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STUDY OF GARLIC (*Allium sativum L.*) GROWING TECHNOLOGY AND VARIETY TYPESUSED IN SERBIA AND IN HUNGARY

STUDIJA TEHNOLOGIJE PROIZVODNJE RAZLIČITIH VARIJETETA BELOG LUKA U SRBIJI I MAĐARSKOJ

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ABSTRACT

The garlic is grown and consumed from the age of pyramids in Egypt (2700-2100 BC) as a food, spicy and a medicine . Garlic production is high in Asia (China the first), Latin America, North Africa and in Southern part of Europe. The world production area 1422428 ha, European 103348 ha. Serbia on the top of the 10 European country 7744 ha, In Hungary the garlic area decreased to 1048 ha. The garlic is very important in the Serbian and Hungarian meat industry and kitchen.The aim of the study was to survey the level of growing technology and produced varieties in the garlic farms in the traditional region in Serbia Vojvodina (Vrbica, Torda, Backo Petrovo Selo) and in Hungary Makó and Kalocsa. We analysed the answers of 20 questioners, filled in the farms. The most important were from the 19 questions: - area of the farm, - size of garlic growing, -produced varieties, harvest method,-curing system , -storage method. We also tested the 33 different garlic bulb samples, collected from the farms. We measured the weight of bulb, diameter, cloves number, pealing weight loss, dry material and sulphur content of the samples.We found the big differences in the size of garlic growing area between the countries, in Serbia 0.3-2.8 ha, in Hungary 1-50 ha. The produced varieties in region Kalocsa, village Bátya and Vojvodina local varieties, in region Makó local and import (French , Spain) varieties. The harvest method, curing system, storage method are similar. Only one farm Dombegyház includes the Makó region has complete mechanized garlic growing, curing, store technology.The results of measuring of garlic bulb samples shown no direct correlation among the weight, diameter, cloves number, dry material of the samples. That characteristics genetically determined by variety characteristics. Between weight of bulb and pealing weight loss have a close relationship. The conclusion of the results in the small farms alone can develop the technology. The import varieties have a good quality and high yield, but the local varieties have a highest dry material and sulphur content.To keep the high value of the local varieties in the Serbia and in Hungary need a supported programme.

***Key words**: garlic production, curing, harvest; garlic varieties, quality parameters, inner contents.*

REZIME

Beli luk se uzgaja i konzumira još iz perioda piramida u Egiptu (2700-2100 pne.) kao hrana, začin i lek. Proizvodnja belog luka je visoka u Aziji (prvenstveno u Kini), latinskoj Americi, na severu Afrike i južnom delu Evrope. Proizvodnja belog luka na svetskom nivou kreće se na površini od oko1422428 ha, a u Evropi na oko 103348 ha. Srbija je jedna od najvećih proizvođača belog luka u Evropi na površini od oko 7744 ha, u Mađarskoj je ova površina manja i kreće se od oko 1048 ha. U Srbiji i Mađarskoj beli luk je važan sastavni deo u industriji mesa i u domaćinstvima. Cilj ove studije jeste da se ispita nivo razvojnih tehnologija proizvodnje i sorte belog luka koje se proizvode u tradicionalnim regionima u Srbiji, Vojvodini (Vrbica, Torda, Bačko Petrovo Selo) i u Mađarskoj Makó i Kalocsa. Analizirani su odgovori 20 ispitanika, ispitivanih na farmama. Najznačajniji odgovori dobijeni su na osnovu 19 pitanja koji se odnose na: površinu farme, period razvoja belog luka, sorte koje se proizvode, metode ubiranja, tretmane zaštite, metode skladištenja. Takođe testirani su 33 različita uzorca lukovice, prikupljenih na farmama. Merena je masa lukovica, prečnik, broj čenova, gubitak težine nakon čišćenja, sadržaj suve materije i sadržaj sumpora. Utvrđena je značajna razlika u širenju površine proizvodnje belog luka i u susednim zemljama, u Srbiji oko 0,3-2,8 ha, a u Mađarskoj 1-50 ha.Metode ubiranja, metode zaštite i metode skladištenja su sličene. Te karakteristike definišu karakteristike sorte. Bliska povezanost uočena je između mase čenova i masenih gubitaka nakon čišćenja. Zaključci dobijeni na osnovu ispitivanja malih farmi mogu da doprinesu razvoju tehnologija proizvodnje. Uvozne sorte belog luka imaju visok kvalitet i dobar prinos, ali lokalne sorte imaju najveći ideo suve materije i sadržaj sumpora. Da bi se sačuvala visoka vrednost domaćih sorti u Srbiji i Mađarskoj potrena je podrška razvojnih programa.

