The Effect of Cultivation Ways on Selected Morphological Characters of Bitter Gourd (*Momordica charantia* L.) Transplants and Plants, Fruit Yield and Chemical Content

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Abstract

Bitter gourd or bitter melon (*Momordica charantia* L.) is an unknown in Poland vegetable of the Chinese origin commonly used in Eastern Asia to feed and cure diabetic people. In the years 2012-2013, the investigations were carried out on preparing its transplants and growing it in Poland using two ways of cultivation: with the supporting sticks or lying directly on the ground. The received transplants and then plants were analyzed for their selected morphological characters. The collected fruits were analyzed for their ash, dry weight, total protein, fats and carbohydrates, Ca, Mg, K, Na, Fe, Mn, Zn and Cu contents. The best transplants were those of 3 leaves, 7 cm high with the biggest leaf's width over 5 cm. The growing the species with the sticks lowered their total fruit yield but increased the weight of an individual fruit. When planting the transplants before June 1st, germinating seeds were produced. When planting after that time, fruit were set but seeds were not ripened. The fruits from plants grown with the sticks had lower dry matter and Mn contents than the ones lying on the ground. The way of cultivation of the plants had no effect on all other analyzed chemical elements and characters.

Keywords: *cucurbit crops, field vegetables, bitter gourd transplants, bitter melon*

INTRODUCTION

A bitter gourd (*Momordica charantia* L.) is a cucurbit vegetable originated from China. It has been used widely in the Far East countries, e.g. China, Japan and India, for diet of diabetic people and for curing people in natural medicine. For commercial use, heterosis has been reported for the species (Robinson, 1999). Although the species had been known and used for years, only recently, it was found to have also some other active chemical compounds suitable to control and cure many other human diseases and malfunctions (Huang *et al.*, 2008, Neurocar *et al.*, 2010, Tarkang and Ofogba, 2010, Wang *et al.*, 2011, Zhang *et al.*, 2012).

Till only a few years ago, bitter gourd had been completely unknown in Poland (Hołubowicz and Bralewski, 2006). The preliminary research showed a possibility to grow it in the field in Poland and get its germinating seeds (Hołubowicz *et al.*, 2009). Since 2010, the seeds of this vegetable are available on the Polish seed market (Anonymous, 2010).

The objective of this experiment was to look at the best way to produce bitter gourd transplants and grow it in the field in the climatic conditions of Western Poland.

MATERIALS AND METHODS

Seeds. The bitter gourd seeds of the cultivar 'Nana" used for this experiment came from India. They were imported to Poland by "W. Legutko" – a Polish plant breeding and seed production company.

Two independent experiments were performed: one with the plants in the field – run in 2012 - to find out which way of production is better and one with the transplants - run in 2013 - to find out the optimal size of the transplants.

Transplants production. Transplants were produced in the cold greenhouse of the above mentioned seed company. The seeds were sown into the mixture of compost and peat in the volume ratio as 1 to 1. In order to produce transplants, 100 seeds in 4 replications were sown on May 24th, 2012. The ready transplants were received on 20th June, 2012. At that time, no measurements of transplants were done.

Transplants quality. In order to evaluate the transplants most convenient size, transplants production was repeated in the spring of 2013. The seeds were sown on 15th April, 2013 but the spring of 2013 was late and May was cold, so it took altogether longer to produce them. Just before planting the transplants, on 24th June, 2013, the transplants field emergences were counted and, before planting them on the field, their height, number of leaves and the width of the biggest leaf were measured.

The fruit production ways. The experiment was started on 20th June, 2012 on the field of the Marcelin Experimental Station of the Faculty of Horticulture and Landscape Architecture in Poznań in Western Poland. The field had podzol type of soil with heavy sand on the clay. The transplants were planted into 4 rows of 20 plants each with the spacing 20 cm x 150 cm. They were cultivated into 2 ways: 1/ climbing on the wooden sticks and strung and 2/ creeping freely on the ground. Each combination had 4 replications of 10 plants. On 15th October, 2012, the fruits were collected, counted and weighted. Then samples of their flesh were taken and frozen at -10^{o}C. From the 5 randomized plants, the number of side branches and lengths of their 3 longest side branches were measured.

