Annals of Agri-Bio Research **24** (2) : 211-215, 2019

Identification and Morphology of *Portulaca* on Various Altitudes in East Java, Indonesia

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(Received : March 20, 2019; Accepted : May 21, 2019)

ABSTRACT

Portulaca plants are beneficial both as a source of food and medicinal ingredients. The development of portulaca cultivation requires the knowledge of plant characteristics through identification of portulaca plants. The purpose of this study was to obtain information on portulaca morphological characters from various altitudes in an effort to preserve portulaca germplasm so that later it can be used as a reference in determining the good and superior portulaca character to be developed. This research used a survey method where sampling was done intentionally (purposive sampling). Identification activities were carried out in the lowland area of Rungkut sub-district, Surabaya, medium altitude land in the DAU district of Malang, and in the highlands of Bumiaji Batu sub-district. The results of purslane exploration in the lowlands of Surabaya had four types of species, namely, *Portulaca oleraceae* L., *Portulaca grandiflora* Hook, *Portulaca pilosa* L. and *Portulaca quadrifida* L. In the plain area DAU Malang, there were three species, namely, *P. oleraceae* L., *P. grandiflora* Hook and *P. quadrifida* L. In the highland area of Bumiaji district, there were two types of species, namely, *P. oleraceae* L. and *P. grandiflora* Hook.

Key words : Portulaca, identification, morphology, altitude

INTRODUCTION

Indonesia is a country with high biodiversity of life. Portulaca is an annual plant, which grows in many regions of the world, with large varieties and local names, growing in various climates and regions. It can be found in Europe, Africa, North America, Australia and Asia (Liu *et al.*, 2000; Rashed *et al.*, 2003). This plant ranks eighth of the most common plants in the world and widely distributed as a weed, growing fast, compatible and has the extraordinary ability to produce seeds along the lifespan. It is commonly used in human consumption, animal drugs (Liu *et al.*, 2000) and contains good nutrition (Palaniswamy *et al.*, 2004; Iranshahy *et al.*, 2017).

Portulaca plants have good potential and prospects but there has been no effort in cultivation practices in order to population is still low and grows wildly spread. In several studies, portulaca is reported to have higher nutritional value than the main vegetable plants with high content of vitamin A, C, E, β-carotene (Liu *et al.*, 2000) and Omega 3 (Palaniswamy *et al.*, 2004). In addition, portulaca plants can be used as functional food which has a positive impact on health including antioxidant (Erkan, 2012; Uddin *et al.*, 2012; Chowdhary *et al.*, 2013), anti-microbes (Ercisli *et al.*, 2014; Nayaka *et al.*, 2014), alkaloids (Xiang *et al.*, 2005) and flavonoids (Xu *et al.*, 2006). Therefore, some efforts are needed to develop portulaca plants as cultivated plants.

In Indonesia, the presence of portulaca has not been studied further, and a few results have been reported, even though portulaca is a very potential with high economic value. Significant morpho-physiological and biochemical variations can be found among the same plant species due to geographical or regional variations (ANPC, 2006) and characterization activities of all properties possessed by sources of plant genetic diversity.

Portulaca plants can live in various altitudes. Differences in altitude, geography and weather cause some differences in plants. Place height influences air temperature and rainfall (Ping *et al.*, 2013; Saeed *et al.*, 2014). Higher place has lower air temperature and the higher

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rainfall, which produce more fertile soil (Van Beusekom *et al.*, 2015). The purpose of this study was to obtain information on portulaca morphological characters from various elevations in an effort to preserve portulaca germplasm which later could be used as a reference for good and superior portulaca character to be developed.

MATERIALS AND METHODS

The research was conducted from January to August 2017. The study was conducted in the lowland area of Rungkut sub-district, Surabaya, in the medium altitude land in DAU district of Malang, in the highlands of Bumiaji Batu sub-district (Table 1). The research method was carried out using a survey method with purposive sampling. Ten plant samples were determined for each species. The total portulaca samples used were 10 portulaca plants.

