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Morphological and physiological changes of aloe (*Aloe barbadensis* Miller.) in response to culture media

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Abstract

Aloe is a plant of the family Liliaceae, with fleshy leaves and filled with gel containing health care costs are enormous and are used in the treatment of many diseases. To investigate the effects of culture media on morphological and physiological parameters of Aloe (*Aloe barbadensis* Miller.) plants, an experiment on the basis of randomized complete blocks design with 13 treatment and 4 replications was conducted in 2013. The treatments were components of manure, sand, peat, pumice, tea wastes and rice husks in two level (25% and 50%) with soil in two level (50% and 75%). Effect of culture media was significant on all of parameters except for leaf diameter and total suspended solid (TSS). Results showed that the most number of leaves per plant (13 leaves.plant^{-1}) and root weight (41g.plant^{-1}) in medium of 25% pumice + 75% soil, the most leaf width (3.4 cm) with 25% peat + 75% soil, the maximum offset weight (65.5 g.plant^{-1}), gel weight (257.2 g.plant^{-1}) and weight of plant aerial parts (547.5 g.plant^{-1}) in treatment of 50% pumice + 50% soil and the highest number of offset per plant (3.25 offset.plant^{-1}) with application of 25% tea wastes + 75% soil was attained. The best treatments to increase the morphological and physiological parameters are components of pumice, peat and tea wastes in combination with soil because of higher amount of organic carbon and cation exchange capacity and proper pH of the media.

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Introduction

Aloe genus is from Liliaceae family with more than 500 species in the world. It is a succulent plant species and endemic to Africa, tropical and semi-tropical regions. The known species of Aloe is *Aloe vera* L. and its synonym is *Aloe barbadensis* Miller. The plant has triangular, fleshy leaves with serrated edges, yellow tubular flowers and fruits that contain numerous seeds (Surjushe *et al.*, 2008). The leaves have a thick epidermis (skin) covered with a cuticle surrounding the mesophyll, which can be differentiated into chlorenchyma cells and thinner walled cells that form the parenchyma (fillet). The parenchyma cells contain a transparent mucilaginous jelly which is referred to as *Aloe vera* gel (Ramachandra and Srinivasa, 2008). *Aloe vera* L. has marvelous medicinal properties. Its gel has been used as a traditional medicine to heal the wound, and as anti-cancer and anti-viral agent (Maze *et al.*, 1997; Paez *et al.*, 2000).

A suitable culture medium can preserve and supply water and nutrients, aeration and root stability. Some factors like expenses, specific gravity and availability to these media should be considered (Larson, 1980; Nelson, 1985). Fungal diseases, saline soils and contamination of environment are problems of greenhouses cultivation. In case it can be controlled with application of organic and inorganic culture media such as perlite, lika, rice husk, peat and pumice (Moghimi, 2003). Khalighi (1997) results showed that waste materials application of tea factories in North of Iran was a suitable substitution for pit medium in cultivation of Anthorium plants. By comparing the beds of rock wool, perlite + carbonized rice hull, cedar bark and coconut coir, Inden and Torres (2004) reported the highest yield of strawberry on the bed of perlite + carbonized rice hull. Sorokina *et al.* (1984) reported that bark and peat mixture was the best medium for growing ornamental plants. The present studies were conducted to investigate the effect of different culture media on growth and phytochemical parameters of *Aloe barbadensis* Miller. plants.

Materials and methods

Plant materials and Experiment design

This pot plant experiment was carried out in 2013 at commercial greenhouses of Mahalat and on the basis of randomized complete blocks design with 13 treatment and 4 replications. Seedlings of *Aloe barbadensis* Miller. With similar height and weight should be selected. The treatments included: M_1 (25% manure + 75% soil), M_2 (50% manure + 50% soil), S_1 (25% sand + 75% soil), S_2 (50% sand + 50% soil), L_1 (25% peat + 75% soil), L_2 (50% peat + 50% soil), P_1 (25% pumice + 75% soil), P_2 (50% pumice 50% soil) + T_1 (25% tea wastes + 75% soil), T_2 (50% tea wastes + 60% soil), R_1 (25% rice husk + 75% soil), R_2 (50% rice husk + 50% soil) and control (soil). Theses culture media were supplied from commercial greenhouses of Mahalat. Characterizations of culture media are shown in Table 1.Measured parameters.

Data Measurement

The studied parameters were number of leaves per plant, leaf width (cm), leaf diameter (cm), number of offsets per plant, offset weight ($g.plant^{-1}$), gel weight ($g.plant^{-1}$), Total suspended solid ($mg.g^{-1}$), root weight ($g.plant^{-1}$) and weight of plant aerial parts ($g.plant^{-1}$). Total suspended solids were measured by method of APHA, 1995.

