Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (3): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

Halophytes: What are their Defines, Important, and their Strategies to be Live in Saline Habitats? (A Review)

Batool Mohammed Hassan [1] **Shaymaa O. H. Al-Mamoori** [2] **Noor Mahmmoud Naji** [3]

1. Department of Biology, College of Science, University of Babylon, Iraq. batool_aladily@yahoo.com
2. Department of Biology, College of Science, University of Babylon, Iraq.biobiobio16@yahoo.com
3. Department of Biology, College of Science, University of Babylon, Iraq. ommohammoudridha@yahoo.com

Article Information
Submission date: 15 /7 / 2020
Acceptance date: 20/ 9/ 2020
Publication date: 31/ 12/ 2020

Abstract

Halophytes or saline plants characterized in their ability to live and give production in saline soils or in other saline habitats. They refer to plants that can live in high salts habitats like saline marshes and saline deserts, and can give relatively a high production of biomass in such habitats. They are very important due to their different uses of them as food, fodder, drugs and many other different important. They may solve salinity problem tolerant or avoidant species by several adaptations which may by morphological, anatomical or cellular modifications. In this review tend to answer the main questions related to halophytes which including: what are their defines, important, and their strategies to be live and give good productivity in saline habitats?

Key words: halophytes, adaptations, tolerant, avoidant, salinity.

Introduction

Soil salinity is one of the biggest problems today because it ruins agricultural lands, then which lead to plants production disturbance[1], so more than 930 million hectares or about 7% of land area in the world are threated with salinity[2]. In Iraq, for example, studies referred that about 25%of its area are saline[3] specially in the middle and south parts of Iraq this area is increasing about 2500 hectares every year[4].

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (3): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

Halophytes or saline plants characterized in their ability to live and give production in saline soils or in other saline habitats, thus it form true wealth due to high uses of these species[5]. Many edaphic factors including soil salinity, nutrients concentrations and humidity all can determine the type of halophytic community in many countries[6]. In the middle east few studies that are related with halophytes, and in general they included classified genera and families, and such flora studies stile the less in many countries like Iraq[7], Iran[8], Syria[9], Turkey[10] and Kuwait[11]. The general purpose of these studies is limited to the determination of the total number of species, such as the study of Sher and Al-Dosari, in 2012 when the halophytes of Saudi Arabia were described.[12], or describe the halophytic communities and the environmental factors effecting on them[13].

The aim of this study was focused the differences in the classification, importance and main adaptations in halophytes, to increase interest with this group of plants.

1-Definition of halophytes

The first use to the term halophytes was in 1809 which mean plants grow in saline habitat, but the seriousness studies were after 1972[14]. There are many definitions to the halophytes due to many considerations[15] including :1- these plants are returned to many differenced environmental groups, that mean many environmental factors in addition to salinity all effecting on them.2- the notion of salinity has some ambiguity, especially when related to habitat. 3- the knowledge of halophytes is still not completed. 4- finally these plants are related to plant taxonomy.

In simple, it refer to plants that can live in high salts habitats like saline marshes and saline deserts[16], and can give relatively a high production of biomass in such habitats[17].

Perss and his team[18] defined them as plants which continue their life cycle in saline habitats (salt concentration in soil solution about 5g/l of dissolved salts). Other stipulated complete their life in at least 200 mM of salts in conditions equal to that exposed to them in the environment[19], while some scientists stipulated their growth in natural saline condition only[20].According to these detentions, Anderson (in 1989) recorded about 1550 species, while Lieth and Mnzel registered more than 2600 halophytic species[21].

2- Importance of halophytes

Halophytes are posed an important part of the plant kingdom and they have much importance including:

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (3): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

