, M. J., González-Córdova, A. F., & Vallejo-Córdoba, B. (2016). Invited review: Fermented milk as an antihypertensive functional food. *Journal of Dairy Science*, 99(6), 4099-4110.
- Boulos, Loutfy.(1988). "contribution to the flora of South Yemen (PDRY)." Candollea, 43.549-585.
- Brown, L.; Caligiuri, S.P.B.; Brown, D.; Pierce, G.N. Clinical trials using functional foods provide unique challenges. (2018). *J. Funct. Foods*, 45, 233–238.
- Carrubba, A.; Lombardo, A. (2020). Plant structure as a determinant of coriander (Coriandrum sativum L.) seed and straw yield. Eur. J. Agron. 113, 125969.

- Chen, S.H. and. Wu, M.J. (2007). A taxonomical study of the genus *Boerhavia* (Nyctaginaceae) in Taiwan. *Taiwania*. 52: 332-342.
- Duyff, R.L. and Ada, A.F. (2011). American dietetic association complete food and nutrition guide: Houghton Mifflin Harcourt.
- Ebrahimzadeh, M. A, Pourmorad, F., Hafezi, S. (2008). Antioxidant activities of Iranian corn silk. *Turk J Biol*, 32:43-49.
- Fosberg, F. R. (1978). Studies in the Genus *Boerhavia* L. (Nyctaginaceae). Washington D.C., Smithsonian Contributions to Botany.
- Fosberg, F.R. (1999). Nyctaginaceae. In: Wagner, W. L. et al. (eds.), Manual of the Flowering Plants of Hawaii, rev. ed. 1: 976-988. Bishop Museum, Honolulu, USA.
- Gahruie, H.H.; Eskandari, M.H.; Meeren, P.V.D.; Hosseini, S.M.H. (2019). Study on hydrophobic modification of basil seed gum-based (BSG) films by octenyl succinate anhydride (OSA). Carbohydr. Polym. 219, 155−161.
- Gajendiran, A.; Abraham, J.; Thangaraman, V.; Thangamani, S.; Ravi, D. (2016). Antimicrobial, antioxidant, and anticancer screening of Ocimum basilicum seeds. Bull. Pharm. Res., 6, 114−119.
- Ghahraman, A. (1996). Color Atlas of Iranian Flora. Research Institute of Forests and Rangelands Publishing, code 030,001,003. No 2021.
- Ghahraman, A. (2004). Plant systematics: coromophytes of Iran. Vol. 1, pp. 316, Tehran, Iran University Press.
- Ghanbari, R, Ghavami, M., Safafar, H. (2006). Antioxidant potential of methanolic extracts of Rosmarinus officinalis for stabilization of Canola oil, 12-13 April, 16th National Congress of Iran Food Industry, Gorgan, Iran
- Gilbertson, P.K.; Berti, M.T.; Johnson, B.L. (2014). Borage cardinal germination temperatures and seed development. Ind. Crops Prod., 59, 202−209.
- Huang, W. Y., Cai, Y. Z., Zhang, Y. (2009). Natural phenolic compounds from medicinal herbs and dietary plants: Potential use for cancer prevention. Nutr Cancer, 62: 1-20
- Jayavelu, A., Natarajan, A., Sundaresan, S., Devi, K., Senthilkumar, B. (2013). Hepatoprotective activity of *Boerhavia Diffusa L.* (Nyctaginaceae) against Ibuprofen Induced Hepatotoxicity in Wistar Albino Rats. Int J Pharm Res Rev, 2: 1-8.
- Khalid, M., Hefazat, Hussain, S., and Sheeba, F., (2011)."In vitro estimation of the antioxidant activity and phytochemical screening of *Boerhaavia diffusa* root extract." Asian Journal of Traditional Medicines.
- Lourens-Hattingh, A., and Viljoen, B. C., (2001). Yogurt as Probiotic Carrier Food. International Dairy Journal, 11, 1-17.
- Lu, T.; Gaspar, F.; Marriott, R.; Mellor, S.; Watkinson, C.; Al-Duri, B.; Seville, J.; Santos, R. (2007). Extraction of borage seed oil by compressed CO2: Effect of extraction parameters and modeling. J. Supercrit. Fluids, 41, 68−73.
- Mahesh, A. R., Kumar, H., Ranganath, M. K., Devkar, R. A. (2012). Detail study on *Boerhavia diffusa* plant for its medicinal importance- a review. Res J Pharm Sci, 1: 28-36.
- Olaleye, M. T., Akinmoladun, A. C., Ogunboye, A. A., and Akindahunsi, A. A., (2010). "Antioxidant activity and hepatoprotective property of leaf extracts of *Boerhaavia diffusa* Linn against acetaminophen-induced liver damage in rats." Food and Chemical Toxicology, 48. 2200-2205.
- Parsa, A. (1980). Flora of Iran, vol. 4, pp. 1175, Tehran, Tehran University Press.
- Rafii, F.; Ameri, F.; Haghani, H.; Ghobadi, A. (2020). The effect of aromatherapy massage with lavender and chamomile oil on anxiety and sleep quality of patients with burns. Burns, 46, 164−171.
- Rai, A.K.; Pandey, A.; Sahoo, D. (2019). Biotechnological potential of yeasts in functional food industry. Trends Food Sci. Technol., 83, 129−137.
- Ramazani, A., Zakeri, S., Sardari, S., Khodakarim, N., Dinparas Djadidt N. 2010. In vitro and in vivo anti-malarial activity of *Boerhavia elegans* and *Solanum surattense*. Malaria J, 9:124.
- Rocha-Guzmán, N., Herzog, A., González-Laredo, R. F., IbarraPérez, F. J., Zambrano-Galván, G., and Gallegos-Infante, J. A., (2007). "Antioxidant and antimutagenic activity of phenolic compounds in three different color groups of common bean cultivars (Phaseolus vulgaris)." Food chemistry 103; 521-527.
- Sahoo, S.; Brijesh, S. (20200. Anxiolytic activity of *Coriandrum sativum* seeds aqueous extract on chronic restraint stressed mice and effect on brain neurotransmitters. J. Funct. Food., 68, 103884.
- Shahrajabian, M.H.; Sun, W.; Cheng, Q. (2020). Traditional herbal medicine for the prevention and treatment of cold and flu in the autumn of overlapped with COVID-19. Nat Prod Commun. 2020, 15, 1934578X20951431.
- Sonboli, A., Mojarrad, M., Nejad, Ebrahimi, S., Enayat, S. (2010). Free radical scavenging activity and total phenolic content of methanolic extracts from male inflorescence of Salix aegyptiaca grown in Iran. Iranian J Pharmaceut Res, 9: 293-296.
- Spellenberg, R. (2003). Boerhavia. In: Flora of North America Editorial Committee, Flora of North America. 4: 17-28. Oxford Univ. Press, New York, USA.
- Terpou, A.; Papadaki, A.; Lappa, I.K.; Kachrimanidou, V.; Bosnea, L.A.; Kopsahelis, N. (2019). Probiotics in food systems: Significance and emerging strategies towards improved viability and delivery of enhanced beneficial value. Nutrients, 11, 1591
- Zargari, A. (1987). Medicinal plants, University of Tehran Press, 7th edition, 4: 278.