Statistical analysis

Analysis of variance of the results was done using the SPSS software (ver.17), and means in the results were compared using the Fisher's protected Least Significant Differences (LSD) Test.

Results

According to results of analysis variance, the effect of culture media was significant ($P<0.01$) on number of leaves per plant, leaf width, number of offset per plant, offset weight, gel weight, root weight and weight of plant aerial parts, while it was insignificant on leaf diameter and total suspended solid (Table 2).

In relation to the mean comparisons, the maximum number of leaves per plant and root weight in medium of 25% pumice + 75% soil and the most leaf width in treatment of 25% peat + 75% soil was obtained. However, the most offset weight, gel weight

and weight of plant aerial parts was recorded by application of 50% pumice + 50% soil. The most number of offset per plant was attained in 25% tea wastes + 75% soil. The least of all these parameters was observed in soil medium. The least of all parameters was obtained in control treatment (Table 3).

Table 1. Soil analysis of culture media from Laboratory.

Characterization	Saturation percent (SP)		EC	pH	CO (%)
	Total Fresh weight (%)	Dry biomass (%)	(ds.m-1)		
C (Control (soil))	50.1	46.74	0.61	7.76	3.58
M2(50% manure + 50% soil)	50.4	56.86	3.13	7.95	3.53
M1 (25% manure + 75% soil)	50.05	45.79	4.32	7.99	3.43
S2 (50% sand + 50% soil)	50.06	30.97	1.22	8.08	0.686
S1 (25% sand + 75% soil)	50.06	42.62	1.03	7.06	1.02
L2 (50% peat + 50% soil)	50.25	62.62	2.05	6.73	3.45
L1 (25% peat + 75% soil)	51.1	68.40	0.86	7.76	3.58
P2 (50% pumice + 50% soil)	50.1	44.67	0.42	8.21	1.008
P1 (25% pumice + 75% soil)	50.03	44.42	0.65	8.21	1.711
T2 (50% tea wastes + 60% soil)	50	90.54	1.52	7.27	3.78
T1 (25% tea wastes + 75% soil)	50.03	61.59	1.68	7.58	3.75
R2 (50% rice husk + 50% soil)	50.2	57.34	0.73	7.95	3.56
R1 (25% rice husk + 75% soil)	50.04	87.06	1.37	7.49	3.71

Table 2. Analysis of variance for effects of culture media on measured parameters of Aloe (*Aloe barbadensis* Miller.).

Source of variance	d.f.	Number of leaves per plant	Leaf width	Leaf diameter	Number of offset per plant	Offset weight	Gel weight	Root weight	Weight of plant aerial parts	Total suspended solid
Rep.(block)	3	1.10	0.024	0.02	0.12	9.30	597.59	12.22	2405.1	0.35
Treatment	12	13.93**	0.65**	0.02^{ns}	4.89**	1583.5**	7075.9**	281.58**	41187.5**	0.16^{ns}
Error	36	1.11	0.04	0.01	0.19	11.12	716.7	8.63	4987.07	0.33
CV (%)	11.13		8.42	11.44	34.32	20.72	15.15	15.58	18.58	4.98

ns, *and **: not significant, significant at the 5% and 1% probability levels, respectively.

Discussion

The application of different culture media was appeared to have significant effect on morphological and physiological parameters of Aloe plants. Culture medium of 25% pumice + 75% soil caused the most increase in number of leaves per plant. This result is in line with an experiment of Tzortzakis and Economakis (2008) results on tomato plants and pumice medium in increase of permeability and hydraulic conductivity and they found that pumice can be considered as a reformatory in agriculture. Its permeability was the best in the beginning of experiment. The most leaf width was obtained by application of 25% peat + 75% soil. Alan *et al*. (1994) grew tomato plants in soil, perlite, peat, sand, pumice and different combinations of them. Their results showed that the highest total as well as marketable yield was produced with a mixture of 80% pumice + 10% perlite + 10% peat medium, providing about 30% more product in comparison to the soil. These results in leaf width can be the result of the highest amount of organic carbon measured by soil laboratory (Table 1) in peat medium compared to the other media and also the proper pH of the medium that is effective on nutrition absorption from the soil. Addition of inorganic substances to organic ones has resulted in a

