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INFLUENCE OF THE MEDIUM WITH ADDITION OF COCOA HUSK ON THE PRODUCTION OF SEEDLINGS OF SELECTED SPECIES AND CULTIVARS OF BEDDING PLANTS

WPŁYW PODŁOŻA Z DODATKIEM ŁUSKI KAKAOWEJ NA PRODUKCJĘ ROZSADY WYBRANYCH GATUNKÓW I ODMIAN ROŚLIN KWIETNIKOWYCH

Abstract: The experiment was conducted in the years 2007–2008. Its purpose was to compare the germination, further growth and the quality of seedlings of annual plants grown on a traditional medium (peat) and on a medium with the addition of cocoa husks. The test plants were: *Tagetes erecta*, 'Klaun' cv., *Tagetes patula nana*, 'Bolero' cv., *Impatiens walleriana*, 'Candy White' and 'Candy Red' cvs. Seeds of all the taxons were sown onto two media: 1. deacidified high peat with the addition of Azofoska fertilizer in the dose of 2 g · dm^{-3} (control medium); 2. peat + cocoa husks (1:1 v/v). Cocoa husk constituted a waste product from a confectionery plant, prior to use it had been composted for a period of approx. 12 months.

Chemical analysis of the cocoa husks has shown that this component is rich in nutrients. After the 12-month period of composting the structure of the husks changed, the pH value of the husks dropped, their electrical conductivity (EC) lowered, and the amount of plant-available nitrogen increased. It was found that the 1:1 v/v cocoa husk medium, used for sowing shortened the time of plant emergence and also shortened the production period of marigold and impatiens seedlings by 6 to 14 days. Cocoa husks favourably influenced the development of the root system and accelerated the blossoming time of the tested cultivars.

Keywords: flower bed plants, medium, cocoa husk, *Tagetes, Impatiens*

Bedding plants constitute an important part of Polish ornamental horticulture. By devising a production technology of these plants the improvement of growing conditions plays an important part, on the other hand, however, a lot of emphasis is put on environmental protection. Peat is the basic medium for protected cultivation of ornamental plants. However, its resources are constantly decreasing. In order to reduce peat extraction, only to a small extent, research is being conducted to explore the

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possibility of using other substances, including waste products, which might partially replace it [1–3].

In recent years new medium components have been more and more widely used in horticultural cultivations, especially organic ones [4, 5]. They are frequently treated as organic fertilizers, as they constitute a valuable source of macro- and micronutrients for cultivated plants, improve soil structure and play an important role in organic matter balance [6]. On the other hand, their composting and application in cultivation allows efficient utilization of wastes, especially in urban areas or in the vicinity of processing plants where such by-products are produced. Cocoa husks, constituting a waste product of chocolate production, are an example of such materials. Owing to the high dry mass content they are used to stabilize other waste materials, especially liquid ones, as a structure-forming component [2].

The studies conducted were aimed at determining the cocoa husk value as a component of the medium and defining its fertilizing value. The applicability of cocoa husks in the production of *Tagetes erecta*, *Tagetes patula nana* and *Impatiens walleriana* was also verified.

Material and methods

The experiment was conducted at the Department of Ornamental Plants, University of Agriculture in Szczecin within the Vegetation Hall in the years 2007–2008. Cocoa husk used for the study was a waste product from a confectionery plant. Prior to use, it had been composted for a period of 12 months with the addition of 1.5 kg of urea per 1 m^3 of husks. Before the commencement of the experiments the chemical and physical properties of cocoa husks were analyzed. They allowed to determine the content of individual nutrients, the reaction of the husks, their salinity and moisture capacity.

The test plants were: *Tagetes erecta*, 'Klaun' cv., *Tagetes patula nana*, 'Bolero' cv., *Impatiens walleriana*, 'Candy White' and 'Candy Red' cvs. The seeds of all the taxons were sown after the March 20th into seedling punnets. As the control medium sphagnum peat with the addition of Azofoska fertilizer in the dose of 1 g · dm^{-3} was used. The other medium consisted of a mixture of peat and cocoa husks in a 1:1 volume ratio with no fertilizer added. The pH value of both media was increased to 6.0 by means of chalk and dolomite. Young marigold plants were planted in pots 4–6 weeks after sowing, impatiens plants – after 8 weeks after sowings. These differences resulted from the growth rate of plants on the individual media. Pots with ∅ 12 cm were used for planting, also two media were used – peat and a mixture of peat and cocoa husks (1:1 v/v). Osmocote Exact Hi-Start fertilizer at a dose of 5 g · dm^{-3} was added to the peat medium. The plants grew in patches in an unheated high tunnel until the end of the experiment.