1- **Sources of food**: many species of halophytes are rich in protein, carbohydrates, vitamins, oils and minerals. These materials can find in fruit like *Zizyphys numulartia* or in fresh stems as *Chenopodium album*. Some species are essential to produce some industrial material foods as well as baking soda which get from *Suada frutcosa* [22], or in production of high quality oils [23].
2- **Sources to fodders**: due to morphological diversity of halophytes as trees, shrubs and herbs, and due to high content of proteins, menirals and fibers; these plants are very suitable to be food of caws and cattle. For example, they are five species of *Atriplex* used in all the world because they contain 39.5-15.5%of plant are fibers, and 19.5-10,2 % are row protein [24]. But the main challenge to use forage halophytes is their high salt contain, thus it should be careful to give such forage to special spices of animals, for example can used oils of *Suada bigelovii* as protein source to fish but not to poultry [25].
3- **Source to chemicals**: many of the important chemicals are extracted from halophytes as aromatic resins which have many different are from *Gridalelia comporum, jajuba* oil from *Simmondsia chinensis* and many edible oils with 70-80% content are from *Kochia scoparia*[26]. Some saline plants like *Arthrocnemun indicum* are rich with non-saturated fatty acids (74-65%)[27]or production of paper pulp and fibers from *Juncus rididius* and *Saccharum griffithii* respectively[28].
4- **Sources of many pharmaceutical and medical materials**: halophytes contributing in provide of primary materials that used in production of drugs, for example the plant *Kochia indica* used in preparation of cardiac muscle stimulants, *Citrullus colocynthis* is wide used in asthma, jaundice, and bladder diseases drugs[26],or production of multiple use flavonoids which can be extracted from *Ceassacretica*[29].
5- **Alternative energy sources**: modern researches are heading to provide alternative energy sources, especially that with from biota in production of biofuel like methane, ethane and etc. due to halophytes content of cellulose, semi cellulose and lignin about 26-37%, 24-38% and less than 10% respectively, thus used *Typha domingensis, Phragmites karaka* and *Panicum turgidum*[30] and *Saccharum griffithii*[31] in bio ethane production.
6- **Used in tertiary water treatment methods**: some of halophytes characterized with their ability to absorb trace elements from polluted water, thus such water can used in irrigated of them[32], and there are many studies in this filed, for example both *Chenopodium btrys* and *C. album* L. absorb cadmium and retain it in their roots[33,34]. So some halophytes used to decrease soil salinity like *Tamarix aphylla* and *Atriplex*[35], or collecting special ions from soil as sodium and chloride ions in shoot parts of plants[36].
7- **Take care of a wild life**: because high diversity of halophytes and their ability to live in extreme environments, they act important role in the enrich of ecosystem.so they form suitable habitats for different animals such as insects and arthropods [32,37].

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (3): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

3- Classification of halophytes

There is more than one regulation to classify halophytes, and each of them depends on one specific factor or more to division. In 1993 Le Hourous suggested three schemes to the halophytes. In the first, divided them in four groups according to their tolerant of salinity. while in the second he made them five groups depended on the other environmental attendants. In last scheme suggested that halophytes are twelve groups depended on edaphic factors. In general, they can divide to the fallowing groups of divisions [38]:

3-1- Division depending on inner saline content in plant:

This class include different species some of them are salt regulators while the other are salt accumulators, or classified them in salt excluders and succulents [39].

3-2- Division depending on plants need to salt:

Some halophytes are obligate to live in saline habitats and thus they called true halophytes and such plants give best production when salinity increased, so called salt tolerant. The second group has the facultative halophytes which can live saline habitat but the best growth seen in saline soils thus called salt avoidant [40].

The modern concept of halophytes division depending on soil traits, ground water level, and phonological and reproductive traits, thus made halophytes in seven groups which are: **hyper halophytes** which live in high salinity (more than 100DS.m-1), **hydrohalophytes** including all species that can live in water lands and saline water, and such plants tolerant salinity above 1000ppm. **Euhalophytes** , this group can see saline deserts and saline marshes, the plants of this group are salt collectors or salt excretes. **Haloxerophytes** represent the fourth set ad their plants can live until if the groundwater deep than 4 m, while the fifth is called **halogemimesophytes,** such plants are well adapted to live in desert, semidesert habitats and the edges of water bodies. The halophytes which can extended their roots to depth about 8 m are called halogemipetrophytes**.** The final group called **metahalophytes,** such as halophytes are distinguished by high ability to collect metals and ions [41,42].

4- halophytes adaptations to salinity:

Each group of halophytes identified with special adaptations to enable these plants to live in their habitats by one or more of the fallowing adaptations [43]:

Journal of University of Babylon for Pure and Applied Sciences, Vol. (28), No. (3): 2020
Online ISSN: 2312-8135, Print ISSN: 1992-0652

4-1 phonological adaptations:

Some halophytes reduce the action of salinity by form some phonological parts [44]. In the fore front of these are small leaves, increased both succulent, cuticle and wax layers to reduce water losses [45] and increased rates of each of seeds germination, vegetative growth and formation of both flowers and seeds [46].

4-2 Anatomical adaptations:

The presences of some structural differences leave or stems or roots or all together enable plant to prevent salt toxicity by many adaptations as well as reduce number of stomata per leaf unite area and thickness of leaf [47] or excreting salts out the body by salt secretary trichomes or by salt glands. In stem many specific tissues are found in pith and cortex to stock water, other stems identified by thick layer of wax or the parenchyma and plastid cells are modified to store water [48,49].

