

Influence of the Planting Dates on Chemical Composition and Yield of Brussels Sprouts *(Brassica oleracea var. gemmifera)*

Natasa Mirecki

Biotechnical Institute, Podgorica, Montenegro

Abstract: This paper presents the results of examination of the influence of planting dates (10th of April, 10th of May, 10th of June, 10th of July) on chemical composition (dry matter contents, ash, cellulose, vitamin C and total sugar content) and yield of Brussels sprouts. The three-year experiment shows that Brussels sprouts can be successfully cultivated in agro-ecological conditions of southern region of Montenegro (Zeta Plain). Earlier planting (April-May) provides higher yield and better quality of sprouts when compared to later planting dates (June-July). The planting date had a significant effect on contents of dry matter, sugar and vitamin C, while no correlation between planting date and variety was recorded for other parameters of chemical contents.

Key words: Brussels sprouts, chemical composition, yield.

Introduction

Brussels sprout (*Brassica oleracea* var. *gemmifera*) is a biennial agricultural crop that belongs to the cabbage family (*Brassica oleracea*). The specific characteristic of this crop is its high resistance to low temperatures. It survives temperatures down to -10 °C without any damage, so it can be successfully cultivated in later sowing dates and picked during the winter months when the market lacks fresh vegetables.

The edible part of the Brussels sprouts are sprouts (buds) that develop under the armpit of leaves on the main stalk, and the top leaf rosette can also be used as food after cutting it off in order to accelerate its ripening (Sanders, 1996).

The sprouts can be eaten raw, stewed or preserved (pickled, marinated, dried or frozen). Quite delicious stewed meals can be made of leaves of the top rosette and leaves from the stalk.

Materials and Methods

The three-year experiment was done in the southern region of Montenegro (Zeta plain), in the area with modified Mediterranean climate. When compared to the narrow coastal (Mediterranean) stripe, summers are dryer, while winters are slightly more wet and colder with stronger frosts.

The experiment was located on the ground with acid reaction (5.05), with high content of humus 12.07%, which is the result of continuous and uncontrolled practice of adding peat from the adjacent Skadar Lake.

The experiment covered two hybrids of Dutch origin, of the selection company Bejo zaden: Diablo F₁ and Harley F₁. Sowing in beds was done on the same dates in all three years: 10th of March, 10th of April, 10th of May, 10th of June. All the necessary measures of care (foliar fertilization, preventive protection against diseases and pests, watering, etc.) were performed during the seedlings production. The transplantation of seedlings to the permanent cultivation site was done in the phase when 4-5 leaves were developed on the seedlings. The transplantation was done manually on four occasions, on 10th of April, 10th of May, 10th of June and 10th of July.

The distance between the plants was 60x40 cm. After the transplantation, all regular measures of care for crops were performed: watering, hilling, fertilization and protection against diseases and pests.

Upon visual valuation of ripeness, the sprouts were picked successively, depending on the time of ripening.

The chemical analysis of the Brussels sprouts was done at the Chemical Engineering Faculty in Novi Sad, by standard methods coordinated with the Association of Official Agricultural Chemists, Washington (Marković and Vračar, 2001). The content of matters examined was analyzed by the following methods:

- total dry matter – drying in the oven at 105 °C till obtaining the constant weight,
- ash – by method of drying, igniting at the temperatures of 650 °C,
- total sugar content by Fehling,
- cellulose – Kurschner -Gankova,
- vitamin C by method of oxydometric titration by Tillmann

Results and Discussion

Chemical content of sprouts

Brussels sprouts is a vegetable of high nutritive value. Like many other plants from the cabbage family, it is rich in anticarcinogenic substances. When compared to other plants in the cabbage family, it has significantly higher contents of nutritive components.

Tab. 1. Average contents of dry matter (%) in sprouts of Brussels sprouts

			PLANTING DATE			
VARIETY (B)			planting date 1	planting date 2	planting date 3	planting date 4
DIABLO F ₁			12.87	13.38	11.41	12.51
HARLEY F ₁			12.97	13.09	11.26	10.95
mean			12.92	13.23	11.34	11.73
LSD	A	1%	2.74			
		5%	1.48			
	B	1%	0.89			
		5%	0.61			

Moisture content in Brussels sprouts ranges from 70 to 90%, and the rest is dry matter. 95% of dry matter make organogenic elements (C, H, O, N) and 5% mineral components, i.e. ash. Ash content depends on the plant type and cultivation conditions.