better plant growth and higher yield probably owing to increasing water-holding capacity and aeration of peat. Better aeration of peat promotes vigorous root growth, which allows better growth of foliage and therefore increases whole yield of plants (Vaughn *et al*., 2011). As pumice is inexpensive and light having high macro-pores providing aeration and high water retention capacity under low matric potentials it is an important material for the composition of ideal growth media (Sahin *et al*., 2002, 2004; Kuşlu *et al*., 2005; Sahin and Anapali, 2006). The highest number of offsets in Aloe plants was attained in treatment of 25% tea wastes and 75% soil compared to control. Harte *et al*. (1990) studied the different ratio of tea wastes and peat on tomato plants and they showed that 1:1 ratio of these media caused the highest yield in these plants. In a study comparing various growth media, Bilderback *et al*. (2005) showed that the head weight of lettuce was highest in plants grown in tea waste compost, lower in plants grown in tree bark compost and lowest in plants grown in soil (Mastouri *et al*., 2005). The treatment of 50% pumice + 50% soil increased the amount of *Aloe vera* L. gel to highest weight. Not only the soil improvement in cation exchange capacity, medium condensation and porosity caused the most plant weight in medium of 50% pumice + 50% soil, but also the gel weight reached the highest amount in this medium. The most root weight in Aloe plants was observed in 25% pumice + 75% soil in comparison with control. These results agreed with those of Tzortzakis and Economakis (2008). They showed that pumice improved the soil condition and this medium had the most cation exchange capacity that improved the absorption of nutritional elements. The most weight of plant aerial parts was obtained by 50% pumice + 50% soil that this result is due to higher amount of organic carbon and cation exchange capacity. A study in which soil, perlite, peat, sand and pumice as growing media were used, it was determined that growing media statistically affected yield, fruit weight, ascorbic acid values and TSS of pepper cultivars (padem and Alan, 1994; Gungor and Yildrim, 2013).

Table 3. Mean comparison for effects of different treatments on measured parameters.

Treatment	Num. of leaves per plant (leaves.plant^{-1})	Leaf diameter (cm)	Leaf width (cm)	Number of offset per plant (offset.plant^{-1})	Offset weight (g.plant^{-1})	Gel weight (g.plant^{-1})	Root weight (g.plant^{-1})	Weight of plant aerial parts (g.plant^{-1})	Total suspended solid (mg.g^{-1})
C (Control (soil))	7.5^{d}	0.93	2.1^{d}	0^{d}	0^{b}	133.5^{c}	9^{d}	280^{d}	11
M2 (50% manure + 50% soil)	9^{cd}	0.98	2.4^{bc}	0.5^{bcd}	33^{ab}	180^{b}	20^{c}	477.5^{ab}	12
M1 (25% manure + 75% soil)	8.2^{cd}	1.15	2.2^{cd}	0.25^{d}	1.13^{b}	142.2^{bc}	10.2^{d}	317.5^{cd}	11
S2 (50% sand + 50% soil)	8.5^{cd}	1.10	2.2^{cd}	0.25^{cd}	5.25^{b}	141.7^{bc}	10.8^{d}	285^{d}	12
S1 (25% sand + 75% soil)	8.2^{cd}	1.02	2.3^{bcd}	1.5^{abcd}	10.63^{b}	170.7^{bc}	20.8^{c}	312.5^{cd}	12
L2 (50% peat + 50% soil)	9^{cd}	0.96	2.2^{cd}	1.25^{abcd}	3.13^{b}	143^{bc}	11.7^{d}	305^{d}	12
L1 (25% peat + 75% soil)	12.2^{ab}	1.14	3.4^{a}	2.5^{abc}	14.5^{b}	170.2^{bc}	19.2^{c}	360^{cd}	11
P2 (50% pumice + 50% soil)	9.5^{c}	1.13	2.4^{bc}	3^{ab}	65.5^{a}	257.2^{a}	26.2^{b}	547.5^{a}	12
P1 (25% pumice + 75% soil)	13.5^{a}	1.18	2.6^{b}	1^{abcd}	7.5^{b}	230.7^{a}	41^{a}	515^{ab}	11
T2 (50% tea wastes + 60% soil)	11.7^{b}	1.13	3.1^{a}	1.75^{abcd}	34.63^{ab}	247.7^{a}	17.3^{d}	510^{ab}	11
T1 (25% tea wastes + 75% soil)	8.7^{cd}	1.03	2.1^{cd}	3.25^{a}	33.5^{ab}	149^{bc}	20.2^{c}	420^{bc}	12
R2 (50% rice husk + 50% soil)	7.7^{cd}	1.13	2.1^{d}	0^{d}	0^{b}	177.5^{bc}	17.6^{c}	257.5^{d}	12
R1 (25% rice husk + 75% soil)	8.5^{cd}	1.05	2.3^{d}	0^{d}	0.5^{b}	154.2^{bc}	20.6^{c}	352.5^{cd}	13

* Means in each column followed by the same letter are not significantly different (P <0.01).