4-3 Cellular adaptations:

The presence of some essential dissolved organic compounds in cell cytoplasm helps it to prevent the action of salt toxicity. Such chemicals may be proline, glycine betaine, sugar alcohol inositol, pentol, sorbitol and mantol[51]. Some halophytes reduce the effect of salts by store them in special vacuoles [50]. Other ways including produce special plant hormone like abscisic acid or special antioxidant enzymes [46].

Conclusion

The term halophyte is wide difference according to the main basis which done on them. So due to their different uses, most increasing the interest in halophytes breeding and protect the wild species of them. Finally the understanding of halophytes strategies to solve salinity in their habitat can help to make non halophyte species to endure salinity by some chemical or genetic treatments.

Conflict of Interests.

There are non-conflicts of interest .

References

[1] Khan, M.A. ; Qasim, M. ; Gulzar, S. ;Shinwari, Z.K. ; Aziz, I. (2010). Traditional ethno botanical uses of halophytes from Hub , Baluchistan. Pak. J. Bot.,42(3):1543-1551.

[2] Zhang, H. ; Irving, L.J. ; Craig, M.G. ; Mathew, C. ; Zhou, D.& Kemp, P. (2010). The effects of salinity and osmotic stress on barely germination rate: sodium as an osmotic regulator. Annals of Botany,106:1027-1035.

[3] Altay, V.& Ozturk, M. (2012). Land degradation and halophytic plant diversity of Milleyha wetland ecosystem (Samnda G'- Hatay), Turkey. Pak. J. Bot.,44:35-50, special issue.

[4] Qadir, M. & Shadeed, K. (2012). Soil Salinity Management Central and Southern Iraq, ICARDA, Australian Center for International Agriculture Research.

[5] Khan, M.A.; Gulzar, S.; Gul, B. & Aziz, I. (2011). Seasonal variation in plant water status of four desert halophytes from semi- arid region of Karachi. Pak. J. Bot.,43(1):587-594.

[6] Gul, B. ; Khan, M.A.; Jing, L. X. & Glangli, W. (2008). Relationship between soil characteristics & halophytic vegetation in coastal region of north China. Pak. J. Bot.,40(3) : 1081- 1090.

[7] Al-Adily, Batool Mohammad Hassan(2014). Study of some halophytic vegetation environments in Babylon Governorate/Iraq. A thesis, college of Science –University of Babylon.

[8] Hossein, A. & Ghorbanli, M. (1993). A contribution to the halophytic vegetation and flora of Iran, towards the rational use of high salinity tolerant plants, vol.1:35-44.Netherlands.

[9] Al-Oudat, M. & Qadir, M. (2011). The halophytic flora of Syria. ICARDA.

[10] Yavuz, M. ; Aslan, M. ; Cetin, E.; Aktoklu, E. & Atamov, V. (2006). Halophytication in Harran (Sanliurfa) and Amik plain (Hatay) in Turkey. Phytol. Balcanic, 12(3):401-412.

[11] Di Mohamad, A.E.; EL- Ghareeb, R.M., Anna, T.& PignattiS.(2006). Ecologia,17(9):311-331.

[12] Sher, H. & Al-Dosari, A. (2012). Overview on the ecological and geographical appraisal of important medical and aromatic plants: An endangered component in the flora of Saudi Arabia. Sci. Res. Essays, 7(16):1639-1646.

[13] Clanton, B. ; Aralova, D. ; Shuyskaya, E. Khujanazarov, T.; Toderich, Kristina, Taha, F.; Oishi, S.& Voronin, P.(2009). Assessment of halophytic vegetation to improve livestock-feeding resources on saline desert rangelands. Roczniki Geomatyki, 5(35):7-16.

[14] Abdul Wahid .(2003). Physiological significance of Morpho- Anatomical features of halophytes with particular reference to Cholistan flora. Int. J. Agri. Biol., 5(2):207-212.

[15] Grigore, M.N. ; Toma, C. ; Boscaiu ,M. (2010).Dealing with halophytes :An old problem , the same continuous exciting challenge. Tamul LVI, Fasc. 1,A Biologie Vegetala.

[16] Garcia, R. M. (2010). Physiological studies of the halophyte Salicornia bigelovii:A potential food and biofuel crop from integrated aquaculture –agriculture systems. PhD thesis ,Graduate College, Arizona University.