In the experiment the seed ability to germinate and the rate of germination were evaluated and the length of the aboveground parts of the seedlings as well as the size and quality of the root system were measured. In the second part of the experiment, after planting the seedlings in pots, the time needed to obtain ready-to-sell blossoming seedlings was evaluated, the size of the plants was measured and the number of buds

and flowers and their general ornamental value were assessed. The results of the measurements of the plant biometric features were analyzed statistically by means of year synthesis. Differences between means were verified statistically by the means of Tukey's test at the significance level $\alpha = 0.05$.

Results and discussion

Cocoa husks are characterized by a high dry mass content, a high content of total nitrogen and the C:N ratio is lower compared with other structure-forming materials such as straw or shredded paper [7]. The chemical analysis showed that cocoa husks, after the period of composting, had a high NO_3-N content, on the other hand, the content of P and K decreased. Similar dependencies were found by Lis-Krzyscin [8], although in her studies the medium with the addition of cocoa husks had been composted only for six months. According to the literature, the decrease in potassium content is beneficial as too high its amount may block the absorption of other elements and the plants wither easily [9]. It was found that the composting process of cocoa husk improved its physical properties, increasing its porosity and moisture capacity. Composted cocoa husks also had a lower electrical conductivity and the medium was characterized by a low pH (Table 1). As cocoa husks decompose quickly under the influence of water and fertilizers, they can be primarily used as a component of mixtures in protected cultivations of ornamental plants, eg in seedling production which does not last longer than 12 weeks [10].

Table 1

Physical and chemical properties of fresh cocoa husks and after composting

Cocoa husks	Physical properties				The contents of macroelements [mg · dm^{-3} of medium]					
	Bulk weight [g · dm^{-3}]	pH in H_2O	EC [mS · cm^{-1}]	Full water capacity [% v/v]	NO_3-N	P	K	Ca	Mg	Cl
Fresh cocoa husk	250	6.8	3.102	—	81	377	2154	137	380	168
Composted cocoa husk	380	4.3	1.156	84.6	161	126	932	443	203	43

After the analysis of the content of the most important macronutrients in cocoa husks and commonly used fertilizers it can be concluded that cocoa husks have a high fertilizing value. The dose of 142.5 g per pot used in the experiment introduced large amounts of NO_3-N into plants (60 mg per plant), and a similar amount of potassium as Osmocote Exact Hi-Start fertilizer (Table 2). Although no fertilizer had been added to the medium containing the composted cocoa husks the plants developed properly and grew even faster than the plants grown on the peat medium.

Table 2

Comparison of fertilizer value of cocoa husk and common fertilizers: Azofoska and Osmocote Exact Hi-Start

Fertilizer	Dose [g per plant]	Amount of N	Amount of P	Amount of K
		[mg per plant]		
Cocoa husk	142.5	60.4	47.2	349.5
Azofoska	3.75	510	240	600
Osmocote Exact Hi-Start	3.75	637	375	375

On the basis of the measurements and observations of the plants grown on both media it was found that the seeds of almost all cultivars germinated 1–2 days more quickly and the germination was more balanced when the medium with cocoa husks was used. Only in *Impatiens Walleriana*, 'Candy Red' cv., a larger percentage of germination was observed on the peat medium than on the medium with cocoa husks (Table 3).

Table 3

Influence of cocoa husk on quality of marigolds and impatiens seedlings – synthesis of 2 year experiments

Species and cultivar	Medium	Seedlings traits				
		Height of seedling [cm]	Number of leaves	Number of roots	Number of roots longer than 3 cm	Germination [%]
Tagetes erecta 'Klaun'	peat	11.5 a**	5.97 a	11.83 a	3.75 a	76
	*peat + cocoa husk (1:1 v/v)	*12.1 a	*5.45 a	*12.26 a	*3.22 a	94
Tagetes patula nana 'Bolero'	peat	6.08 a	4.9 b	12.71 b	3.92 b	59
	*peat + cocoa husk (1:1 v/v)	*6.51 a	*6.4 a	*14.82 a	*4.59 a	76
Impatiens walleriana 'Candy Red'	peat	3.23 b	3.51 b	10.02 a	4.75 a	82
	*peat + cocoa husk (1:1 v/v)	8.23 a	4.66 a	7.42 b	3.53 b	75
Impatiens walleriana 'Candy White'	peat	3.26 b	3.36 b	6.92 a	4.07 a	73
	*peat + cocoa husk (1:1 v/v)	7.41 a	4.64 a	7.57 a	3.17 b	90

* The measurements were performed 2 weeks earlier due to the large size and the necessity to replant the seedling growing on the cocoa husk medium; ** Averages followed by the same letter do not differ significantly at $\alpha = 0.05$.

Marigold cultivars growing on the cocoa husk medium needed to be pinched out 14 days earlier than the same cultivar growing on the peat medium (Table 3). Marigolds of the 'Bolero' cultivar grown on the cocoa husk medium had more leaves and roots,

including roots longer than 3 cm, although the measurements were performed 2 weeks earlier due to the large size and the necessity to replant the seedling growing on this substrate.

