Bangladesh J. Bot. **52**(3): 829-835, 2023 (September) DOI: https://doi.org/10.3329/bjb.v52i3.68927

EFFECTS OF HAZELNUT HUSK WASTE ON QUALITY PARAMETERS OF GERMAN PRIMROSE (*PRIMULA OBCONICA* HANCE)

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Keywords: Hazelnut husk waste, Sphagnum moss peat, Esthetic appearance score, Growth parameters, German primrose, *Primula obconica*.

Abstract

The study was conducted to determine the feasibility of using hazelnut shell waste as a growth medium for German primroses (*Primula obconica* Hance) under greenhouse conditions. Five different media combinations were prepared using sphagnum moss peat (SMP) and hazelnut husk waste (HHW). Some quality and growth parameters of *P. obconica* appeared to be significantly different depending on the growth medium. Results showed that HHW had a statistically significant impact on two parameters, namely aesthetic appearance score and mean flower weight, but had no impact on the other qualitative traits. The highest (8.94) and lowest (4.70) esthetic appearance scores were observed at 100% HHW and control treatments, respectively. In addition, the maximum (0.15 g) and minimum (0.097 g) mean flower weights were observed in HHW2 treatment and control plants, respectively.

Introduction

Modern agricultural practices have enabled year-round crop cultivation in controlled environments. This has led to increased use of inputs and the generation of significant agricultural waste such as stems, straw, greenhouse waste and hazelnut shells, as well as residues from agricultural processing including molasses, beer brewing waste and rosewater processing waste in Turkey. Kütük and Çayci (2000) reported that incorporating agricultural waste directly into the soil can serve as a source of organic matter and nutrients for plants, and in specific ratios, can even be used as a growth medium (However, the organic matter content of plant waste varies depending on factors such as genus, species, growth type, and climatic conditions (Di blassi *et al*. 1997). For instance, hazelnut husk waste, containing 46% nitrogen at harvest time, can serve as an excellent source of nitrogen when mixed with fertilizers (Çalişkan *et al*. 1996). Various mixtures of peat are used in greenhouses to supply the nutrient requirement for plant growth and be economical too. To meet the organic matter requirements for ornamental plants, a common substrate mix of peat and tree bark compost is presently used (Jones 2005). German primrose (*Primula obconica* Hance.) an herbaceous plant belonging to Primulaceae, is widely regarded for its ornamental value due to year-round flowering and diverse flower colors (Öge 1997). Nonetheless, interests have been piqued in exploring alternative compounds like cocopeat, sawdust, and rice bran, with hazelnut husk waste being effectively utilized as a substrate for ornamental plants in Turkey. Thus conserving natural resources, preserving the environment, and proving economically beneficial (Ozcimen and Ersoy-Mericboyu 2010). Dede *et al*. (2010) explored the utilization of hazelnut husk waste, maize straw, and poultry manure, along with other materials, as growth media for ornamental plants such as ligustrum (*Ligustrum lucidum*) and cypress (*Cupressus macrocarpa*). Additionally, in recent times, numerous materials have been adopted for propagation techniques, especially in nurseries, where cost-effective potting media are preferred.

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The present study investigated the novel use of hazelnut shell waste as a substrate for *P. obconica* with the intention of evaluating its potential to optimize and introduce an ideal and cost-effective growth medium. Furthermore, this research represents the first investigation of hazelnut husk waste as a substrate for *P. obconica*, with the aim of assessing its impact on plant growth and development, and its economic viability as a sustainable alternative substrate.

Materials and Methods

In the present study, German primrose (*P. obconica*) of the Primulaceae family was used as a test plant. Rooted seedlings with four leaves were purchased from a commercial floriculture farm (Ayvalı Sera Tarımsal Ürün San. Tic. Ltd. Şti., Ankara). Hazelnut husk waste (HHW) was collected from the piled sample kept in an open storage area in the Black Sea region. The samples were dried at room temperature until the moisture level decreased to 25%, and they were then milled and screened (6.35 mm) to obtain homogeneity before using to fill the pots (Atikmen *et al*. 2018). Sphagnum moss peat (SMP used as the control) was supplied by Florafleur, Netherlands. Five different media combinations (v/v) using sphagnum moss peat (SMP) and hazelnut husk waste (HHW) were as follows:

1. Control: 100% peat
2. HHW_1: 75% peat + 25% hazelnut husk waste
3. HHW_2: 50% peat + 50% hazelnut husk waste
4. HHW_3: 25% peat + 75% hazelnut husk waste
5. HHW_4: 100% hazelnut husk waste

The experiment was carried out in the greenhouse of the Department of Soil Science and Plant Nutrition of the Faculty of Agriculture of the University of Ankara, Turkey. In the greenhouse, the average day and night temperature was between 28 and 22°C, relative humidity was between 60 and 70 %, and the light regime was between 400 and 500 mol/m^2 for a 12-hrs photoperiod. The treatment materials were placed in one litre plastic pots. A *P. obconica* seedling was then placed in each pot and the pots were watered with tap water every other day for 50 days to allow the seedlings to acclimate to the new environment. A completely randomized design (CRD) with five replications for each treatment was followed to conduct the present experiment. The plants were watered once a week for seven months with a nutrient solution (Sonnoveld and Straver 1992). All the changes in the appearance and growth of the plants were recorded and photographed (Figs 1-5). At the end of the experiment, 11 experts rated the Aesthetic Appearance Score Index of plants on a scale of 1 to 10, with 1 indicating the least beauty and 10 the greatest beauty (Erdoğan 2004).

