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Studying the Effects of Various Yeast on the Three-Year Aging Process of Brandy Spirits Made From "Kangun" and "Meghrabuyr" Grape Varieties

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ABSTRACT

Brandy spirits, matured for three years and produced with various yeasts, were examined to assess their quality. The study included evaluating sensory indicators and conducting a qualitative and quantitative analysis of volatile aromatic compounds. Results showed that brandy spirits fermented with "Oenoferm Bouquet" yeast, displayed the highest concentrations of volatile aromatic substances, with this variant receiving the most favorable tasting evaluation among the sampled spirits.

Introduction

It is well-established that yeasts play a significant role in brandy production. The use of different yeasts alters the qualitative composition of brandy wine materials, the revelation of this fact also became apparent during our research. Taking into account the obtained results, we delved into the study of brandy spirits from the scrutinized brandy wine materials distilled and further aged for three years in oak barrels (Petrosyan, et al., 1991).

Volatile aromatic substances play a crucial role in shaping the sensory characteristics of aged brandy spirits, and our study is dedicated to the qualitative and quantitative exploration of these compounds. The latter transforms into young brandy, drawing from both the brandy wine materials and the distillation process they undergo.

The quality of the wine spirit from which brandy is produced depends on many factors during the production process; however, we can distinguish the following: primary aroma substances which are generated from the grape varieties; secondary aroma substances generated during the vinification and fermentation process following the aroma substances generated during the distillation and maturation process (Milicevic, et al., 2002). The main aroma compounds of grapes belong to the chemical classes of terpenols, linalool, geraniol, and nerol, norisoprenoids, β-damascone, β-damascenone; benzenoids, β-phenylethanol, methyl salicylate, etc. Volatiles originating from the fermentation process are mainly constituted by alcohols, 2-methyl-1-propanol, β-phenylethanol, isoamyl alcohols formed by the Ehrlich pathway, and fruity esters, such as ethyl esters and acetates,

ethyl hexanoate, octanoate, and decanoate, isoamyl acetates (Flamini, 2009). Moreover, other volatiles such as acetals, ethoxy derivatives, and other terpenols such as α-terpineol, and terpinen-4-ol are formed by the hydrolytic reactions which occur during distillation and that are promoted by the high ethanol content and temperature (Mayr, et al., 2021).

The olfactory characteristics of aged brandy spirit are attributed to aromatic substances derived from natural oak wood, emerging through their transformation and aging. This includes middle esters, volatile acids, higher alcohols, aldehydes, and more (Skurikhin, 2005).

Our investigation explored the sensory characteristics of brandy spirits derived from diverse grape varieties and yeasts. Additionally, we conducted a qualitative-quantitative analysis of volatile aromatic substances using gas chromatography. The studied brandy spirits underwent a three-year aging process in Artsakh oak barrels (80 cm^2 per liter), with a regular enrichment of oxygen during the aging period (Kazumyan, et al., 2012).

Materials and methods

The research material comprised brandy spirits obtained from distillation of the brandy wine materials made of individual "Kangun" and "Meghrabuyr" grape varieties and three-year aging in oak barrels. These spirits were fermented using "FC" 9 yeast from the Danish company "Lalvin" along with "Oenoferm C 2" and "Oenoferm Bouquet" Saccharomyces cerevisiae strains. A control sample consisted of brandy spirits distilled from wine materials obtained through spontaneous fermentation from the same grape varieties and subjected to a 3-year aging process.

The assessment of taste is contingent upon the examination of individual constituents, including ethyl spirit, sugar colors, high molecular spirits, ethers, aldehydes, acids, vanillin, lignin, furfurol, ethyl acetate, acetaldehyde, acetic acid, and mineral substances. The collective interplay of these components, termed harmony, holds considerable sway in shaping the overall taste perception. Additionally, the sustained taste experience lingering in the mouth further contributes to the holistic evaluation of flavor (Avanesyants, et al., 2010).