The addition of cocoa husks also influenced the growth rate at the further stage of cultivation (Table 4).

Table 4

Influence of cocoa husk on vegetative and generative traits of marigolds and impatiens – synthesis of 2 year experiments

Species and cultivar	Medium	Seedlings traits			
		Height of plants	Diameter of plants	Number of buds	Number of flowers
		[cm]			
Tagetes erecta 'Klaun'	peat	55.2 a**	43.3 a	3.33 b	2.00 a
	*peat + cocoa husk (1:1 v/v)	*43.8 b	*30.2 b	*5.00 a	*1.00 a
Tagetes patula nana 'Bolero'	peat	17.6 a	25.7 a	7.67 b	3.00 a
	*peat + cocoa husk (1:1 v/v)	*17.7 a	*18.8 b	*9.75 a	*0.75 b
Impatiens walleriana 'Candy Red'	peat	9.0 b	23.0 a	17.25 a	3.23 b
	peat + cocoa husk (1:1 v/v)	15.3 a	23.3 a	19.00 a	10.50 a
Impatiens walleriana 'Candy White'	peat	9.5 b	27.5 a	24.75 a	2.00 b
	peat + cocoa husk (1:1 v/v)	13.8 a	22.5 a	21.00 a	15.65 a

Explanation, see Table 3.

Both marigold and impatiens plants grown on the cocoa husk medium entered the generative growth stage earlier and were ready for sale. *Tagetes erecta*, 'Klaun' cv., grown on the cocoa husk medium was more compact, lower and less expansive than those grown on the peat medium, however, it had more flower buds. Both cultivars of *Impatiens walleriana* were taller when grown on the cocoa husk medium, they also blossomed more abundantly. They started to blossom on average 6 days ('Candy White' cv.) and 9 days ('Candy Red' cv.) earlier than plants grown on the peat medium. Also in the studies by Lis-Krzyscin [8] it was found that compost with the addition of cocoa husks had a beneficial effect upon the development of plants and the abundance of blossom of bedding geranium, 'Susan Improved' cv. In the experiments conducted by Ochmian et al [11] the influence of cocoa husk addition on the yield and quality of fruits of highbush blueberry, 'Sierra' cv., was examined. It was found that plants cultivated in sphagnum peat and cocoa husk were characterized by lower yield, smaller fruits, but higher content of phenolics and anthocyanins in fruits.

Conclusion

1. Composted cocoa husk constitutes a valuable addition to the medium, it also has a high fertilizing value.

2. The addition of composted cocoa husks to the peat medium (1:1 v/v) with no other fertilizers favourably influences the growth and development of .

3. By growing plants in a mixture of peat and cocoa husks (1:1 v/v) ready for sale seedlings of *Tagetes erecta*, 'Klaun' cv., can be obtained by approx. 14 days earlier than in the case of a peat medium.

4. *Impatiens walleriana* from the Candy group develop better, grow more strongly and blossom 6–9 days earlier when they are grown on a mixture of peat and cocoa husks (1:1 v/v).

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Abstrakt: Celem doświadczenia przeprowadzonego w latach 2007–2008 było porównanie kiełkowania i dalszego wzrostu oraz jakości rozsady roślin jednorocznych uprawianych w podłożu tradycyjnym (torf) oraz w podłożu z dodatkiem łuski kakaowej. Roślinami testowymi były: *Tagetes erecta* odm. 'Klaun', *Tagetes patula nana* odm. 'Bolero', *Impatiens walleriana* odm. 'Candy White' i 'Candy Red'. Nasiona wszystkich taksonów wysiano do dwóch podłoży: 1. odkwaszony torf wysoki z dodatkiem nawozu Azofoska w dawce 2 g · dm^{-3} (podłoże kontrolne); 2. torf + łuska kakaowa (1:1 v/v). Łuska kakaowa stanowiła odpad pochodzący z zakładu cukierniczego, przed użyciem do doświadczeń kompostowano ją przez okres około 12 miesięcy.

Analiza chemiczna łuski kakaowej wykazała, że komponent ten jest zasobny w składniki pokarmowe. Po rocznym okresie kompostowania zmieniła się struktura łuski, obniżyło się pH łuski, obniżyła się także konduktywność (przewodność właściwa EC), wzrosła natomiast ilość dostępnego dla roślin azotu. Stwierdzono, że podłoże z dodatkiem łuski kakaowej (1:1 v/v), zastosowane do wysiewu przyspieszyło wschody, a także skróciło okres produkcji rozsady aksamitki i niecierpka od 6 do 14 dni. Łuska kakaowa korzystnie wpłynęła na rozbudowę systemu korzeniowego i przyspieszyła kwitnienie roślin badanych odmian.

Słowa kluczowe: rośliny kwietnikowe, podłoże, łuska kakaowa, *Tagetes, Impatiens*