



# ZBORNIK APSTRAKATA

V NAUČNO-STRUČNI SIMPOZIJUM  
SA MEĐUNARODNIM UČEŠĆEM

**„PIVO, PIVARSKJE SIROVINE I  
OPREMA“**

Zrenjanin, Srbija  
25 - 28.10.2022. godine  
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**„PIVO, PIVARSKJE SIROVINE I OPREMA“**

5<sup>th</sup> SCIENTIFIC-PROFESSIONAL SYMPOSIUM  
WITH INTERNATIONAL PARTICIPATION  
**"BEER, BREWING RAW MATERIALS AND  
EQUIPMENT"**

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# KVALITATIVNA I KVANTITATIVNA ANALIZA ETARSKOG ULJA DOMAĆIH SORTI HMELJA

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Kao jedna od najznačajnijih sirovina za proizvodnju piva, šišarice hmelja se kuvaju sa sladovinom kako bi gorke, aromatične i taninske materije prešle iz šišarica u rastvor i dale sladovini svojstven gorak ukus i prijatnu aromu. Dodavanjem hmelja se u značajnoj meri određuju parametri kvaliteta piva poput ukusa, biološke stabilnosti i pene.

Domaći sortiment hmelja obuhvata staru, autohtonu sortu Bačka, kao i dve selekcionisane sorte Aroma i Robusta. Pored materija koje određuju pivarske parametre kvaliteta (sadržaj  $\alpha$  i  $\beta$ -kiselina, gorkih materija, smola), šišarice domaćih sorti sadrže i etarska ulja – mirisnu, uljanu tečnost koja može da se izoluje različitim tehnikama u laboratorijskim i industrijskim uslovima. Etarsko ulje predstavlja lipofilnu smešu proizvoda sekundarnog metabolizma biljaka, koja se sastoji od više hemijskih jedinjenja izoprenoidne strukture, uključujući i njihove derivate (estre, aldehide, ketone, alkohole, itd.).

Procentualni sadržaj etarskog ulja u domaćem sortimentu hmelja značajno varira, čak i u okviru iste sorte, što je najverovatnije posledica uticaja uslova spoljne sredine, poput lokaliteta, godišnjih klimatskih uslova ili vremena berbe. Prosečni sadržaj etarskog ulja u šišaricama sorte Aroma iznosi 0,32%; kod sorte Bačka 0,60%; dok se kod sorte Robusta kreće u širokom rasponu od 0,06% - 0,77%.

Kvalitativnom GC/MS analizom etarskog ulja iz šišarica hmelja ispitivanih sorti utvrđeno prisustvo oko 30 isparljivih jedinjenja od kojih su najzastupljeniji mircen, humulen i kariofilen. Najveći relativni udeo mircena (63,0%) i humulena (36,8%) se nalazi u etarskom ulju sorte Bačka, a kariofilena (15,5%) u etarskom ulju sorte Robusta. Na osnovu GC/MS analize, najmanji relativni udeo mircena (31,2%) je zabeležen u etarskom ulju sorte Robusta, a kariofilena (9,22%) i humulena (19,5%) u etarskom ulju sorte Bačka.

Na osnovu kvantitativne <sup>1</sup>H NMR analize, najveći procentni sadržaj mircena određen je u etarskom ulju sorte Bačka (60,0%), dok je sorta Robusta imala najviši sadržaj humulena (36,1%) i kariofilena (9,0%). Najmanji procentualni sadržaj mircena se nalazi u etarskom ulju sorte Rrobusta (27,4%), humulena u etarskom ulju sorte Aroma (20,3%), a kariofilena u etarskom ulju sorte Bačka (6,1%).

# QUALITATIVE AND QUANTITATIVE ANALYSIS OF ESSENTIAL OIL DOMESTIC VARIETIES OF HOPS

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As one of the most important raw materials for beer production, hop cones are boiled with wort so that the bitter, aromatic and tannic substances pass from the cones into the solution and give the wort its characteristic bitter taste and pleasant aroma. The addition of hops significantly determines beer quality parameters such as taste, biological stability and foam.

The domestic assortment of hops includes the old, autochthonous variety Bačka, as well as two selected varieties Aroma and Robusta. In addition to substances that determine brewing quality parameters (content of  $\alpha$  and  $\beta$ -acids, bitter substances, resins), pine cones of domestic varieties also contain essential oils - a fragrant, oily liquid that can be isolated using different techniques in laboratory and industrial conditions. Essential oil is a lipophilic mixture of products of the secondary metabolism of plants, which consists of several chemical compounds of the isoprenoid structure, including their derivatives (esters, aldehydes, ketones, alcohols, etc.).

The percentage content of essential oil in the domestic assortment of hops varies significantly, even within the same variety, which is most likely a consequence of the influence of external environmental conditions, such as locality, annual climate conditions or harvest time. The average content of essential oil in cones of the Aroma variety is 0.32%; for Bačka variety 0.60%; while for the Robusta variety it ranges widely from 0.06% - 0.77%.

Qualitative GC/MS analysis of the essential oil from the hop cones of the studied varieties revealed the presence of around 30 volatile compounds, the most abundant of which are myrcene, humulene and caryophyllene. The highest relative share of myrcene (63.0%) and humulene (36.8%) is found in the essential oil of the Bačka variety, and caryophyllene (15.5%) in the essential oil of the Robusta variety. Based on GC/MS analysis, the lowest relative share of myrcene (31.2%) was recorded in the essential oil of the Robusta variety, and caryophyllene (9.22%) and humulene (19.5%) in the essential oil of the Bačka variety.

Based on quantitative <sup>1</sup>H NMR analysis, the highest percentage content of myrcene was determined in the essential oil of the Bačka variety (60.0%), while the Robusta variety had the highest content of humulene (36.1%) and caryophyllene (9.0%). The lowest percentage content of myrcene is found in the essential oil of the Robusta variety (27.4%), humulene in the essential oil of the Aroma variety (20.3%), and caryophyllene in the essential oil of the Bačka variety (6.1%).

