Potravinarstvo, vol. 7, Special Issue, March 2013

Available online: 20 March 2013 at www.potravinarstvo.com
ISSN 1337-0960 (online)

THE COMPOSITION OF SELECTED VOLATILE COMPOUNDS IN FERMENTED MASHES OBTAINED FROM DIFFERENT VARIETIES OF PLUMS

Pawel Satora, Iwona Drozdz, Pawel Sroka, Tomasz Tarko

Abstract: The aim of this study was to determine the influence of plum variety (Wegierka Dabrowiecka, Wegierka Zwykla, Cacanska Lepotica, Stanley) on the volatile composition of spontaneously fermented plum mashes which after distillation could be used for plum brandies production. The GC-SPME was used for selected volatile components analysis. The variety of plums strongly influenced the volatile composition of obtained fermented plum mashes. The highest concentration of ethanol, acetaldehyde and propanol was found in the Wegierka Dabrowiecka mashes, while ethyl acetate and acetic acid were present in increased amount in Wegierka Zwykla mashes. Other two mashes – Cacanska Lepotica and Stanley were characterized by the highest levels of isobutanol and amyl alcohols, and methanol, butanol, hexanol and 2-phenylalcohol, respectively.
Keywords: slivovitz, plum mashes, spontaneous fermentation, volatile compounds

INTRODUCTION

In Eastern and Central Europe, plum brandies (slivovitz) matured under proper conditions are the most popular fruit brandies, prepared from fresh *Węgierka* plums. This beverage originating from the Balkan Peninsula is also quite well known in Central Europe (Hungary, Poland, Czech Republic, Slovakia, Romania) and, to a lesser extent, in France (eau-de-vie de prunes), Germany (Zwetschgenwasser) and Switzerland (Pflumliwasser) (**Satora and Tuszynski, 2008**).

Śliwowica Łącka is a strong plum brandy (slivovitz) that is produced in a submontane region of Poland with specific climatic and soil conditions by means of spontaneous fermentation of Węgierka Zwykła plums. Its originality depends on a high sugar concentration and unique aroma profile of blue plum fruits, as well as diverse microbiota that are present during spontaneous fermentation (**Satora and Tuszyński, 2010**).

The blue plum fruits are colonized mainly by the yeast-like fungi of genus *Aureobasidium sp.* and *Kloeckera apiculata*, these microorganisms get through the must during fruits processing and start the fermentation process. The first phase of the fermentation is dominated by the representatives of *Kloeckera apiculata* and *Candida pulcherrima* species, also the growth of *Rhodotorula* and *Aureobasidium* species occur to a lesser extent. The increase of the yeast microbiota continued during the first 4 days of fermentation until the maximum of $10{,}3 \cdot 10^6$ cfu/mL is achieved. As the fermentation progresses, the non-*Saccharomyces* species succesively die off, leaving *Saccharomyces cerevisiae* to dominate and complete the fermentation. The *S.cerevisiae* species population is fairly differentiated with reference to both oenological properties and other traits such as sensibility towards the actions of killer toxins and the ability to produce them (**Satora and Tuszyński, 2005**).

The aim of this study was to determine the influence of plum variety on the volatile composition of spontaneously fermented plum mashes which after distillation could be used for plum brandies production.

MATERIALS AND METHODS

Plum mashes used for the fermentation were obtained from Wegierka Dabrowiecka, Wegierka Zwykla, Cacanska Lepotica and Stanley plum fruits (harvested on August/September 2012 from three plum orchards in Łącko area). The plums were sorted (mechanically injured, decayed and rotten fruits were removed), cut in quarters and weighed out to 0.5 kg per 1-L sterile glass flask. The fruits were pressed so that the juice covered their surface, then the flasks were stopped with fermentation tubes with glycerine. Alcoholic fermentation was conducted for 30 days at 20 °C. All samples were done in triplicate.