Analysis of phenotypic variability was done using a standard deviation, and similarity analysis using the Ntsys Ver.2.02 program with Sequential Agglomerative hierarchical and Nested (SAHN) clustering method.

Identification was carried out on 26 characters (16 qualitative and 10 quantitative characters). Characterization refers to Tjitrosoepomo (2003), by observing root characters (3 characters), stem (8 characters), seeds (3 characters), leaves (7 characters) and flowers (5 characters). Characterization was done by observing and measuring the object of research directly. Direct observation was determined from purposive sampling by choosing a portulaca plant population based on the number of portulaca plants found in several existing areas, namely, at an altitude of <400 meters above sea level, >400-700 m above sea level and >700 m above sea level.

RESULTS AND DISCUSSION

Morphological characteristic of portulaca on three different altitudes from lowland altitude of Surabaya, medium land altitude of DAU, Malang and high land of Bumiaji, Batu. Observation result showed that portulaca in the lowland of Surabaya had four species of portulaca (*P. oleracea* L., *P. grandiflora* Hook, *P. pilosa* and *P. quadrifida* L.). On the medium altitude land of DAU, Malang, three species were found (*P. oleracea* L., *P. grandiflora* Hook and *P. quadrifida* L.). On the Bumiaji, Batu, two species were found, which were *P. oleraceae* L. and *P. grandiflora* Hook.

The root character at three heights had the same shape which was in the form of thread. While the root colour at low altitude *P. grandiflora* Hook (white, orage, red, pink), *P. oleracea* L. and *P. pilosa* L. had the same colour, namely, brownish root colour, while *P. quadrifida* L. (pink, white) had a white colour. At medium and high altitudes, portulaca had the same root colour.

The results of characterization of portulaca roots indicated that there was no diversity in the shape of the roots. Portulaca root type was taproots. The hair root of portulaca was the only real part of the protrusion of the root stem cells that were long in shape like hair, therefore, it was called hair root or root hair. These roots expanded the absorption area of ??the roots, allowing more water and food substances absorbance.

Most distinguishing character of the stem was found in *P. pilosa* L. The stem is covered with thin white hair compared to other portulaca, and the most number of branches was *P. oleracea* L. up to 30 pieces. The results of characteric observation of the portulaca stem showed that there was no diversity in the shape of the stem. Diversity was shown in the colour

Table 1. Ecological data on various altitudes in east Java Indonesia

Altitude	Location	Average temperature (°C)	Rainfall (mm/thn)	Humidity (%)	Soil type
Low 47 m asl	Surabaya Rungkut District	28.9	180.6	74	Vertisol
Medium 572.82 m asl	Malang DAU District	24.2	434	66	Andisol
High 978 m asl	Batu Bumiaji District	22.8	517	82	Andisol

of the stem, which was Red-greenish red, Red-greenish white, Green-reddish green, Red-greenish red. *P. pilosa* L. hair on the stem was more in number compared to the other three portulacas. The texture of the stem surface, in general, was slippery. The form of monopodial branching was characterized by distinct form of main stem which was bigger and longer than the branches.

The results of characterization analysis of portulaca leaves showed that there was diversity in leaf shape for *P. oleracea* L. and *P. quadrifidia* which had an oval leaf shape. *P. grandiflora* Hook and *P. pilosa* had cylindrical round leaves. Diversity in the colour was green leaves, greenish red and reddish green. The diversity in the colour of flowers was yellow-coloured *P. oleracea* L. and purple for *P. pilosa* L. Whereas in *P. grandiflora* Hook had various colours which were white, orange, red, pink, yellow and *P. quadrifida* with pink and white colour. There was no diversity in the shape of the seeds, but the colour consisted of brown to blackish brown.

