

**TECHNOLOGICAL QUALITY OF DOMESTIC CABBAGE  
(*Brassica oleracea* var. *capitata* L.) POPULATIONS AND VARIETIES  
FROM THE VOJVODINA PROVINCE-SERBIA\***

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*SUMMARY: The research treated in this paper dealt with cabbage varieties and populations from the Vojvodina Province, Serbia. Those were two varieties, NS-Futoški and Orion, and two local populations, Čuruški and Deronjski. The common characteristics of these cabbages are late maturation, fresh use in the fall and the pickling of whole heads and sauerkraut. The tender leaves in the head make these cabbages suitable for the uses mentioned above. Since cabbage pickling is practiced widely in Serbia, our aim was to investigate the chemical composition of the local cabbages, i.e., the contents of total sugars, dry matter and minerals. It was found that the sugar content in the heads ranged from 5.27% (NS-Futoški) to 6.33% (Orion). The dry matter content ranged from 8.07% (NS-Futoški) to 11.03% (Orion). The contents of minerals ranged as follows: Magnesium – from 88.7 mg/kg (NS-Futoški) to 143 mg/kg (Orion), Potassium – from 3003mg/kg (Orion) to 3772 mg/kg (Čuruški), Calcium – from 417.1 mg/kg (Deronjski) to 519.9 mg/kg (Orion), and Sodium – from 152.7 mg/kg (Čuruški) to 210.9 mg/kg (Orion).*

**Keywords:** pickling, sugar content, variability, cabbage.

## INTRODUCTION

In the previous period two cabbage varieties were recognized: NS-Futoski, and Orion, recognized 2004 and 2007, respectively. The stated varieties in the region of Vojvodina are traditionally most often used for fresh consumption in autumn, but also for the pickling of whole heads and as sauerkraut. Besides, two local cabbage populations, Čuruški and Deronjski, from the same region have similar purpose, (Fig. 1).

Original scientific paper / Originalni naučni rad

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\*The authors gratefully acknowledge the financial support from the Ministry of Science and Technological Development of the Republic of Serbia (Project TR 31030).

The tradition of growing cultivars and populations is primarily due to their intended use, which is fresh consumption, and sauerkraut making as well. In this way, local OP populations of cabbage or cultivars are specific to a particular cabbage-growing area (Červenski et al., 2011). Cabbage and cabbage products are interesting from both marketing and dietary points of view because cabbage has many beneficial effects on health. From a traditional point of view, cabbage in the form of sauerkraut is one of the best known traditional foods (Jevsnik et al., 2009). As in other Eastern European areas (Luczaj et al., 2007; Pieroni, 2008), in Vojvodina, most vegetables are preserved for consumption during the winter via lacto-fermentation. Cucumbers, cabbages, tomatoes, turnips, and sometimes egg plants are harvested, stored in barrels of salt water, and left to ferment. On the other hand, the people of Vojvodina have retained a few traditions surrounding their use of local plant resources. Although, the available local OP populations of cabbage are suitable for fresh consumption and sauerkraut making, local growers prefer to grow foreign cultivars (Červenski et al., 2010).

In the region of Vojvodina, cabbage is traditionally consumed in the autumn and winter mostly as sauerkraut, cabbage rolls and grated fresh cabbage. Locals in their households make many more other cabbage dishes. Therefore, local varieties and populations have an advantage over hybrids in the region, which makes it more attractive to consumers from the sensory point of view.

Geographic altitude, climate, relief and soil characteristics, classify Serbia among growing regions capable of continuous provision the market with quality goods during the whole season (Đilas et al., 2011).

Since cabbage pickling is practised widely in our country, aim of the study was to investigate the local cabbage varieties and populations chemical composition like total sugar content, dry matter content, and minerals content. In this way it would be possible to demonstrate good quality of the local cabbage varieties and populations for purposes of pickling and fermentation in the region of Vojvodina Province, Serbia.

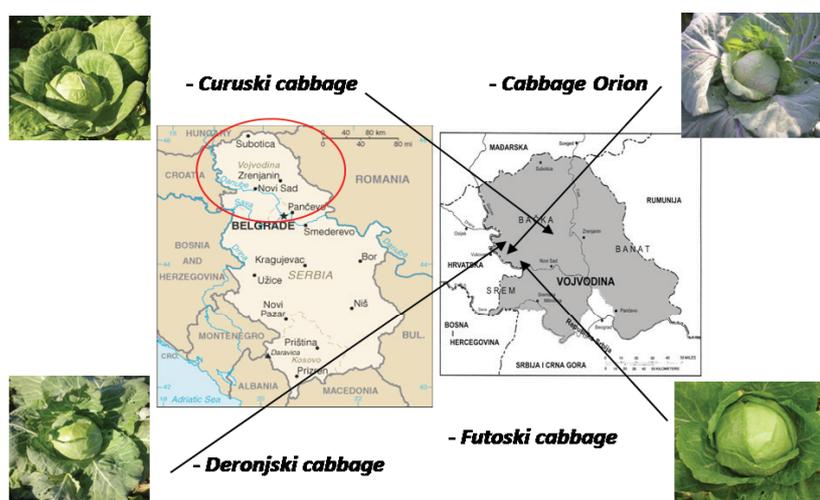


Figure 1. Local populations of white cabbage localize and collect in previous period (Červenski, et.al.2011)