***Ključne reči:** proizvodnja belog luka, zaštita, ubiranje; sorte belog luka, parametric kvaliteta, unutrašni sadržaj.*

INTRODUCTION

The garlic is grown and consumed from the age of pyramids in Egypt (2700-2100 BC) as a food, spicy and a medicine. The garlic is a queen of the spices, essential vegetable in the Serbian and Hungarian meat industry and kitchen.

The history of using as a spice and medicinal plants is very long and rich Scientific studies have shown pharmacological effects, there has been particular interest in benefits in the prevention and treatment of atherosclerosis and coronary heart disease. Numerous tests of garlic extracts in vitro have demonstrated they can aggregation of human body platelets to form cloth which have to potential for arterial blocking *(Block, 1985).*

Marketed garlic mainly grown from cloves. During its cultivation history in different regions, garlic was adapted to various climates and selected for cold resistance, bigger bulbs, or higher pungency. In order to obtain a larger bulb, flower stalks were often removed or clones with reduced flowering potential were

selected. The loss of garlic fertility, and today garlic varieties are completely sterile. They don't produce seeds and are propagated only vegetatively. In modern garlic varieties, the presence of vegetative topsets (bulblets), which develop in garlic inflorescence, is one of the major causes of the inability of this plant to develop normal flowers and true seeds *(Kamenetsky, 2004/a)*

A results of the long time research growing garlic from seed offers the opportunity to produce new cultivars that enhance and expand garlic's genetic diversity. It also offers the prospect of more vigorous and higher yielding plants that are free of pests, viruses, and other diseases in the practice for consumption garlic grown vegetatively from cloves *(Etoh,1985)*.

At the end of the twentieth century several reports of fertile garlic clones, both in the wild and in cultivation, initiated intense interest in seed propagation of garlic, which appears to be a realistic proposition (Brewster, 1994).

Kamenetsky at al., (2004/b) have shown in their experiments that the environmental conditions, especially temperature and photoperiod, strongly affect garlic morphology and development, including leaf elongation, clove formation, and dormancy induction and that the environmental regulatory effect is obligatory and yet quantitative.

The world production was decreasing in the last 10 years. Garlic production is high in Asia (China the first), Latin America, North Africa and in Southern part of Europe (Table 1.).

Table 1. Garlic production data in 2011

County	Area (ha)	Yield (t/ha)
World production	1422408	16
Europe	103348	7
China, mainland	827000	23
India	200600	5
Ukraine	21200	8
Egypt	12145	24
Spain	34900	6
Republic of Korea	43643	10
Romania	12128	5
Russian Federation	26800	9
Italy	3155	10
Myanmar	29194	7
Belarus	2454	9
Bangladesh	41997	5
Serbia	7744	3
United States of America	10180	18
France	2615	9
Argentina	17739	10
Albania	1586	10
Ukraine	21200	8
Republic of Moldova	2340	5
Hungary	1048	6
Source FAOSTAT		

In the Hungarian National List have four garlic varieties Lelexir, (Makói tavaszi, (spring)) Makói őszi (autumn) Tibadúr, Vigor supreme *(Füstös, 2012)*. Selected varieties in Serbia , Bosut (autumn) , Labud (spring) *(Gvozdanovic-Varga J. et al. 2009)*

Beside the national listed varieties in the traditional garlic production regions in the both countries grown local varieties. In Hungary in the last years grown varieties from the EU Common Catalogue. Varieties .