In order to determine of the volatiles, two milliliters of each fermented plum mash sample was transferred to a 15 mL amber vial having screw caps (Supelco) with a magnetic stirrer and 1 g of NaCl, which was then spiked with 2 µL of internal standard (4-methyl-2-pentanol; Fluka). The SPME device (Supelco Inc., Bellefonte, PA, USA) coated with PDMS (100 µm) fiber was first conditioned by inserting it into the GC injector port at 250°C during 1h. For sampling, the fiber was inserted into the headspace under magnetic stirring (300 rpm) for 35 min at 40°C. Subsequently, the SPME device was introduced in the injector port for chromatographic analysis and was remained in the inlet for 2 min.

The GC-SPME analysis was performed on a Hewlett Packard 5890 Series II chromatograph system. The tested components were separated on a capillary column HP-INNOVAX (crosslinked polyethylene glycol stationary phase; 30 m × 0.53 mm ID with 1.0 µm film thickness). The detector and injector temperature was 250°C, and the column was heated using the following temperature program: 35°C for five minutes at an increment 5°C/min to 110°C, then 40°C/min to 220°C and maintaining a constant temperature for three minutes.

The qualitative and quantitative identification of volatile substances (acetaldehyde, ethyl acetate, methanol, propanol, isobutanol, butanol, amyl alcohols, pentanol, hexanol, 2-phenylethanol and acetic acid; Sigma-Aldrich) was based on the comparison of retention times and peak surface area read from sample and standard chromatograms. All tests were carried out three times.

SPSS 13.0 software was applied for statistical results analyses. Statistically significant differences between results ($p = 0.05$) were evaluated using one-way analysis of variance (ANOVA). Comparison of mean values were made using the Duncan test ($p<0.05$).

RESULTS AND DISCUSSION

The main component that is formed during alcoholic fermentation is ethyl alcohol. Studied fermented plum mashes contained averagely 7.2-7.5 % vol. of ethanol. Only samples obtained from Wegierka Dabrowiecka were distinguished by higher concentration of this compound - 10 % vol. (tab.1). These results confirmed earlier that using Węgierka Zwykla mashes after fermentation from 6.3 up to 8.4 % vol. of ethanol can be produced, in case of samples spontaneously fermented significantly more (**Satora and Tuszynski, 2010**). It is mainly connected with the fermentable sugars content in fruits which depends on a variety and climatic conditions present during individual year and it amounts from 9 to over 20% w/w (**Walkowiak-Tomczak et al., 2008; Bohačenko et al., 2010**).

The variety of plums strongly influenced the volatile composition of obtained fermented plum mashes (tab.1).

Acetaldehyde is one of the most important carbonyl compounds in alcoholic beverages, and is produced by yeast during fermentation (**Erten, 2002**). It originates as an intermediary product of yeast metabolism from pyruvate through the glycolytic pathway enzymes and it is a precursor for acetate, acetoin, as well as for ethanol. Studied plum mashes, showed significant differences in the acetaldehyde content. The lowest amounts were found after fermentation of Stanley mashes (7.5 mg/L), while the samples obtained from Wegierka

Dabrowiecka fruits were characterized by over 3 times higher level of this compound (23.6 mg/L).

The formation of larger amounts of methanol depends mainly on the content and level of methylation of pectins (plum variety), the activity of the original pectin methylesterase in the fruit, processing that causes tissue homogenisation (addition of enzymatic preparations) or the yeast strain used for fermentation (**Soufleros et al. 2004**). The highest amount was found in fermented mashes obtained from Stanley plums (805 mg/L), the lowest - after fermentation of Cacanska Lepotica plums (527 mg/L).

Ethyl acetate and acetic acid are mainly produced during ethanol fermentation by yeast. The fermented mashes obtained from Wegierka Zwykla contained considerably more ethyl acetate (91.6 mg/L) and acetic acid (435 mg/L), whereas in other samples were distinguished by lower level of these components, the lowest in the Wegierka Dabrowicka samples.

Amyl alcohols and 2-phenylethanol were predominant in group of higher alcohols with exception of Stanley samples, were the highest concentration of phenyl alcohol was found. Fusel content in fruit fermented mashes mainly depends on the type of material processed as well as fermentation conditions (**Satora and Tuszynski, 2008**).
Wegierka Dabrowiecka samples contained the highest level of propanol (49.4 mg/L), over two times more than other samples. Cacanska Lepotica mashes after fermentation were characterized by the highest concentration of isobutanol and amyl alcohols, while Stanley samples were distinguished by increased levels of butanol, hexanol and 2-phenylethanol. Mashes obtained from Wegierka Zwykla plums contained avarge amount of higher alcohols.