The results of the uniformity (diverdity) analysis by comparing the diversity of standard deviations of portulaca plants from three altitudes, indicating that phenotypic variability for quantitative characters in lowland characters was narrow (uniform) in all types of portulaca which were shown by the parameters of root length, stem length, stem diameter, leaf length, leaf width, flower diameter, number of petals and number of stamens and in the number of branches found in the types of *P. glandiflora* L. and *P. pilosa* L. While broad characters (variety) classification was shown on the number of branches found in the types of *P. oleraceae* L. and *P. quadrifida* L., in the number of leaves quantity found in the types of *P. glandiflora* L. (pink), *P. oleraceae* L., *P. quadrifida* L. and *P. pilosa* L. On the medium altitude land, the character diversity which classified as narrow (uniform) was found in all types of portulaca except in the character of the number of leaves from *P. oleracea* L., while *P. quadrifida* L. (pink).

The characters analyzed generally have a narrow to wide variability. This is because, generally, the characters analyzed are qualitative characters which are usually controlled by simple genes and limitedly influenced by environmental factors.

Fig. 1 shows that the morphological variations were quite high at the coefficient of 55%. The first group consisted of seven individuals (DR1, DR3, DS3, DS1, DT2, DR2 and DR4), the second group consisted of four individuals (DR8, DS2, DR6 and DS4), and the third group consisted of three individuals (DR5, DT1 and DR7). The next three groups also showed variations between each individual in one group to form several

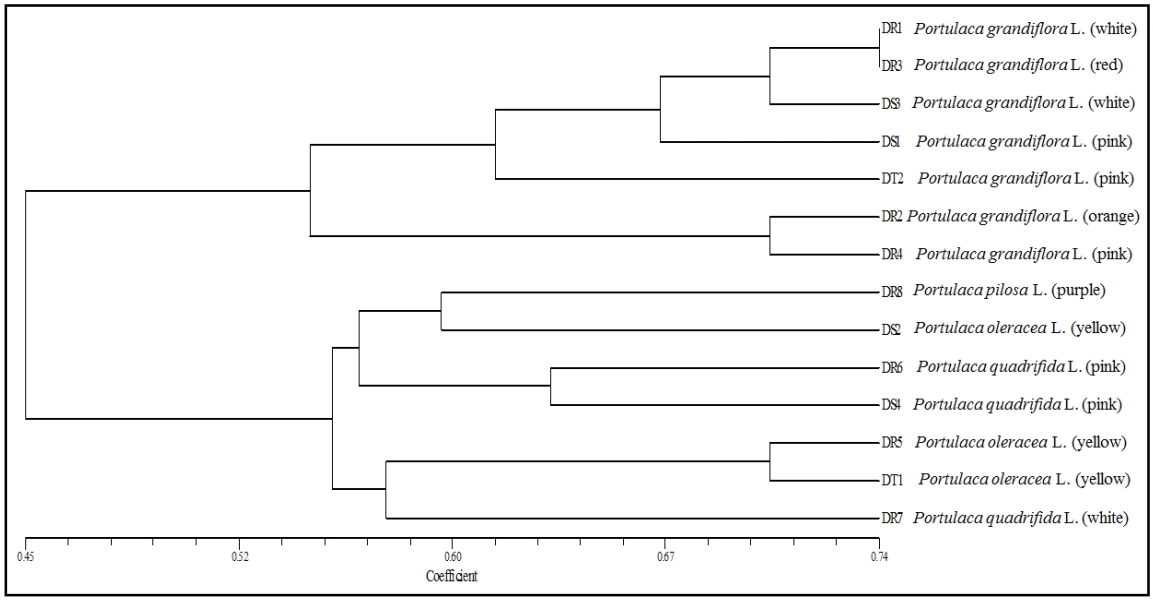

Fig. 1. Dendrogram of kinship from 14 samples in three different altitudes based on morphological characters. DR1-8 = Samples from the lowlands; DS1-4 = Samples from medium land and DT1-2 = Samples from the highlands. Dendrogram is designed using the Ntsys Ver. 2.02 program with the SAHN (Sequential Aglomerative Hierarchical and Nested) clustering method.