The main aim to study the reality and the problems of Garlic production and usual current of varieties in two countries because the production in Hungary decreased, the average of yield in Serbia is very low, see Tables 2 and 3.

Table 2. Garlic area and yield in Serbia

	Serbia					
Year	2006	2007	2008	2009	2010	2011
Area (ha)	8658	8419	8215	8113	7867	7744
Yield (t/ha)	3	2.5	2.9	2.9	2.8	2.7

Table 3. Garlic area and yield in Hungary

	Hungary					
Year	2006	2007	2008	2009	2010	2011
Area (ha)	1122	641	636	636	602	1048
Yield (t/ha)	6.5	8	7.4	7.4	6.9	6.2

MATERIAL AND METHOD

We studied to survey the level of growing technology and produced varieties in the garlic farms in the traditional region in Serbia Vojvodina (Vrbica, Torda, Backo Petrovo Selo) and in Hungary Makó (includes Dombegyháza) and Bátya (region Kalocsa).

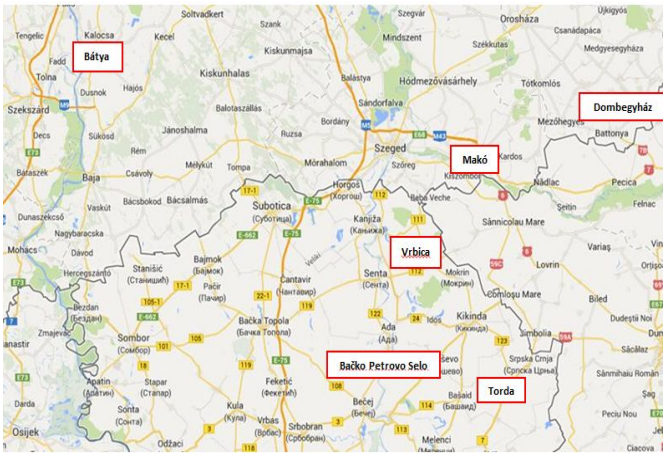

Fig. 1. Map of the studied garlic regions

We analysed the answers of 20 questioners, included detailed information of growing technology, economical problems, marketing of garlic. The questioners were filled in the farms during of visit and study the system. The most important were from the 19 questions - area of the farm, - size of garlic growing, - produced varieties, harvest method,- curing system, - storage method. We evaluated the answers of that topics.

We also tested the 33 different garlic bulb samples, from the 38 collected samples from the farms. The varieties origined from Serbian , Hungarian local selections French (FR) regitered varieties: Arno, Flavor, Cledor, Jolimont, Messidrome, Messidor and from Spanish (E) registered varieties: Garpek, Gardacho, Garcua, Gardos (Table 8.)

RESULTS AND DISCUSSION

During evaluation of the questioners we have got a very colourful picture about the garlic production and farms. We have shown only the main tendency of the results.

Table 4. The size of farms and part production area of garlic growers

Size of farms (ha)				Garlic production area (ha)		
	Serbia	Hungary			Serbia	Hungary
Smallest	0.3	2		Smallest	0.3	1
Largest	12.5	2700		Largest	2.8	50

The size of studied farms and garlic fields small in both countries but in Hungary have some bigger mechanised farm.

We have summarised the crop rotation used in garlic growing farms include as answer of the questioners.

Table 5. Crop rotations

Crop rotation systems	
Serbia	Hungary
1+1 year (garlic-barley)	1+3years (garlic -wheat)
2+2year (garlic -wheat-barley)	1+4year (garlic-maize-mustard,sunflower-wheat)
1+2 year (garlic-sunflower-wheat)	1+ 4 year (garlic-wheat-vegetable-maize-wheat)
2+5+1 years (garlic- clover - wheat)	1+5year (garlic–petroselinum-pea-onion-maize-wheat)
1+3 year (garlic – wheat)	1+4 year (garlic- wheat)
1+2+1year (garlic- maize-wheat)	1+5 year (garlic wheat)

Table 6. The number of Autumn and Spring production of tested garlic growing farms

	Serbia	Hungary
Autumn	2	3
Spring	3	0
Autumn and Spring	1	11

Crop rotation is very important in a vegetatively propagated garlic production. The optimal rotation is longer than 5 year.