All the chemical analyses were done in 4 replications at the laboratory of the Department of Human Nutrition and Hygiene of the Poznań University of Life Sciences. The dry mass content in fruits from plants climbing on the sticks and creeping on the ground were 8.77% and 9.37% respectively. The frozen fruit were freeze-dried using Christ Alpha 1-4 LSC freeze dryer (Christ, Germany), than powdered and used for further analyses. The proteins were measured using the Kjeldahl's method (Bobrzański, 1956), the lipids – by the Soxhlet's method (Stepnowski *et al*., 2010), dry matter – by the drying method (Kocjan, 2002), ash content - by using a muffle oven (Iwińska *et al.*, 1964). The macro- and micro-elements contents were measured by the atomic absorption spectrometry method (Ditrich, 1988, Borkowska-Burnecka, 2012).

The weather conditions during the experiment in the field, i.e. from June till October, 2012, were good for cucurbit vegetables plants and transplants production, including bitter gourd. The average monthly air temperature was in June 5^{o}C higher than the average value of the same parameter in the years 2000-2010, but 5^{o}C lower than average for August. The monthly sums of precipitation in all of the months of the experiment were lower than the average values for the same periods in the years 2000-2010. The biggest difference was recorded for August, 2012, which for it was less than half of the average value.

Statistical analysis of the results. The variance for all the received results was calculated. The smallest significant differences were calculated based on the Duncan's test for α - 0.05 and marked with different letters.

RESULTS AND DISCUSSION

The received results proved that in the conditions of Poland, in the cold greenhouse, it was possible to produce transplants of bitter gourd. The seeds of the bitter gourd emerged in the greenhouse in 2012 and 2013 in 50% and 30%, respectively (Tab. 1). The best transplants were those of 3 leaves, 7 cm high with the biggest leaf's width over 5 cm (Tab. 1). This results, when taking under consideration the origin of the species from Far East countries (Wang *et al.*, 2009), could be considered as acceptable for the seed amateur market. Also the parameters of the transplants met the size of typical cucurbit transplants available on the Polish market (Rekowska, 2007). The crucial here was the time of transplants planting in the field. Just after the spring frost is a main danger, i.e.

after May 20th. If they were planted on June 20th, as it was in 2012, they gave fruits but the seeds were not ripened. From the unpublished observations in the 2 previous years: 2010-2011, it was learnt that if planting of the transplants takes place before June 1st, the germinating seeds in fruits were produced. Due to the climatic conditions in Poland, i.e. relatively short vegetation period without frosts, when growing bitter gourd in the field, only early cultivars can be used for seed production.

The carried out in the field experiment proved that it is better to grow bitter gourd in the field using sticks than letting the plants to be grown freely on the ground. Although the number of fruits per one plant was smaller, still the produced fruits were bigger (tab. 2) and more ripened. The way of cultivation had no effect on the mean length of side branches. The plants climbing on the sticks and strung had higher number of side branches than the ones creeping on the ground (tab.2). The method of growing bitter gourd in China is most commonly with the sticks. However, it is so not because of the yield or fruit ripening, but mostly due to saving the space on the field or parallel growing another vegetable species as the second crop on the same field (Zhen, 2001,Wang, 2009).

The fruit from plants grown with the sticks had lower dry matter than the ones lying on the ground (Tab. 3) and also the Mn content was lower in the fruits grown with the sticks than in the ones lying on the ground (Tab. 4). The way of cultivation of the plants had no effect on all other analyzed chemical elements and characters.

Today, in the world, the bitter gourd is well known and recognized, not only as a vegetable species to feed people, but also as a source of precious chemical compounds with a potential to be used for pharmacy to cure people (Sharma *et al.*, 2010, Malik *et al.*, 2011)). Moreover, there is still research going on its new, yet unknown, bioactive chemical compounds present in its seeds (Wei, Luo, 2010, Huang *et al.*, 2011, Krishna *et al*., 2011) as well as in leaves.