[17] Hozayen ,M. ; Bahr, A. Abd El Lateef, E.M. Tawfik ,M.M. (2011). Prospect of biofertilizer inoculation for increase saline irrigation efficiency. J. Agri. Biol. Sci., 6(8):1033-1038.

[18] Press, M. C. ; Scholes , J.D. & Barker, M.G. (1998). Physiological plant ecology. Blackwell Sceince.

[19] Flower, S. & Colmer ,T.D. (2008). Salinity tolerance in halophytes. New Phytologist., 179: 945-963.

[20] Sardo, V.(2005). Halophytes and salt- tolerant glycophytes, a potential resource. CIHEAM,66:87-98.

[21] Timothy , J.F.; Galal, H.K. & Bromham, L. (2010). Evolution of halophytes : multiple origins of salt tolerance in land plants. Functional Plants Biology,37:604-612.

[22] Khan, M.A.; Kust ,G.S. ; Barth, H. J.(2006).Sabkha ecosystem , Vol.2,: 129-153. Netherlands.

[23] Wang, L.; Zhao, Z. Y.; Zhang, K.& Tian, C.Y.(2012). Oil content and fatty acid composition of dimorphic seeds of desert halophytes Suaeda aralocaspica . African J. Agricultural Research,7(12):1910-1914.

[24] Khan, M.; Musharaf, S.& Shinwari, Z. K.(2011). Ethnobotanical importance of halophytes of Noshpho salt mine, District Karak, Pakistan. Research in Pharmaceutical Biotech,3(4):46-52.

[25] Centofanti , Tiziana and Bañuelos ,Gary (2019). Practical Uses of Halophytic Plants as Sources of Food and Fodder. Chapte· January 2019. https://www.researchgate.net/publication/331123939.

[26] Dagar, J.C.(2005). Ecology, management and utilization of halophytes. National Institute of Ecology, 15:81-97.

[27] Weber, D.J. ; Ansari, R. ; Gul, B. & Khan, M.J.(2007). Potential of halophytes as sources of edible oil, J. Arid Env.68:315-321.

[28] Choukr-Allah, R.(1997). The potential of salt – tolerant plants for utilization of saline water. Ciheam-options Mediterraneennes:313-322.

[29] Shahat, A.A.; Nazif, N.M.; Abdle-Azim, N.S.; Pieters, L.; Vlietinck, A.J. (2005). Flavinoids from Cressa cretica. Qatar Univ. Sci.J., 25:72-77.

[30] Abideen, Z.; Ansari, R.; Khan, M.A. (2011). Halophytes :potential source of lingo-cellulosic biomass for ethanol production. Biomass & Bioenergy,3:1-5.

[31] Kosolapov, V. M.; Shamsutdinov Z. Sh.; Shamsutdinova, E. Z; Natirov, A. K.; Shamsutdinov, N. Z. and Shagaipov, M. M.(2016). Halophytes are promising sources for producing biofuel. Springer. Published: 11 August 2016

[32] Aslam, R. ; Bostan , N.; Amen ,N. ; Maria, M.; Safdar ,W. (2011). A critical review on halophytes: salt tolerant plants. J. Med. Plant Res., 5(33):7108-7118.

[33] Mazhari, M.& Homaeeb, M.(2012). Annual halophyte Chenopodium botrys can phytoextract cadmium from contaminated soils. J.Basic.Appl.Sci.Res.,2(2):1415-1422.

[34] Oosten, Michael James Van and Maggio ,Albino(2015). Functional biology of halophytes in the phytoremediation of heavy metal contaminated soils. Environmental and Experimental Botany 111 (2015) 135–146

[35] Al –Nasir, F.(2009). Bioremidation of a Saline Sodic Soil in a Semiarid Region/ Jordan, American- Aurasian J. Agri. & Environ. Sci., 5(5):701-706.

[36] Badi, H.N. & Ali, S. (2011). Evaluating potential of borage (Borago officnalis L.) in bioremediation of saline soil. J .Bio. Tech., 10(2):146-153.

[37] Koyro, H.-W. ;Khan, M.A. ; Leith ,H. (2011). Halophytic crops :A resource for the future to reduce the water crisis. Emir. J. Food Agri., 23(1): 001-016.

[38] Simpson ,Catherine R. ; Franco, Jose G. Franco; King ,Stephen R. and Volder, Astrid (2018). Intercropping Halophytes to Mitigate Salinity Stress in Watermelon. Sustainability 2018, 10, 681; doi:10.3390/su10030681.