Conclusion

In this experiment, application of pumice, peat and tea wastes as culture media had positive effect on morphological and physiological parameters of Aloe (*Aloe barbadensis* Miller.) plants because of higher amount of organic carbon, cation exchange capacity and proper pH of the media.

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References

Alan R, Zuladir A, Padem H. 1994. The influence of growing media on growth, yield, and quality of

tomato grown under greenhouse conditions. Acta Horticulturae **635,** 631.879. **4,** 631.878.

American Public Health Association. 1995. Standard Methods for the Examination of Water and Wastewater. **19**th Ed. Topic 2540 Solids. APHA, Washington D.C. 541 p.

Bilderback TE, Warren SL, Owen JrJS, Albano JP. 2005. Healthy substrates need physicals too. Horticultural Technology **15,** 747–751. 58-6618-2-2027.

Gungor F, Yildrim E. 2013. Effect of different growing media on quality, growth and yield of pepper (*Capsicum annum* L.) under greenhouse conditions. Pakistan Journal of Botany **45(5),** 1605-1608.

Hart LA, Nibbering PH, van den Barselaar MT, van Dijk H, van den Burg AJ, Labadie RP. 1990. Effects of low molecular constituents from *Aloe vera* gel on oxidative metabolism and cytotoxic and bactericidal activities of human neutrophils. International Journal Immunopharmacol **12,** 427–34.
http://dx.doi.org/10.1016/0192-0561(90)90026-J

Inden H, Torres A. 2004. Comparison of four Substrates on the growth and quality of tomatoes. Acta Horticulture. 644, 205-210. Acta Horticulture. (ISHS) **644,** 205-210.

Khalighi A. 1997. Floriculture and ornamentals of Iran. Roozbahan publication, Tehran, Iran 392 p.

Kuşlu Y, Şahin Ü, Anapalı Ö, Şahin S. 2005. Use possibilities of pumice in cultural activities obtained from different parts of Turkey for aeration and water retention features. Turkey Pumice Symposium and Exhibition. Isparta, 301-306.

Larson EL. 1980. Introduction to floriculture. Academic Press London. 607.

Maze G, Terpolilli RN, Lee M. 1997. *Aloe vera* extract prevents aspirin-induced acute gastric mucosal injury in rats. Journal of Research in Medical Sciences **25,** 765–766.

Mastouri F, Hassandokht MR, Padasht Dehkaei MN. 2005. The effect of application of agricultural waste compost on growing media and greenhouse lettuce yield. Acta Horticulture **697,** 153–158. (ISHS) **697,** 153-158.

Moghimi S. 2003. About Humat and Humus soils. Abizh publication.

Nelson PV. 1985. Greenhouse operations and management. 3rd ed. Reston Publication. Co., Reston. 598 p.

Padem H, Alan R. 1994. The effects of some substrates on yield and chemical composition of peppers under greenhouse conditions. 2nd ISHS Symposium on Protected Cultivation of Solanaceae in Mild Winter Climates. 13-16 April 1993. Acta Horticulture **36,** 445-451.

Paez A, Michael Gebre G, Gonzalez ME, Tschaplinski TJ. 2000. Growth, soluble carbohydrates, and aloin concentration of *Aloe vera* plants exposed to three irradiance levels. Environmental and Experimental Botany. **44,** 133–139
http://dx.doi.org/10.1016/S0098-8472(00)00062-9

Ramachandra CT, Srinivasa RP. 2008. Processing of *Aloe vera* leaf gel: A review. American Journal of Agricultural and Biological Science **3,** 502-510.
http://dx.doi.org/10.3844/ajabssp.2008.502.510

Sorokina LI, Kuclurk EL, Torgashever VV. 1984. Using bark in greenhouses. Lesnaya Promysch-lennost. **5**, 9.

Surjushe AR, Vasani R, Suple DG. 2008. *Aloe vera*: A short review. Indian Journal of Dermatology. **53,** 163-166.

http://dx.doi.org/10.4103/0019-5154.44785

Sahin U, Anapali O, Ercisli S. 2002. Physicochemical and physical properties of some substrates used in horticulture. Gartenbauwissenschaft **67,** 55-60. Eingereicht: http://dx.doi.org/12.10.01/25.02.02

Sahin U, Anapali O. 2006. Addition of pumice affects physical properties of soil used for container grown plants. Agriculturae Conspectus Scientificus. **71,** 59-64.

Tzortzakis NG, Economakis CD. 2008. Impacts of the substrate medium on tomato yield and fruit quality in soilless cultivation. Horticultural Science. (PRAGUE). **35,** 83-89.