THE INFLUENCE OF TECHNOLOGICAL PARAMETERS ON CHEMICAL COMPOSITION OF *MOMORDICA CHARANTIA* FRUITS

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Abstract. Bitter gourd (*Momordica charantia* L.) is appreciated for the nutritional qualities and biochemical compounds of fruits that are rich in folic acid and vitamin C. In Asia this species is cultivated to heal many diseases of human body. Experiments regarding the influence of technological parameters on chemical composition of *Momordica charantia* fruits took place at University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Romania. Several determination concerning total yield, proteins, fibres, momordicine, charantin and vitamin C were made. The obtained results show that highest total yield was noted in case of variant conducted with two branches and organically fertilized. The content of protein is higher than in the fruits of common cucumber. Vegetable fiber and mineral content are higher compering with other succulent vegetables. The mature leaves bioactive compounds ratio is 2,5:1 for charantin and 2:1 for momordicine. The highest content of vitamin C (197.12 mg/100 dry substances) was detected in the fruits of variants conducted with one branch and organically fertilized. At the same variants the total acidity with superior level (11,6%) was noticed.

Keywords: cultivation technology, bitter gourd, chemical composition

INTRODUCTION

Bitter melon or bitter gourd is a species which origin is not very clearly defined yet. Different authors declare its origin from different parts of Africa, India (Herklots 1972, Oomen and Grubben, 1977), China (Fohs A. et al., 2014) and Southeast Asia (Bharathi LK, 2011) due to its wide distribution in the tropics and subtropics. Currently, it is grown on a large scale across China, India, Indonesia, Suriname and Philippines (Seshardi, 1986) but it can be encountered also in California and Florida covering smaller areas (Morton 1962: Johnson 1981). According to Grebenscicov (1986), Jansen and Rademaker (1992) this species was firstly cultivated in India. The overripen fruits are very bitter, as also the common name of the species reflects its taste, and become inedible. In contrast, crushed seeds can be used for various seasoning preparation. From the red arils that cover the seeds of bitter melon food colorants can be prepared and the seeds can be used for tincture preparation (Bharathi et al., 2011; Sinha, 2011).

From the very beginnings, the fruits of this species was used for consumption. *M. charantia* is a popular health-promoting vegetable with multifunctionality. It is highly appreciated for its important medicinal and nutritional properties being widely grown and consumed in Asia especially in India, Sri Lanka, Vietnam, Thailand, Malaysia, Phillipines and South China.

The nutritional values of bitter melon are very similar to other species from the *Cucurbitaceae* family, the only difference that worth mentioning is, that bitter melon has a higher content of folic acid and Vitamin C. A number of clinical studies have been conducted to evaluate the efficacy of bitter melon in the treatment of diabetes and other infectious diseases (Leung et al., 2009; Fuangchan et al., 2011; Dans et al., 2007), which have drawn the attention of many people to bitter melon as a glycerine level regulator in the blood by

interrupting the neuronal response to sweet taste.

The main aim of this research was to monitor the growth and development of *M. charantia* grown in solar tunnels in the climate and soil conditions of Cluj-Napoca from Romania, and to analyze the quality and the quantity of fruit production obtained by applying different plant cultivation techniques.

MATERIAL AND METHODS

The researches regarding the influence of technological parameters on chemical composion of *Momordica charantia* L. was conducted at University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca. The experiment took place in the experimental field which is belonging to the Vegetable Growing Department. The aim of the research was to establish some technological measurements for cultivation of *Momordica charantia* L. which is less known in our country. Therefore, during the experimental period, different parameters were measured and recorded such as early crop production, total crop production and chemical composition of the leaves and fruits of bitter melon due to the type of foliar fertilizer and growing techniques applied and used. The need to carry out this research was also defined by the fact, that all parts of the bitter melon plant have great economic, medicinal and nutritional importance. In order to reach the aims set out in this study, a bitter melon plantation was established in 2016, in a solar tunnel with diverse experimental variance. Statistical analyses (LSD and Duncan test) were performed to show the statistically significant differences between the variants.

The plant material used was chosen very carefoully to be able to obtain satisfactory crop production in the local climate and soil conditions. Thus, the most proper planting material for this research was found to be *M. charantia* "Enaja" that has been purchased from a company from Oradea.