## MATERIALS AND METHODS

The studied material consisted of 2 local OP populations of cabbage: Čuruški cabbage and Deronjski cabbage and two varieties: NS-Futoški and Orion, which are suitable for fresh use late in the season as well as for pickling and which have a history of being grown in the country for more than 30 years now, (places are shown in Fig. 1).

Trials were carried out on chernozem at the Rimski Šancevi Experiment Field of the Institute of Field and Vegetable Crops in Novi Sad, Serbia, 45°19'N latitude and 19°50'E longitude, at altitude 79 m above mean sea level. The horizons in which most of the root system of cabbage develops are neutral in reaction and slightly calcareous. The soil has a medium supply of total nitrogen, an optimum supply of readily available phosphorus, and a high readily available potassium content (Vasin et al., 2002).

The trial was carried out over a one-year period (2011) using a randomized block design with three replications. Before the planting, the plots were fertilized prior to primary tillage using NPK (8:16:24) at 600 kg per hectare. During the season, the crops were top-dressed on two occasions, and they were protected from diseases and pests as well. After the transplantation, irrigation was applied. The crops were also irrigated in the course of the growing season on several occasions depending on the soil moisture status and plant water requirements. The time and degree of head maturity were determined based on visual observation and head compactness. Thirty plants were analysed per replicate and genotype.

We selected 50 cabbage heads of satisfactory firmness, hardness and uniform appearance from each cabbage variety and population. In the laboratory of the Institute of Food Technology in Novi Sad, percentage of dry matter, percentage of soluble dry matter (with refractometer) (Bylaw of taking samples 29/83), and total sugar content (using method developed by Luff School) in raw material were determined.

Chemical analysis of cabbage heads miner content was performed according to domestic legislations quality parameters of taking samples methods and chemical and physical analysis for quality control of fruit and vegetable products (Bylaw of taking samples 29/83).

## RESULTS AND DISCUSSION

*Brassica* spp. have different edible portions that are sometimes separated for consumption. Water is the main component of *Brassica* spp. Water content varied between 76.09% and 92.5% in the samples studied. The sugar content is a basic parameter used in evaluating quality attributes of vegetables. Total soluble solids (TSS) can be used as an estimate of sugar content, (Martinez et al., 2010).

Winter cabbage varieties containing higher soluble dry matter and sugar content in heads are suitable for lactic acid fermentation. *Leuconostoc mesenteroides* is a bacterium associated with the sauerkraut and pickle fermentations. Sugar, added salt and temperature between 18 to 22 °C initiate growth of this organism in vegetables (4). It produces carbon dioxide that replaces the oxygen, making the environment anaerobic and suitable for the growth of subsequent species of *Lactobacillus*. In Vojvodina, varieties and populations NS-Futoški, Orion, and Deronjski Čuruški are cabbages most often used for pickling in the fall and early winter. Total sugar content in the heads of the examined varieties and

populations ranged from 5.27% to 6.33% in cv. NS Futoški and cv. Orion, respectively (Table 1). High sugar content makes those cabbages excellent for the purposes of fermentation and pickling.

Table 1. Results of chemical quality parameters of analysed cabbages

Parameters	Cabbages varieties and populations			
	NS-Futoški	Orion	Čuruški	Deronjski
Dry matter (%)	8,07	11,03	10,66	10,52
Soluble dry matter(%)	6,14	8,32	7,98	8,04
Total sugar content(%)*	5,27	6,33	6,11	6,13
Magnesium-Mg (mg/kg)	88,75	143,00	97,15	116,79
Potassium-K (mg/kg)	3500	3003	3772	3201
Calcium-Ca (mg/kg)	516,79	519,56	427,89	417,12
Sodium-Na (mg/kg)	165,52	210,92	152,76	157,89

\*By Luff-Schoolr method.

In the present study, dry matter content ranged from 8.07% to 11.03% and soluble dry matter content ranged from 6.14% to 8.32% in cv. NS Futoški and cv. Orion, respectively (Table 1). Dobričević et al. (2006) obtained results similar to ours.

Dobričević et al. (2006) reported that dry matter content in fresh cabbage heads ranged from 6.63 to 8.74%. These results are 2-3% less than the results we obtained. According to Martinez et al. (2010), variation in the composition of the plants is caused by many factors such as variety, growth conditions, time of harvest and maturity at harvest, post-harvest storage conditions and industrial processes. Hence, differences between our and the results obtained by Dobričević et al. (2006), could reasonably be attributed to different tissue strength and structure of cabbage varieties that were used in those two studies, as well as different growing conditions.