REFERENCES

Bohačenko, I., Pinkrová, J., Komárková, J., Paprštein, F. 2010. Selected processing characteristics of new plum cultivars grown in the Czech Republic. In *Hort. Sci.* (Prague) 2010, 37, 2: 39-45.

Erten, H. 2002. Relations between elevated temperatures and fermentation behaviour of *Kloeckera apiculata* and *Saccharomyces cerevisiae* associated with winemaking in mixed cultures. In *World J. Microb. Biot.* 2002, 18, 373-378.

Satora, P., Tuszyński, T. 2005. Biodiversity of yeasts during plum Wegierka Zwykla spontaneous fermentation. In *Food Technol. Biotechnol.,*43, 2005, (3), 277-282.

Satora P., Tuszyński T. Chemical characteristics of Śliwowica Łącka and other plum brandies. In *J. Sci. Food Agric*. 2008, 88, 167-174.

Satora, P., Tuszyński, T. 2010. Influence of indigenous yeasts on the fermentation and volatile profile of plum brandies. In *Food Microbiol.,* 2010, 27(3), 418-424.

Soufleros, E. H., Mygdalia, A. S. and Natskoulis, P. 2004. Characterization and safety evaluation of the traditional Greek fruit distillate „Mouro" by flavor compounds and mineral analysis. *Food Chem*. 2004, 86, 625-636.

Walkowiak-Tomczak, D., Reguła, J., Łysiak, G. 2008. Physico-chemical properties and antioxidant activity of selected plum cultivars fruit. In *Acta Sci. Pol., Technol. Aliment.* 2008, 7(4), 15-22.

Acknowledgements: This research was financed in part by the Polish Ministry of Science and Higher Education in 2012-2014 as scientific project number IP2011 048371.

Contact address: Pawel Satora, dr hab. ing., Department of Fermentation Technology and Technical Microbiology, ul. Balicka 122, 30-149 Krakow, POLAND

Table 1. The volatile composition of analyzed fermented plum mashes

ash	Acetaldehyde	Ethyl acetate	Methanol	Propanol	Isobutanol	Butanol	Amyl alcohols	Pentanol	Hexanol	2-Phenylethanol	Sum of fusel alcohols	Acetic acid
	[mg/L]											
rka	23.6b	25.6a	679	49.4b	24.4b	2.0b	56.8	1.2a	5.4	9.7a	149	227a
ecka	(±6.2)	(±5.9)	(±139)	(±6.2)	(±5.3)	(±0.1)	(±10.7)	(±0.1)	(±1.3)	(±2.5)	(±30)	(±52)
rka	10.4a	91.6c	591	14.1a	35.4c	1.9ab	42.1	5.5c	6.6	46.7b	152	435b
la	(±1.8)	(±16.8)	(±95)	(±2.4)	(±5.8)	(±0.1)	(±5.7)	(±0.9)	(±1.2)	(±7.5)	(±24)	(±61)
ska	11.3a	45.9ab	527	21.4a	35.9c	1.7a	61.7	3.0b	6.3	11.3a	141	361b
ca	(±0.7)	(±4.4)	(±38)	(±2.9)	(±2.2)	(±0.0)	(±3.5)	(±0.2)	(±0.4)	(±2.3)	(±7)	(±27)
ey	7.5a	66.8bc	805	24.8a	15.0a	2.5c	51.2	2.0a	7.2	55.6b	158	408b
	(±2.4)	(±6.6)	(±155)	(±4.2)	(±3.1)	(±0.1)	(±8.0)	(±0.2)	(±1.5)	(±5.9)	(±38)	(±75)
	**	*	ns	***	***	***	ns	***	ns	***	ns	**

[1] Sig.: significance; *, **, *** - display the significance at 5, 1 and 0.5 % by least significant difference; ns: not significant

Values with different superscript roman letters (a-c) in the same column are significantly different according to the Duncan test ($p<0.05$).