RESULTS AND DISCUSSIONS

Results regarding the total yield of *Momordica charantia* fruit production in two years of culture (2016 și 2017). The combied effect of cultivation tecniques on the average crop production for the two years show, that the highest values (Table 1 and Table 2) were obtained in plants trained to grow on two main branches undergoing chemical fertilization, followed by the plants trained in the same way, but organic fertilizers were applied. No statistically significant differences were shown between the two variants. In plants, when the main branches and tertiary vines were grown, the average production was equal in both cases of chemical and organic foliar fertilization.

Table 1

The combined influence of experimental parameters on average crop production obtained in bitter gourd in two experimental years (Cluj-Napoca, 2016-2017)

Training method	Type of fertilization	Total crop production (kg.mp)	Relative crop production (%)	Difference of crop production (kg/mp)	Significance of the difference
One branch	Chemical	2,31	100	_	_
One branch	Organic	2,32	100,6	+0,01	_
Two branches	Chimical	2,81	121,6	+ 0,50	xxx
Two branches	Organic	2,76	119,5	+ 0,45	xx

LSD (5%) 0,16, LSD (1%), 0,26, LSD (0,1%) 0,48

Table 2

The combined influence of experimental parameters on average crop production obtained in bitter gourd in two experimental years (Cluj-Napoca, 2016-2017)

Studied variant	Total crop production (kg/mp)	Significance*
One branch +Cropcare	2,31	b
One branch +Siforga	2,32	b
Two branches +Cropcare	2,81	a
Two branches + Siforga	2,76	a

D.S. 5% - 0,16

*****The values shown are mean values. Lowercase letters indicate significant differences between the variants according to Duncan's test

Results regarding the chemical composition of *Momordica charantia*.L fruits

Since the valuable medicinal and nutritional properties of bitter melon fruits have been discovered, more and more areas are getting cultivated with this species over the world. The chemical components of the fruits were determined by analyzing the chemical composition of the fruits obtained by applying both fertilizing methods in the solar tunnel. It was considered that the training method (with one or two main branches) cannot have a remarkable influence on the chemical composition of the fruits.

The level of energetic compounds at full maturity of fruits, it is higher in the plants fertilised by organic foliar fertilizer, Siforga than in the plants fertilized with chemical fertilizers (Tabelul 3). The dry substance (7,8 %) and protein content (28 %), and also their lipid content 6,08 – 6,13 % indicate that bitter melon fruits have relatively high energetic values (247,3 – 255,3 Kcal/100g).

The content of vegetable fiber is also higher in bitter melon than in other succulent vegetables. The organic fertilizer applied had a positive effect on the substances present in the fruits; the values recorded were higher than in the fruits with chemical fertilizers applied. The Vitamin C content of the fruits were significantly higher in the fruits obtained from the plants undergoing organic foliar fertilization than in those with chemical fertilizers. The mineral composition of the fruits of bitter melon is higher than in the fruits of common cucumber. As it is presented in Table 4, the total mineral composition was determined through the ash content concerning dry subtance showing average values of 6,9% in the case of chemical foliar fertilization and 7,2%, in the case of organic fertilizer application. Mineral components have similar values in bitter gourd to those from other succulent vegetables.

Tabel 3

Chemical composition of *Momordica charantia* L. fruits at full maturity concerning dry substance (Cluj-Napoca, 2016-2017)

Foliar fertilization	Total dry subtance (%)	Sugars (%)	Proteine (%)	Lipids (%)	Fiber (%)	Energetic value Kcal/100g	Vitamin C mg/100g
Chemical	7,7	35,51	27,7	6,08	1,6	247,3	119,68
Organic	7,8	35,39	28,0	6,13	1,7	255,3	183,04

Potassium, as a predominant mineral element in vegetables such as Mg have the highest values in bitter gourd fruits as compared to common cucumber. Calcium (204 – 206 mg/100g s.u.), and iron (10-11mg/100g d.s.) have approximately the same values as in the cucumbers from the greenhouses. Such as Mn, Zn and Cu, as the most important elements

in the synthesis of antioxidants can also be found in bitter gourd. The content of bitter melon in these microelements was positively influenced by the organic foliar fertilization.