It was found that they have the potential to slow down the human cancer cell lines development (Zhang *et al.*, 2012, Kwatra *et al.* 2013). Also it has been reported that these bioactive compounds can control some fast developing insects, against which insecticide control is less effective, e.g. diamondback moth (*Plutella xylostella*, Ling *et al.*, 2008).

The carried out experiment proved that in the Polish climatic conditions, there can be produced bitter gourd fruits and in some years also seeds. The research on this topic will be continued.

CONCLUSIONS

In Western Poland, the climatic conditions allow to grow bitter gourd fruits in the field.

The best transplants were those of 3 leaves, 7 cm high with the biggest leaf's width over 5 cm.

The growing the species with the sticks lowered their total fruit yield but increased the weight of an individual fruit. When planting the transplants before 1st June, the germinating seeds were produced. When planting after that time, fruit were set but seeds were not ripened.

Tab. 1 Field emergences and some morphological characters of bitter gourd transplants

Character	Emergences (%)	Number of leaves	The plant's height (cm)	The width of the biggest leaf (cm)
Value	30	6	7	5.3

Tab. 2 Effect of the cultivation way on selected quality characters of bitter gourd plant and fruit

Plants	Number of fruits per plant	Mean length of side branches (cm)	Number of side branches	Fruit weight (g)
Climbing on the sticks	4.1 a*	152 a	11.5 a	143.5 a
Creeping on the ground	7.1 b	229 a	7.9 b	137.1 b

* means followed by the same letter for a given character are not significantly different according to the Duncan's test for α - 0.05

Tab. 3 The effect of cultivation way on selected chemical parameters of bitter gourd fruits (expressed in g/100g of dry matter of lyophilisate)

Plants	Ash (%)	Dry mass (%)	Proteins (%)	Fats (%)	Total Carbohydrates (%)
Climbing on the sticks	11.12 a*	88.85 a	15.86 a	1.29 a	61.58 a
Creeping on the ground	11.92 a	90.02 b	18.07 a	1.42 a	59.60 a

* see tab. 2 for explanation

Tab. 4 The effect of cultivation way on selected macro- and microelements content of bitter gourd fruits (ex- pressed in mg/100 g of dry matter of lyophilisate)

Plants	Ca	Mg	K	Na	Fe	Mn	Zn	Cu
Climbing on the sticks	351.67 a*	203.24 a	4309.24 a	28.03 a	5.56 a	1.14 a	2.57 a	0.74 a
Creeping on the ground	359.99 a	219.28 a	4425.40 a	33.95 a	5.38 a	1.43 b	2.66 a	0.81 a

* see tab. 2 for explanation

The fruits from plants lying on the ground had higher dry matter content than the ones growing with the sticks, and also the Mn content was higher in the fruits lying on the ground than in the ones grown with the sticks. The way of cultivation of the plants had no effect on all other analyzed chemical elements and characters.