In our experiment, the values of the dry matter content in sprouts of Brussels sprouts ranged from 10.95 to 13.8%, which is lower than the quantities recorded by Ilin et al., (1990), Babik et al. (1996), Marković and Vračar (1999), Černe and Vrhovnik (1992). The dry matter content showed dependence on the planting date and variety, which is in line with results of Abuzeid and Wilcockson (1989), but opposite to results of Everaarts and De Moel (1994) i Everaarts et al. (1998).

Tab. 2. Ash content (%) in sprouts of Brussels sprouts

			PLANTING DATE (A)			
VARIETY (B)			planting date 1	planting date 2	planting date 3	planting date 4
DIABLO F ₁			1.09	1.11	1.12	1.21
HARLEY F ₁			1.31	1.13	1.14	1.14
mean			1.20	1.12	1.13	1.18
LSD	A	1%	0.24			
		5%	0.10			
	B	1%	0.33			
		5%	0.24			

Analysis of the contents of ash in sprouts of Brussels sprouts by planting dates and varieties showed no difference of statistical importance. The lowest mineral content was recorded in Diablo variety in the first planting date (1.09), and the highest in Harley variety, in the first planting date (1.31). Our results are in line with results presented by Marković and Vračar (1999). Fachmann (1990) recorded 1.3 µg of iron, 15 µg of iodine and 2.3 µg of selenium in sprouts analysed, while Černe and Vrhovnik (1992), established 1-3 mg of iron and 0.0007-0.0009 iodine units.

Tab. 3. Cellulose content (%) in sprouts of Brussels sprouts

			PLANTING DATE (A)			
VARIETY (B)			planting date 1	planting date 2	planting date 3	planting date 4
DIABLO F ₁			1.58	1.33	1.49	1.50
HARLEY F ₁			1.53	1.23	1.50	1.27
mean			1.55	1.28	1.49	1.38
LSD	A	1%	0.54			
		5%	0.36			
	B	1%	0.15			
		5%	0.10			

In our researches, the content of cellulose in sprouts of Brussels sprouts ranged from 1.23 to 1.58% and it did not show any dependence on planting date, while dependence on variety was recorded only in the first planting date and in mean values per variety.

Tab. 4. Vitamin C content (mg/100g) in sprouts of Brussels sprouts

			PLANTING DATE (A)			
VARIETY (B)			planting date 1	planting date 2	planting date 3	planting date 4
DIABLO F ₁			5.93	5.17	6.10	6.87
HARLEY F ₁			8.20	6.60	6.93	6.70
mean			7.07	5.88	6.52	6.78
LSD	A	1%	1.06			
		5%	0.70			
	B	1%	0.28			
		5%	0.19			

The measured contents of vitamin C in sprouts of Brussels sprouts in our research ranged from 5.17 to 8.20 mg/100g. Correlation between contents of vitamin C and planting date was recorded, while correlation with variety was not established, although the contents of vitamin C in Harley variety were higher than in Diablo variety in all planting dates. Results of our researches show higher values than those presented by Babik et al. (1996), but lower than those presented by Fachmann (1990). Relatively low values per parameter examined can be explained by the fact that samples were collected and frozen without previous blanching and kept for 3-5 months (depending on the year of the experiment) before analysing, and according to Mišković et al., (1990) and Klimcyak and Iryzniec (1991), loss of vitamin C is significant unless enzyme activity is stopped by blanching. Moreover, according to Sciazko et al. (1990a), vitamin C content is higher in sprouts picked in autumn than in those picked during the winter.

Tab. 5. Total sugar content (%) in sprouts of Brussels sprouts

VARIETY (B)			PLANTING DATE (A)			
			planting date 1	planting date 2	planting date 3	planting date 4
DIABLO F ₁			3.31	3.40	3.74	4.17
HARLEY F ₁			2.95	3.93	5.13	4.65
mean			3.13	3.67	4.44	4.41
LSD	A	1%	0.64			
		5%	0.47			
	B	1%	0.86			
		5%	0.21			

In our samples, sugar content ranged from 2.95% to 5.13%. Sugar content increased with later planting dates and it was higher in Harley variety than in Diablo variety. The presented values of sugar content are lower than those presented by Babik et al. (1996) and Marković and Vračar (1999), but higher than those presented by Facmhann (1990). Sciazko et al. (1990) established that the nitrogen quantity above 100 kg/ha results in lower total sugar content in sprouts and that nitrogen added in the form of ammonium nitrate and urea reduces the contents of reducing sugars.