The autumn production is more safety and the potential yield is higher. The grower used the same varieties both autumn and spring time. The bulbs from the spring production have a better quality and longer storage time.

Table 7.Variety type used in the different regions

	Serbia			Hungary		
	Torda	Vrbica	Backo Petrovo Selo	Bátya	Makó	Dombegyház
Local vatiety	*	*	*	*	*	
Registerd variety					*	*

Table 8. Summarised data of collected garlic samples (average of 10 bulbs)

Samples	Planting season, variety and origin of samples	Dry material content (m/m%)	SO_2 (mg/kg)	Weight of bulb(g)	Weight of cloves (g)	Number of cloves/bulb	Diameter (cm)
Sz/1.	Autumn, local, Torda	40.73	5.4	55.09	53.39	11.44	5.21
Sz/2.	Autumn, local, Torda	36.83	0.9	75.48	71.98	11.20	6.41
Sz/3.	Autumn, local, Backo Petrovo Selo	37.03	3.2	41.58	40.35	12.60	4.64
Sz/4.	Spring, local, Vrbica	40.41	2.3	29.90	28.23	9.70	3.94
Sz/5.	Spring, local, Vrbica	40.73	11.6	24.84	23.34	10.30	3.66
M/1.	Spring, local Makó	39.97	2.6	41.46	38.74	9.22	4.59
M/2.	Spring, Cleodor (FR)Makó	37.33	9.1	64.05	60.13	11.00	5.47
M/3.	Spring, local Makó (no irrigation)	40.51	6.4	39.54	35.49	5.10	4.52
M/4.	Spring, local Makó (with irrigation)	39.93	4.6	46.36	43.55	8.70	4.77
M/5.	Autumn Flavor (FR)1. year Makó	38.76	14.2	50.40	48.01	9.70	5.04
M/6.	Autumn Flavor (FR)2. year Makó	39.50	16.3	44.76	42.56	8.60	4.83
M/7.	Spring, local Makó	40.41	13	44.98	40.82	8.80	4.57
M/8.	Spring ArnoMakó	40.71	8.9	57.27	52.75	10.89	5.36
M/9.	Autumn , local, ,Makó	38.99	5	59.93	56.56	9.00	5.73
M/10.	Autumn, local,spring type Makó	38.56	21.6	42.91	39.38	6.10	4.53
M/11.	Autumn Messidrom (FR)1.year Makó	38.70	10.4	60.60	58.09	9.30	5.74
M/13.	Autumn Messidrom(FR) 2.yearMakó	34.52	1.1	72.33	69.04	12.50	6.26
M/15.	Autumn, Makói őszi, Makó	38.61	0	50.17	47.83	8.70	5.23
M/16.	Autumn (FR) Messidor, Makó	39.94	4.8	56.86	53.81	10.30	5.51
M/19.	Autumn (FR) Jolimont, Makó	37.39	8.1	53.05	50.13	10.22	5.29
B/1.	Autumn, local, Bátya	35.25	0	60.17	55.79	10.20	5.81
B/2.	Autumn ,local, Bátya	38.28	3.3	61.04	55.44	8.80	6.10
B/3.	Autumn, local, Bátya	38.26	0	61.49	59.62	9.00	5.81
B/4.	Autumn, local, Bátya	34.97	3.4	58.50	52.91	7.60	6.12
B/5.	Autumn, local,spring type , Bátya	40.86	4.1	55.90	51.82	13.90	5.51
B/6.	Autumn, local,spring type , Bátya	38.78	3.3	25.96	22.18	15.30	4.17
B/7.	Autumn, local, Bátya	39.03	1.6	57.29	54.59	8.50	5.88
B/8.	Spring, local, Bátya	39.11	0	37.29	34.83	13.40	4.45
B/9.	Spring, local, Bátya	39.73	0	32.34	29.53	13.30	4.56
D/1.	Autumn, Garpek (E) Dombegyház	36.38	0.2	54.83	52.35	11.80	5.20
D/2.	Autumn ,Gardacho (E) Dombegyház	38.22	5.1	61.09	58.86	9.90	5.09
D/3.	Autumn, Garcua (E) Dombegyház	38.48	5.1	83.33	80.76	10.56	6.01
D/4.	Autumn, Gardos (E) Dombegyház	39.58	0.7	53.25	51.24	10.50	4.97
* Sz/ *Serbia*, M/*Makó*, B/*Bátya*, D/*Dombegyház*							