Chemical and sensory quality of raw material are affected by characteristics of production areas and climates. The variability reflects in the sustainability and quality of the final product. The dry matter content vary among years due to weather conditions and it is higher when there is less rainy days during the ripening and the harvest (Dobričević et al., 2006).

The study of Anuniação et al. (2010) involved 55 samples of cabbage, being 31 of the white species and 24 of the red species. The results expressed as milligrams of element per kilogram of sample demonstrated that the concentration ranges varied from 1603 to 4068 for potassium, 221,9 to 744,7 for calcium, 67,2 to 286 for magnesium, 27,2 to 591 for sodium. We obtained similar results. Mineral content in the heads of the examined varieties and populations ranged from 88.7 mg Mg/ kg to 143 mg Mg/kg in cv. NS-Futoški and Orion, respectively; 3003 mg K/kg to 3772 mg K/kg in cv. Orion

and cv. Čuruški, respectively; 417.1 mg Ca/ kg to 519.9 mg Ca/ kg in cv. Deronjski and cv. Orion, respectively; and 152.7 mg Na/ kg to 210.9 mg Na/ kg in cv. Čuruški and cv. Orion, respectively (Table 1).

Zahradnik et al. (2007), studied the effect of alternative organic fertilizers on the yield and nutritional value of cabbage. The authors reported that cabbage heads contained: 1865 to 1978 mg / kg of Potassium, 111 to 153 mg / kg of Magnesium, 222 to 276 mg / kg of Calcium, and 97 to 187 mg / kg of Sodium. Cabbage populations have been improved by farmers through mass selection for centuries. Their cultivation as a percentage of the entire cultivated area for cabbage is reducing. Compared with commercial hybrids, the local populations of cabbage are less productive and their heads lack uniformity and field durability, but they have thinner head leaves that are crisper and juicier. The type of use indicates that these are cabbages with thinner and juicier leaves, which predisposes their heads for fine rating and also makes their leaves readily bendable and easy to roll up when pickled. It is characteristics like those that give the local populations an advantage over hybrids (Koutsos et al., 2001).

## CONCLUSION

In conclusion, fresh cabbage from the production area of Vojvodina is a good raw material for fresh use and biological fermentation. The climatic and pedological characteristics of the typical and traditional production area favor the production of late cabbage cultivars, suitable for this purpose. Cabbage populations have been improved by farmers through mass selection for centuries. Their cultivation as a percentage of the entire cultivated area for cabbage is reducing. Compared with commercial hybrids, the local populations of cabbage are less productive and their heads lack uniformity and field durability, but they have thinner head leaves that are crisper and juicier. The type of use indicates that these are cabbages with thinner and juicier leaves, which predisposes their heads for fine rating and also makes their leaves readily bendable and easy to roll up when pickled. It is characteristics like those that give the local populations an advantage over hybrids.

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## **TEHNOLOŠKI KVALITET DOMAĆIH SORATA I POPULACIJA KUPUSA (*Brassica oleracea* var. *capitata* L.) IZ AP VOJVODINE U SRBIJI**

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### **Izvod**

Istraživanja ovog rada su obuhvatila domaće sorte i populacije kupusa poreklom iz Autonomne pokrajine Vojvodine, u Srbiji. Dve domaće sorte su bile: NS-Futoški i Orion, a dve lokalne populacije su bile: Čuruški i Deronjski. Glavne i zajedničke karakteristike navedenih kupusa su: kasni način proizvodnje, sveža potrošnja te kišljenje celih glavica ili ribanca. Upravo nežni listovi glavice ovih kupusa doprinose navedenoj upotrebi. Pošto je kišljenje kupusa u Srbiji tradicija, cilj nam je bio da ispitamo hemijsku strukturu navedenih kupusa i to pre svega: sadržaj ukupnih šećera, suve materije i sadržaj mineralnih materija. Istraživanjem su dobijeni sledeći rezultati: sadržaj šećera u glavicama se kretao od 27% (NS-Futoški) do 6.33% (Orion). Sadržaj suve materije se kretao od 8.07% (NS-Futoški) to 11.03% (Orion). Sadržaj mineralnih materija je bio sledeći: Magnezijuma od 88.7 mg/kg (NS-Futoški) do 143 mg/kg (Orion), Kalijuma od 3003mg/kg (Orion) do 3772 mg/kg (Čuruški), Kalcijuma od 417.1 mg/kg (Deronjski) do 519.9 mg/kg (Orion) i Natrijuma od 152.7 mg/kg(Čuruški) do 210.9 mg/kg (Orion).

**Ključne reči:** kišljenje, sadržaj šećera, varijabilnost, kupus.

Received / *Primljen*: 21.10.2014.

Accepted / *Prihvaćen*: 05.11.2014.