Yield

Tab.6. Average yield of Brussels sprouts

VARIETY (B)			PLANTING DATE (A)				Mean
			I	II	III	IV	
DIABLO			19,93	18,07	16,30	14,77	17,27
HARLEY			20,90	16,73	12,60	13,37	15,90
mean			20,42	17,39	14,45	14,06	
LSD	A	1%	0,64				
		5%	0,62				
	B	1%	0,63				
		5%	0,43				

The total yield of Brussels sprout per area unit depends on the number of formed sprouts per plant and on their weight. Our researches recorded yield ranging from 13.36 to 20.92 t/ha, while differences in yield per planting dates and varieties were extremely significant.

In earlier planting (the first and the second date) the yield was significantly higher (20.42 and 17.39 t/ha) when compared to the later planting (the third-14.45 t/ha and fourth date-14.06 t/ha). Average yield per variety amounted to 17.26 t/ha (Diablo) and 15.90 t/ha (Harley).

Such significant difference in yield, depending on the planting date, can be explained with the fact that after 21st of July the amount of available light is considerably reduced (Eveerarts and Sukkel, 1999) while assimilation area is also reduced as a result of preparation for autumn (Booij et al., 1996), which has negative impact on accumulation of food and growth of plant (stalks and leaves), and consequently on the yield. Abuzeid and Wilcockson (1989), too, believe that the correlation between the adopted amount of radiation and weight of formed sprouts is constant; therefore plants that were planted earlier have more advantageous conditions for yield. Kunicki (1994) and Campos (1991) believe that lower yield in later planting dates is a result of shorter stalk and smaller number of formed leaves, which consequently results in the smaller number of formed sprouts.

In results of our researches it is noticeable that postponing of planting date reduces the yield, which is in accordance with the results of Campos (1991), Kunicki (1994), Rijbroek (1988), Rempel et al, (1994). Results of researches that are not in line with the facts we noticed in the course of our researches, showing that later planting dates result in higher yields were presented by Babik, (1987), Neuvel (1997), Abuzid and Wilcockson (1989).

Conclusion

On the basis of the three-year researches on influence of planting dates and variety on yield and chemical composition of sprouts of Brussels sprouts in agro-ecological conditions of Montenegro, the following conclusions can be drawn:

- The values of dry matter contents in sprouts of Brussels sprouts ranged from 10.95 to 13.38%. The significant difference in dry matter contents was established depending on planting dates and variety;
- Ash content was the lowest in Diablo variety in the first planting date (1.09), and the highest in Harley variety in the first planting date (1.31). There is no significant difference regarding the ash content depending on planting date and variety;
- The content of cellulose in sprouts of Brussels sprouts ranged from 1.23 to 1.58%. We did not notice any statistically significant difference in contents of cellulose depending on planting dates and variety;
- The total sugar content in sprouts of Brussels sprout ranged from 2.95% to 5.13%. Statistical significance was established between planting dates and varieties;
- The contents of vitamin C (mg/100g) in sprouts of Brussels sprouts ranged from 5.17 to 8.20. Statistically significant difference was recorded in contents of vitamin C in the first (7.24) and the second planting date. No correlation between vitamin C content and variety was recorded;
- The yield ranged from 13.36 to 20.92 t/ha, where differences in yield per planting date and variety were quite significant.