The collected and measured data has shown a high deviation in the diameter and number of cloves. We found small bulbs with a numerous cloves and opposite big bulbs with law number of cloves.

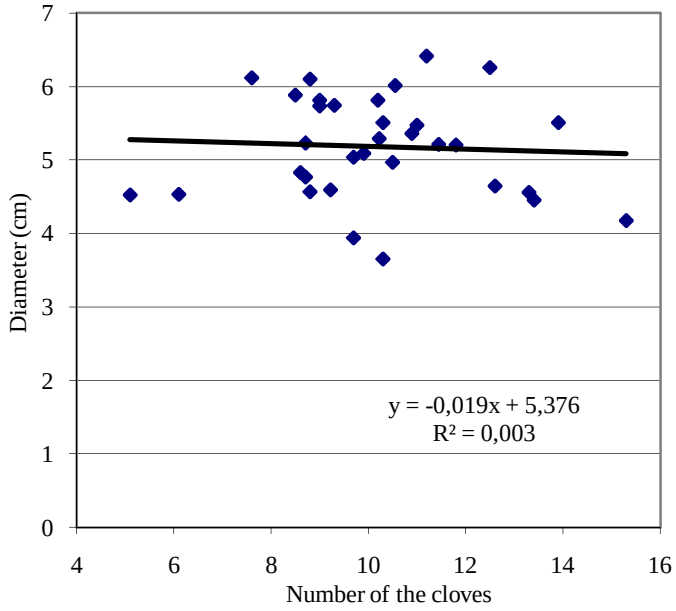

Fig.2. Ratio between diameter and number of cloves of garlic samples

The weight losses after peeling is connected to bulb weight have a close relationship with weight of cloves/bulb.

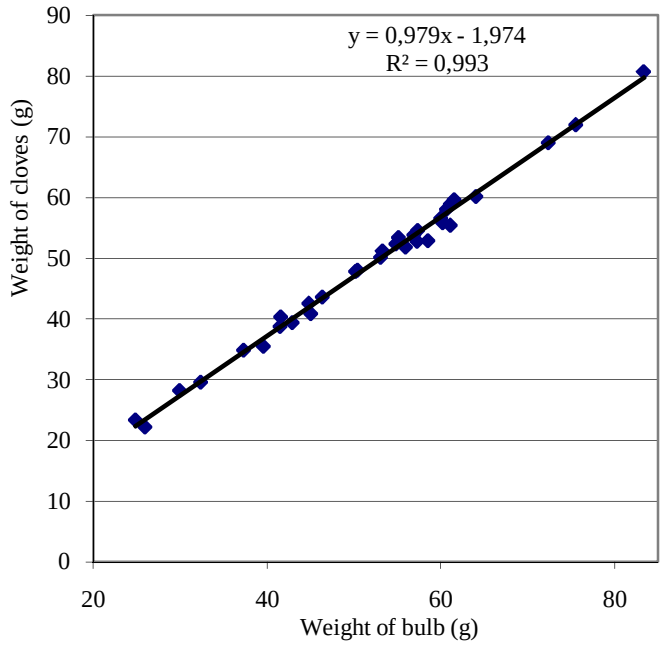

Figure 3.Close connection of weight of bulb and cloves

We have got unaccepted results connected to bulb size, weight and dry material content, the varieties with big size of bulbs gave a high dry material content results too. Some small size bulb had only medium dry material content.