REFERENCES

1. Anonymous (2010). Catalogue of the seed company. "W. Legutko", 9.
2. Bobrzański, B.(1956). Quantitative analysis of organic compounds. PWN, Warsaw (in Polish).
3. Borkowska-Burnecka, J. (2012). Spectro-chemical analysis. PWN, Warsaw (in Polish).
4. Ditrich, K. (1988). Absorbic atomic spectro-photometry. PWN, Warsaw (in Polish).
5. Hołubowicz, R. and T.W. Bralewski (2006). Cucurbit vegetables grown in China. Hasło Ogrodnicze 8: 105-109 (in Polish).
6. Hołubowicz, R., R Xiong and Y. Liu (2009). Bitter guard and adzuki bean – rare in Europe vegetables originated from China can be grown in Poland. Bull. UASVM Hort. 66:420-423.
7. Huang, H.L., Y. Hong, Y. Chen, Y.Y. Chi, C.J. Chuang and P.M. Hao (2008) Bitter melon (*Momordica charantia*) inhibits adipocyte hypertrophy and down regulates lipogenic gene expression in adipose tissue of diet-induced obese rats. Brit. J. Nutr. 99: 230-239.
8. Huang, R.K., H.L. Luo, Y.H. Huang, X.F. Chen, X.L. Liu and J.Z. Liang (2011). Changes in accumulation of ribosome-inactive proteins (RIPs) at different seed development stages in three *Momordica charantia* genotypes. J. Southern Agric. 42(3):236-239 (in Chinese).
9. Iwińska, I., L. Litewka and C. Pietrzyk (1964). Methods of investigation of food products. PWN, Warsaw, 83-86 (in Polish).
10. Ling, B., G.C. Wang, J. Ya, M.X. Zhang and G.W. Liang (2008). Antifeedant activity and active ingredients against *Plutella xylostella* from *Momordica charantia* leaves. Agric. Sci. China 7(12):1466-1473.
11. Kocjan, R. (2002). Analytical chemistry. PWN, Warsaw (in Polish).
12. Krishna, B.L., A.N. Singh, S. Patra and V.K. Dubey (2011). Purification, characterization and immobilization of urease from *Momordica charantia* seeds. Process Biochem. 46:1486-1491.
13. Kwatra, D, D. Subramaniam, P. Ramamoorthy, D. Standing, E. Moran, R. Velayutham, A. Mitra, S. Umar and S. Anant (2013). Methanolic extracts of bitter melon inhibit colon cancer stem cells by affecting energy homeostasis and autophagy. Evid Based Complement Alternat Med. 2013:702869. doi: 10.1155/2013/702869. Epub 2013 Mar 6.
14. Malik, Z.A., S. Manjeet and P.L. Sharma (2011). Neuroprotective effect of *Momordica charantia* in global cerebral ischemia and reperfusion induced neuronal damage in diabetic mice. J. Ethnopharm. 133:729-734.
15. Neurocar, P., Z. Lee and R. Neurocar (2010). *Momordica charantia* L. (bitter melon) inhibits primary human adipocyte differentiation by modulating adipogenic genes. Compl. Altern. Med. 88 2/10/34.
16. Rekowska, E. (2007). Vegetable transplants production. In "General Vegetable Production". (ed. M. Knaflewski), PWR i L – Poznań, 181-189 (in Polish).
17. Robinson, R.W. (1999). Other cucurbits. In "Hybrid Seed Production in Vegetables: Rationale and Methods in Selected Crops" (ed. A.S. Basra), Food Product Press, Inc. New York, 13-15.

18. Sharma, S., M.C. Sharma and D. Kohli (2010). Wound healing activity of ether-chloroform extract of *Momordica charantia* fruits in rats. Digest J. Nanomat. Biostr. 5(1):123-126.
19. Stepnowski, P., E. Synak, B. Szafranek and Z. Kaczyński (2010). The separation techniques. Wydz. Uniw. Gdańskiego (in Polish).
20. Tarkang, A. and C. Ofogba, (2010). Evaluation of the hypoglycemic activity and safety of *Momordica charantia* (*Cucurbitaceae*). African J. Pharm. Sci. 3:17-29.
21. Wang, B., W. Zhang, J. Zhao, F. Wang, L. Fan, Z. Wu and Y. Hu (2011). Gene cloning and expression of a novel hypoglycemic peptide from *Momordica charantia*. Publ. online in Wiley Online Library DOI 10.1002/jsfa4485.
22. Wang, Y.Q. (2009). Bitter guard. In "Vegetable Production in China" 2nd. Edition. China Publ. Co., Beijing, 687-691 (in Chinese).
23. Wei, J. and W. Luo (2010). Antimicrobial experiment of protein contained in Balsam pear seed. J. Chengdu Univ. (Natural Sci. Ed.) 29(2):98-100 (in Chinese).
24. Zhang, J., Y. Huang, T. Kikuchi, H. Tokuda, N. Suzuki, K. Inafuku, M. Miura, S. Motohashi, T. Suzuki and T. Akihisa (2012). Cucurbitane triterpenoids from the leaves of *Momordica charantia,* and their cancer chemopreventive effects and cytotoxities. Chem. Biodiv. 9:428-440.
25. Zhen, H. (2001). Problems in the development of vegetable industry in China and some countermeasures. China's Herald Agric. Sci. Technol. 3.