In addition, some growth parameters were also measured, including the number of flowering shoots, total flower number, mean flower weight, petal width, plant height and leaf number (Erdoğan 2004). All the recorded data were subjected to analysis of variance (ANOVA) followed by comparison means of data using the Duncan's Multiple Range Test ($P < 0.05, 0.01, 0.001$).

Results and Discussion

The one-way ANOVA results revealed that HHW had a statistically significant influence on only two parameters, aesthetic appearance score and mean weight of flower (at P 0.001 and P 0.05 levels, respectively, but had no effect on the other qualitative parameters (Table 1). In contrast, the application of HHW did not make any significant differences in the parameters of flower shoot number, total flower number, petal width, plant height, and leaf number.

The results of the statistical grouping of the HHW treatments by DMRT at the $P < 0.001$ showed that aesthetic appearance score was highest (8.94) in 100% HHW and lowest (4.70) in control treatments (Table 2 and Fig. 6). On the other hand, there was no significant difference

among the treatments of HHW_4 (100% HHW, 25% peat + 75% HHW), and HHW_2 (50% peat + 50% HHW), so all these three treatments were classified in the same statistical group. The DMRT analysis revealed that the plants grown in HHW_2 (50% peat + 50% HHW) had highest mean flower weight of 0.150 g, and the control plants had the lowest (0.097 g) value (Table 3, Fig. 7). While, rest of the treatments did not show any signification variations.

Fig. 1. Growth phase of German primula with different treatments under greenhouse condition.

Fig. 2. Different treatments on German primula. K=Control (% 100 peat), FDA_1 =HHW1(% 75peat + % 25 hazelnut hust waste), FDA_2 =HHW2(% 50peat + % 50 hazelnut hust waste), FDA_3 =HHW3 (% 25 peat + % 75 hazelnut hust waste), FDA_4 = HHW4 (% 100 hazelnut hust waste)

Fig. 3. General view of the differences in the number of flower shoots of the German primula plant by the hazelnut husk waste.

Fig. 4. General view of the differences in the total flower number of the German primula plant in hazelnut husk waste treatment.

Fig. 5. General view of the differences in the crown width of the German primula by the hazelnut husk waste. K=Control (% 100 peat), FDA1 =HHW1(% 75peat + % 25 hazelnut hust waste), FDA2 =HHW2(% 50peat + % 50 hazelnut hust waste), FDA3 =HHW3 (% 25 peat + % 75 hazelnut hust waste), FDA4 = HHW4 (% 100 hazelnut hust waste).

In the recorded qualitative parameters, only esthetic appearance scores and the mean flower weight values were significantly altered by the addition of hazelnut husk waste (HHW) (at the $P < 0.05$ and $P < 0.001$ levels, respectively). Whereas, qualitative parameters such as the number of flower stem, overall blossom count, size of plant canopy, height and leaf numbers were not affected by HHW treatment. The qualitative traits of the plants grown in composted hazelnut husks were superior or even close to the control treatment. The second and third highest scores were obtained from the growth media containing 75 and 50% HHW, respectively. The least amount was also related to the control in which the plants were grown in 100% peat. The two studied groups of the plants (grown in HHW-containing and HHW-free media) remarkably differed in apparent beauty and the good feeling that they provoke in humans at the first sight.

Table 1. ANOVA table on the effect of hazelnut husk waste on the quality parameters of *P. obconica.*

Source of Variation	df	Means of Square						
		AAS	FSN	TFN	MFW (g)	PW (cm)	PH (cm)	LN
Treatment	4	17.67	2.74	479	0.003	50.58	51.66	452.1
Error	20	2.16	2.28	1209	0.0008	49.52	22.21	162
Total	24							
F		8.19^{***}	1.20^{ns}	0.4^{ns}	4.12^{*}	1.02^{ns}	2.33^{ns}	2.79^{ns}

Table 2. Effects of different growing media on Aesthetic appearance score of Primula. Control = %100 Peat, HHW1 = %75 Peat + %25 Hazelnut Husk Waste, HHW2 = %50 Peat + %50 Hazelnut Husk Waste, HHW3 = %25 Peat + %75 Hazelnut Husk Waste, HHW4 = %100 Hazelnut Husk Waste.

Growth media	Aesthetic appearance score (1-10)
Control	4.70 c *
HHW1	6.72 b
HHW2	8.87 a
HHW3	8.85 a
HHW4	8.94 a

*Mean data in a column with same letter are not significantly different at p<0.001 level by DMRT.