subgroups. However, both groups and subgroups formed showed high kinship between individuals in them, as shown by the first group where all seven individual were one of the same portulaca plant species, namely, *P. grandiflora* L. In addition, seven individuals in the first group indicated that four individuals were *Portulaca grandiflora* L. from the lowlands, two individuals were *P. grandiflora* L. from the medium altitude and one individual was *P. grandiflora* L. from the highlands. This showed that DR1 had a high kinship towards DR3, even both could be said to be the same at a coefficient of 74% (almost no morphological differences). While DR2 had the highest kinship towards DR4. However, the first group showed that the *P. grandiflora* L. individuals from the highlands (DT2) had a higher variation compared to the other six individuals from the low and medium lands. This was evident where DT2 individuals were separated in a separate species branch. Likewise, *P. grandiflora* L. (DS3 and DS1) from the plain had a fairly high variation compared to the other five individuals from the low and highlands. So, even though DR1, DR3, DS3 and DS1 were in the same subgroup, both DS1 and DS3 were separate in a separate branch. DR2 and DR4 contained in one subgroup having a high variation from other subgroups (DR1, DR3, DS3 and DT2), at the coefficient of 54%. These data showed that differences in terrestrial heights had a significant influence on variations in the morphology of portulaca plants.

The second group showed a fairly high variation in the coefficient of 56% which formed two sub-groups between the four individuals contained. The first sub-group in the second group consisted of individuals DR8 (*P. pilosa* L.) and DS2 (*P. oleracea* L.), while the other subgroups consisted of individuals DR6 and DS4 who were both *P. quadrifida* L. Although DR8 and DS2 were in the same subgroup, which showed that both of them were quite highly relatives, but the morphological variations were also quite high. Both formed separate branches at a coefficient of 60%. This was influenced by several factors, including differences in the altitude of the land of planted individuals and also genetic factors. While individuals DR6 and DS4 varied quite high at a 63% coefficient. This was also influenced by the differences in the height of the land which may affect the morphological variations of both the individuals. The morphology of an individual plant was strongly influenced by two main factors, genetic and environmental. Therefore, both the portulaca plants from different and same species will show different morphology if planted at different altitudes. This also applied to third group formed on the dendrogram in Fig. 1. Group three consisted of three individuals with two different species and altitude. These groups formed two subgroups, namely, subgroups consisting of individuals DR5 with DT1 and subgroups consisting of one individual, namely, DR7. Both DR5 and DT1 were *P. oleracea* L. with the same yellow flower colour, but both were different in cultivation altitude. DR7 is a *P. quadrifida* L. species from the lowlands. As explained earlier, the difference in elevation of the growing land affects the variation of portulaca morphology, so that even though DR5 and DT1 are portulaca plants of the same species, both are separated in separate branches at a coefficient of 70%, indicating the morphological variation between the two is quite high. DR7 is closely related to DR5 and DT1, but has a high morphological variation on both of them at a coefficient of 57%.

CONCLUSION

Portulaca exploration results showed that portulaca in the lowlands of Surabaya had four species, namely, *P. oleracea* L., *P. grandiflora* Hook, *P. pilosa* and *P. quadrifida* L. In the medium land of DAU, Malang there were species, namely, *P. oleracea* L., *P. grandiflora* Hook and *P. quadrifida* L. There were two types of species of portulaca in the highlands of Bumiaji subdistrict, namely, *P. oleraceae* L. and *P. grandiflora* Hook. Portulaca plants of different or same pecies will show different morphology if planted at different altitudes. This was influenced by several factors, including differences in the altitude of the land and also genetic factors (species differences) so that it influenced the morphological variation.

The results of the grouping analysis of 14 complete accessions resulted in three main groups of portulaca accession morphology variations which were quite high with 55% coefficient. From the results of this study, it was suggested to expand the exploration area, not only in East Java, to get a complete picture of variability of genetic portulaca in Indonesia.

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