Confirming our results the data of the first biggest bulb size samples underscore the observations the varieties characterised by big size and high yield can content high dry materials.

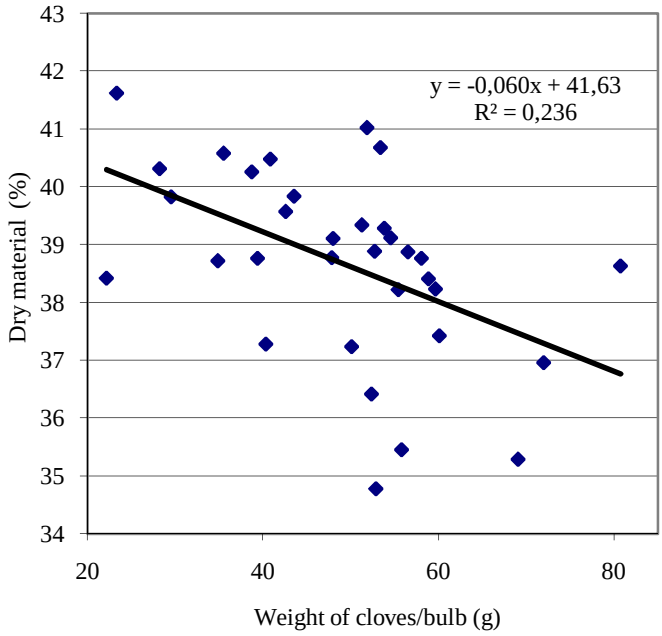

Figure 4. Dry material content of different bulb weight

Table 9. The rank of the garlic bulb weight of the tested samples

Sample	Planting season, variety and origin of samples	Bulb weight (g)	Diameter (cm)	Dry material content (m/m%)
D/3.	Autumn, GarcuaE) Dombegyház	83.33	6.01	38.63
Sz/2.	Autumn, local, Torda	75.48	6.41	36.96
M/13.	Autumn Messidrom (FR) 2.year Makó	72.33	6.26	35.28
M/2.	Spring, Cleodor (FR)Makó	64.05	5.47	37.42
B/3.	Autumn, local, Bátya	61.49	5.81	38.24
D/2.	Autumn ,Gardacho (E) Dombegyház	61.09	5.09	38.41
B/2.	Autumn ,local, Bátya	61.04	6.10	38.23

The data of sulphur content are not significant needed more replication and compare with other method. We only publish as informal information. The fact is on the top the local varieties are standing.

Table 10. Sulphur content of the 5 top samples

Sample	Planting season, variety and origin of samples	SO_2 (mg/kg)
M/10.	Autumn, local, spring type Makó	21.6
M/6.	Autumn Flavor (FR)2. year Makó	16.3
M/5.	Autumn Flavor (FR)1. year Makó	14.2
M/7.	Spring, local Makó	13.0
Sz/5.	Spring, local, Vrbica	11.6

CONCLUSION

We found the big differences in the size of garlic growing between the countries, in Serbia 0.3-2.8 ha, in Hungary 1-50 ha.

The produced varieties in region Kalocsa and Vojvodina local varieties, in region Makó local and registered (French, Spain) varieties. The harvest method, curing system, storage method are similar. Only one farm Dombegyház includes the Makó region has complete mechanized garlic growing, artificial ventilation curing, store technology.

In our study we had similar opinion with *Gvozdanovic-Varga J. et al.2009 and Füstös 2012*,

the yield has correlation with planting time and varieties but has to introduce to the garlic growers the variety sortiment of EU Common Catalogue for developing garlic production in both countries.

The results of measuring of garlic bulb samples shown no direct, close correlation

among the weight, diameter, cloves number, dry material of the samples. That characteristics genetically determined by variety characteristics.

Between weight of bulb and pealing weight loss have a close relationship.

The conclusion of the evaluate the questioners in the small farms alone can' develop the technology. The import varieties have a good quality and high yield. but the local varieties sources of the highest dry material and sulphur content.

To keep the high value of the local varieties in the Serbia and in Hungary need a supported common research programme to save biodiversity of garlic.

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