Table 3. Effects of different growing media on *Average flower weight* of Primula. Control = %100 Peat, HW1 = %75 Peat + %25 Hazelnut Husk Waste, HHW2 = %50 Peat + %50 Hazelnut Husk Waste, HHW3 = %25 Peat + %75 Hazelnut Husk Waste, HHW4 = %100 Hazelnut Husk Waste.

Growth media	Average flower weight (gr)
Control	0.097 b*
HHW1	0.100 b
HHW2	0.150 a
HHW3	0.138 ab
HHW4	0.148 a

*Mean data in a column with same letter are not significantly different at p<0.001 level by DMRT.

These results suggest that hazelnut husk waste can easily serve as a reliable alternative to peat, which is often used as a growing medium for ornamental plants. It is also economically relevant because of the high cost and extensive use of peat as a substrate for plant growth, especially in horticultural potting plants. It is estimated that over 100,000 cubic meters of peat are imported into the country annually. Hazelnut husk waste is considered as a potential natural resource that can be utilized in this context. Research on the impact of organic materials used in growth media on the qualitative parameters of ornamental plants may yield diverse results depending on the properties of the materials and growth conditions. Moreover, greater the soil aeration in the root zone of the pots, the better the root growth and development, nutrient absorption, and nutrient mobilization will be. This parameter is important in improving the appearance of flowers. De boodt and Verdonck (1972) stated that 20-25% aeration is necessary in the growth media to ensure the optimal development of a plant.

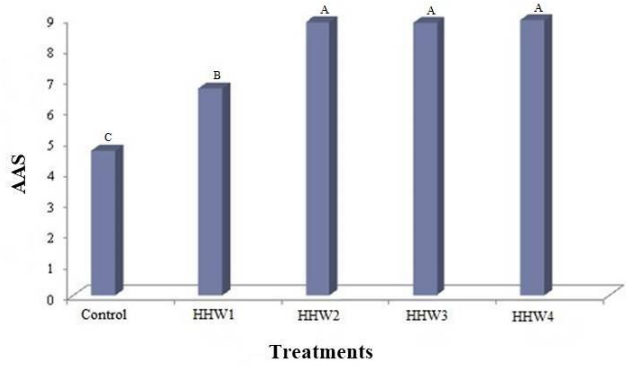

Fig. 6. Effects of different hazelnut husk waste treatments on mean aesthetic appearance score of German primula. (AAS: Aesthetic appearance score; Control: 100% Peat; HHW: Hazelnut husk waste; HHW1: 75% Peat + 25% HHW; HHW2: 50% Peat + 50% HHW; HHW3: 25% Peat + 75% HHW; HHW4: 100% HHW)

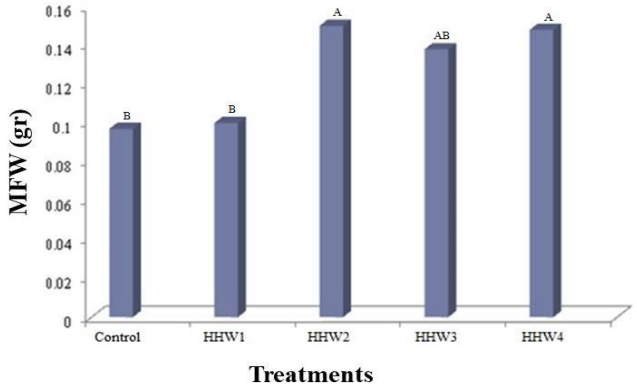

Fig. 7. Effects of different hazelnut husk waste treatments on mean flower weight of German primula. (MFW: Mean flower weight; Control: 100% Peat; HHW: Hazelnut husk waste; HHW1: 75% Peat + 25% HHW; HHW2: 50% Peat + 50% HHW; HHW3: 25% Peat + 75% HHW; HHW4: 100% HHW)

Plants require a medium that provides adequate and balanced water and nutrients, sufficient oxygen supply for capillary root growth, favorable osmotic tension and reaction for the maintenance of water and nutrient exchanges, optimum temperature ranges, the absence of competitive macro and microorganisms, as well as conditions for the improved and warranted beneficial biological activities (Harris 1978). Peat is commonly used as a growth material in artificial media. Botanical origin, humification degree, and formation processes considerably affect the potential to utilize peat materials as growing medium (Dengiz *et al*. 2009).

This investigation determined that the physical characteristics of the media, especially the aeration capacity affect some of nutrient contents and development parameters of German primula plant. When all data were examined, it was found that hazelnut husk waste can be used at least 50% and more for the growth of German primula. Media components used for ornamentals are considerable input for growers. Furthermore, the use of waste materials in floriculture will decrease the extraction of peat from environmentally sensitive swamps worldwide, as well as provide economic incentives for growers at a reduced cost (Najafi *et al*. 2019). In the present

study, it was observed that HHW4 (%100 Hazelnut Husk Waste) and HHW2 (50% Hazelnut Husk Waste + 50% peat) treatments showed best performance for average flower weight. Moreover, physical and chemical properties of the media might had a positive effect on the state of flowering, the number and appearance of flowers, the color and structures of the flowers, the cheerfulness and freshness of the flowers, and the brightness and luster of the flowers.

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Manuscript received on 18 February, 2023; revised on 03 September, 2023)