[39] Chongzhi Xu, Xiaoli Tang, and Hongyan Wang(2014). Salinity Tolerance Mechanism of Economic Halophytes From Physiological to Molecular Hierarchy for Improving Food Quality. Curr Genomics. 2016 Jun; 17(3): 207–214.

[40] Mishra, Avinash and Tanna, Bhakti(2017) Halophytes: Potential Resources for Salt Stress Tolerance Genes and Promoters. Front Plant Sci. 2017; 8: 829.

[41] Toderich, K.N.; Shuyskaya, E.V.; Ismail ,S.; Gismatullian ,L.G. ; Radjabov, T. ; Bekchanov, B.B. &Aralova, D.B. (2009). Phytogenic resources of halophytes of center Asia and their role for rehabilitation of sandy desert degraded rangelands. Land Degrad. Develop. DOI:10.1002/1dr.936.

[42] Toderich, K. & Tsukatani, T.(2007). A new approache for biosaline agriculture development, management and conservation of central Asia degraded drylands., Kier discussion paper series, Kyoto Institute of Economic Research, discussion paper no.638.

[43] Jeschke, W.D. & Wolf,O. (1993). Importance of mineral nutrient cycling for salinity tolerance of plants.

[44] Has, W.K.; Khan M.A. ; Lieth , H. (2011). Halophytic crops : A resource for the future to reduce the water crisis. Emir. J. Food Agric., 23(1):001-016.

[45] Gale, J. (1975). Water balance and gas exchange of plants under saline conditions , sited in Abdul Wahid (2003). Physiological significance of Morpho- Anatomical features of halophytes with particular reference to Cholistan flora. Int. J. Agri. Biol., 5(2):207-212.

[46] Parida, A.K. & Das A.B. (2005). Salt tolerance and salinity effects on plants. Ecology & Environmental Safety , 60:324-349.

[47] Kabar, K.; Kilic, S. & Cavusoglu,K.(2008). Effect of some plant growth regulators on leaf anatomy of radish seedlings grown under saline conditions. J. Appl. Biol, Sci., 2:47-50.

[48] Hameed , M.; Ashraf, M.; NAZ, N. & Al-Qurainy, F. (2010). Anatomical adaptation of Cynodon dactylon (L). Pers., from the salt range Pakistan, to salinity stress .1.Root& stem anatomy. Pak. J. Bot., 42(1):279-289.

[49] Reddy, K. J. ; Raghavendra , A.S. and Rao, K.V.M. (2006). Physiology & molecular biology of stress in plants. Netherlands :41-99.

[50] Chen, Min; Yang, Zhen; Liu, Jing ; Zhu, Tingting; Wei ,Xiaocen; Fan, Hai and Wang, Baoshan(2018). Adaptation Mechanism of Salt Excluders under Saline Conditions and Its Applications. Int. J. Mol. Sci. 2018, 19, 3668;doi:10.3390/ijms19113668.

[51] Al-Adily, Batool Mohammad Hassan; Al-Amery, Shaemaa Muhi Hasoon; Hussein, Rasha Hashim and Al-Haidarey, Mohammed Jawad Salih(2020). SOME RESPONSES OF RICINUS COMMUNIS L. TO SOIL SALINITY IN BABYLON PROVINCE, IRAQ. Plant Archives Vol. 20, No. 1, 2020 pp. 249-252.

الخلاصة

تتميز النباتات الملحية بقدرتها للعيش و الانتاجية في الترب او البيئات الملحية الاخرى. ان مصطلح النباتات الملحية يشير الى تلك الانواع التي تستطيع العيش في مواطن عالية الملوحة مثل الاهوار و الصحاري المالحة, بشرط ان انتاجيتها من الكتلة الحية عالية نسبيا في هكذا بيئات, وهي تمثل نباتات مهمة جدا نظرا لاستخداماتها المتعددة سواء كغذاء او علف او انتاج ادوية و غيرها من الاستعمالات الاخرى.

تستطيع تلك النباتات ان تحل مشكلة الملوحة العالية من خلال ان انواعها اما متحملة او مقاومة للملوحة عن طريق عدد من التكيفات و التي بدورها يمكن ان تكون تحورات مظهرية او تشريحية او خلوية. و تهدف هذه المراجعة إلى الإجابة عن الأسئلة الرئيسية المتعلقة بالنباتات الملحية والتي تشمل: ما هو تعريفها, ما هي اهميتها و استراتيجياتها للعيش وإعطاء إنتاجية جيدة في البيئات المالحة ؟

الكلمات الدالة: النباتات الملحية , التكيفات, متحملة للملوحة, مقاومة للملوحة, الملوحة