References

- Abuzeid, A.E., Wilcockson, S.J. (1989): Effects of sowing date, plant density and year on growth and yield of Brussels sprouts (*Brassica oleracea* var. *gemmifera*). J. Agric. Sci. Camb. 112, 359-375.
- Babik, I. (1987): Yield and some quality properties of Brussels sprouts as affected by time of Harvest and Cultivar. Acta Horticulturae 220, 511-517
- Babik, I., Rumpel, J., Elkner, K. (1996): The influence of nitrogen fertilization on yield, quality and sence of Brussels sprouts. Acta Horticulturae, 407, 353-359.
- Booij, R., Kreuzer, A.D.H., Smit, A.L. van der Werf, A., (1996a): Effects of nitrogen availability on dry matter production, nitrogen uptake and light interception of Brussels sprouts and leeks. Netherlands J. Agric. Sci. 44, 3-19.
- Campos, P. Maria Paulina (1991): Evaluacion del compartimiento de cuatro cultivares de repollito de bruselas (*Brassica oleracea* L. Var. *Gemmifera* D.C.) (Camelot, Valiant, Merlon, Lunet) en cuatro fechas de plantacion. Univerisidad Catolica de Chile. Fac. De Agronomia. 105. p.
- Černe M., Vrhovnik, I. (1992): Vrtnine, vir zdravja in naša hrana. ČZP Kmečki glas, Ljubljana
- Everaarts, A.P., Booij, R., de Moel, C.P., (1998): Yield formation in Brussels sprouts, Journal of Horticultural Science and Biotechnology 73, (5), 711-721.
- Everaarts, A.P., Sukkel, W., (1999): Bud initiation and optimum harvest date in Brussels sprouts. Scientia Horticulturae 81, 361-367.
- Fachmann-Souci-Kraut (1990): Food Compositon and Nutrition Tables, Wiesenshaftlicheverlag.
- Ilin, Ž., Lazić, B., Marković, V., Đurovka, M., (1990a): Uticaj sorte na sadržaj sirovih proteina i nitrata kelja pupčara. VIII Jugoslovenski kongres ishrane, Beograd.
- Klimcyak, J., Irzyniec, Z., (1991): Studies on kinetics of vitamin C degradation during the storage of non blanched brussels. Chlodnictwo. Poland. V. 26(2). P. 12-14
- Kunicki, E., (1994): Effect of the type of transplantat on the yield and quality of some Brussels sprouts cultivars grown in the double-cropping system. Folia Horticulturae. Ann. VI/1, 15-22.
- Neuvel, J.J., (1977): Teelt onderzoek bij spruitkool ten behoeve van eenmalige oogst. (Research on single harvesting of Brussels sprouts). Bedrijfsontwikkeling 8, 283-285
- Marković, V., Vračar, L.J. (1999): Mogućnost korištenja listova kelja pupčara u ljudskoj ishrani. Zbornik radova Jugoslovenskog kongresa prehrambenog, farmaceutskog i hemijskog inžinjerstva, Novi Sad, 87.
- Marković, V., Vračar, L.J. (2001): Uticaj vremena berbe na kvalitet pupova i listova kelja pupčara za ljudsku ishranu. Savremena poljoprivreda. Vol.50, 1-2 (2001), 127-130.
- Mišković, P., Mišković, D., Dević, M. (1990): Uticaj smrzavanja na kvalitet kelja pupčara. Savetovanje jugoslovenske industrije za preradu voća i povrća. Tehnološki fakultet, Novi Sad. Zbornik radova, str. 50-54.
- Rempel, H., Bowen, P., Swenny, M. (1994): Brussels sprouts cultural adaptation for Mechanical Harvesting. 1993 Results. Research conducted by Agriculture Canada and BCMAFF.
- Rijboek, P.Van. (1987): Brussels sprouts production. Not towards more but towards better quality. Groenten en Fruit, 42 (27), 60-62, Wageningen.

- Sanders, D.C. (1996): Brussels sprouts. Leaflet No. 6. North Carolina Cooperative Extension Service.
- Sciazko, D., Kolota, E., Sciazko, T. (1990a): Wpływ nawożenia mineralnego i terminu zbioru na zawartość witaminy C w kapuscie brukselskiej. Zeszyty Naukowe Akademii Rolniczej we Wrocławiu. No. 190(51), p. 117-124. Rolnictwo. Poland.
- Sciazko, D., Kolota, E., Tyrakowska-Bielec, U. (1990b): Zmiany w zawartości cukrów w kapuscie brukselskiej pod wpływem nawożenia azotem. Zeszyty Naukowe Akademii Rolniczej we Wrocławiu. No. 190(51), p. 109-115. Rolnictwo. Poland.

**UTICAJ ROKA SADNJE NA HEMIJSKI SASTAV I VISINU
PRINOSA KELJA PUPČARA (*Brassica oleracea* var. *gemmifera*)**

- originalni naučni rad -

Natasa Mirecki

Biotehnički institut, Podgorica, Crna Gora

Rezime

U radu su prikazani rezultati ispitivanja roka sadnje (10. april, 10. maj, 10. jun, 10. jul) na hemijski sastav (sadržaj suve materije, pepela, celuloze, vitamina C i ukupnih šećera) i visinu prinosa kelja pupčara. Trogodišnja ispitivanja su pokazala da se u agroekološkim uslovima južne Crne Gore (Zetska ravnica) može uspešno gajiti kelj pupčar. Ranijom sadnjom (april-maj) obezbeđuje se veći prinos i bolji kvalitet glavičuraka u odnosu na kasniju sadnju (jun-jul). Rok sadnje je značajno uticao na sadržaj suve materije, šećera i vitamina C, dok kod ostalih posmatranih parametara hemijskog sastava nije uočena zavisnost od roka sadnje i sorte.