Tabel 4

Mineral composition of *Momordica charantia* L. fruits at full maturity (mg/100g d.s.) (Cluj-Napoca, 2016-2017)

Foliar fertilization	Ash (% d.s.)	K	Mg	Ca	Fe	Mn	Zn	Cu
Chemical	6,9	4246	240	204	10	1,6	1,2	0,28
Organic	7,2	4227	263	206	11	1,7	1,4	0,28

Chemical subtances present especially in the aerial parts of the plant (leaves and fruits) have multiply therapeutical effects, called charantin and momordicin. The content of these chemical substances in bitter gourd are presented in Table 5 accumulated under different types of fertilizers applied durng the growing period.

The result indicate that the content of charantin and momordicin are higher in the leaves than in the fully maturated fruits showing a proportion of 2,5:1 in charantin and 2:1 in momordicin. The type of the foliar fertilizer had only a slight influence on these specific chemical components. Both in the leaves and fruits, their content is equal or a litter higher in the case of organic fertilizers Siforga than in the case of chemical fertilizers. Cropcare provide a better quality and better production from food supplies point of view.

Results regarding the Vitamin C content of the fruits harvested during this research show a higher content than those obtained by Moon et al. 2013, in one of their research carried out in India (112,4 ± 12,0mg/100g d.s.), but is much lower than those reported by Goo et al. 2016. According to their study, the Vitamin C content in bitter gourd fruits can reach very high values such as 2343,86 mg/100g d.s.

As it is summarized in Table 7, V_3 (plants trained with two brances and chemical fertilization) showed a higher level of acidity (14,6 %) as compared to V_2 (plants trained with one main branch and organic fertilization) which showed a lower level of acidity (9,68%).

Tabel 5

Specific chemical substances present in the fruits and leaves of bitter gourd (Cluj-Napoca, 2016-2017)

Foliar fertilization	Charantin		Momordicine	
	leaves	fruits	leaves	fruits
Chemical	11,38	4,60	1,29	0,61
Organic	11,72	4,64	1,34	0,61

Table 6

Vitamin C content recorded in bitter gourd fruits (Cluj-Napoca, 2016-2017)

Studied variant	Vitamin C content (mg/100g d.s.)
One main branch, chemical fertilization (V_1)	98,56
One main branch, organic fertilization (V_2)	197,12
Two branches, chemical fertilization (V_3)	140,8
Two brances, organic fertilization (V_4)	168,96

Table 7

The total volum of acidity accumulated in the fruits of *Momordica charantia* L. (Cluj-Napoca, 2016-2017)

Studied variant	Total acidity (%)
One main branch, chemical fertilization (V_1)	11,6
One main branch, organic fertilization (V_2)	9,68
Two branches, chemical fertilization (V_3)	14,6
Two brances, organic fertilization (V_4)	10,72

CONCLUSIONS

The results of this research show that the highest crop production was provided by the plants trained with two branches with chemical fertilization applied, followed by the same training method but organic fertilization. In case of the plants trained with one branch and tertiary vines, on a lower level of harvest, the average crop production for two years of cultivation is equal when applying the two different types of fertilizers.

The dry subtance content of 7,8 %, the protein content and their proportion 6,08 – 6,13 % proves that bitter gourd is a vegetable product with a higher energetic value 247,3 – 255,3 Kcal/100g dry subtance as compared to common cucumbers (150 – 160 Kcal/100g d.s.).

The content of vegetable fibres and mineral components reach very high values as compared to other succulent vegetable products. The organic foliar fertilizer applied, contributed significantly to the accumulation of the chemical components, reaching higher values than those with chemical fertilization.

Content of the specific chemical subtances are much higer in leaves than in the fully maturated fruits expressed by a proportion of 2,5:1 in charantin and de 2:1 in momordicin.

The highest Vitamin C content (197,12 mg/100 g su) was registered in the variant grown on one main branch with applied organic foliar fertilizers, while the total volum of acid reached a superior level (11,6 %) in the plants trained with one main branch and fertilized with chemical foliar fertilizers.

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