The research activities took place within the laboratory and tasting hall of the Scientific Research Center at Yerevan Ararat Brandy Wine Vodka Combine JSC. The tasting committee, consisting of 11 individuals, undertook the evaluation of brandy spirit quality utilizing both 8- and 10-point assessment systems, conforming to the standards accepted in the Commonwealth of Independent States (CIS) countries. Qualitative and quantitative analyses of the volatile aromatic compounds in the researched samples were executed using an "Agilent 7890" gas chromatograph manufactured in the USA. This equipment features a quartz capillary tower, incorporating two ionizing detectors — flame ionization (FID) and mass spectral detectors — operating in parallel. The analysis duration was set at 45 minutes. The equipment is specifically equipped with an HP-FFAP capillary tower, boasting an inner diameter of 0.25 mm and a length of 30 m. Dual detection was achieved by connecting a flame ionization detector (FID) and an "Agilent 5975C" mass spectrometer in parallel.

The gas chromatograph operates under the following parameters:

Carrier gas: Helium of 99.999 % purity

Combustible gases: Hydrogen and air

Sample injection volume: 0.8 µl

Gas flow rate: 0.3 ml/min

Constant injector temperature: 290 ^{0}C

Gas flow split ratio: 1:50

Thermostat temperature range: 35°C to 230 ^{0}C

Flame ionization detector temperature: 250 ^{0}C

Analysis duration: 42.4 minutes

Calibration involved the construction of a scaling curve using German standard solutions. Post-experimentation, a thorough analysis of the obtained results is conducted.

Results and discussions

Figure, illustrates the averaged evaluations of sensory indicators for brandy spirits made from "Kangun" and "Meghrabuyr" grape varieties, aged over 3 years. A discernment of the sensory indicators depicted in the chart reveals that the highest score, 9.1 points, was attributed to the brandy spirit fermented with "Oenoferm Bouquet" yeast. This specific variant was derived from "Kangun" grapes and underwent a 3-year aging process. In contrast, the lowest score was assigned to the spontaneously fermented brandy.

The same trend is evident in the case of the "Meghrabuyr" variety, affirming that brandy spirits produced with "Oenoferm Bouquet" yeasts achieved the highest sensory assessment.

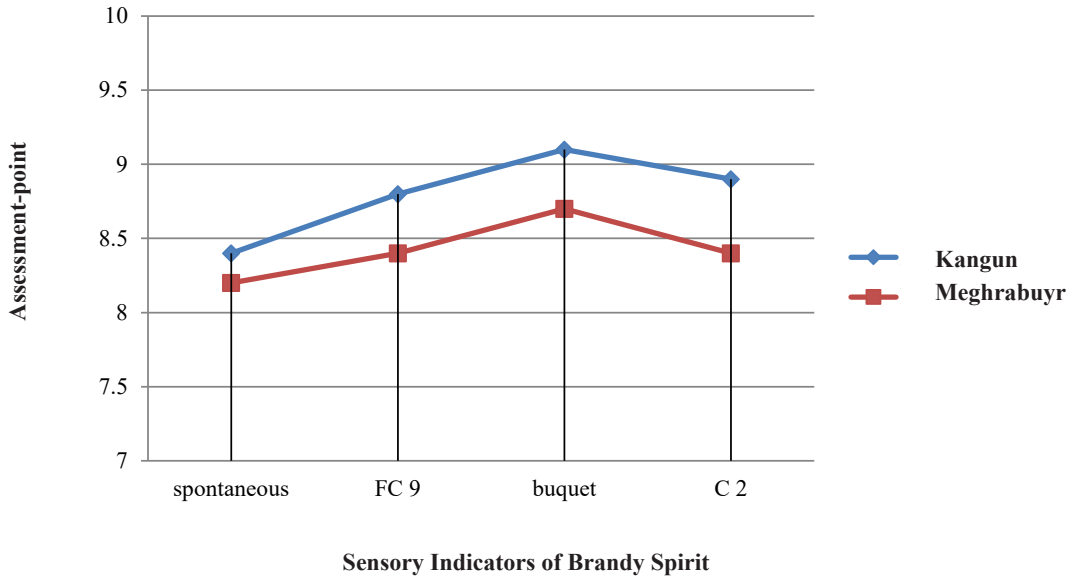

Figure. Sensory Indicators of Brandy Spirits Depending on Yeast Strains and Grape Varieties (*composed by the authors*).

A parallel observation emerges when scrutinizing the results of gas chromatographic analysis of volatile aromatic substances (Table).

Gas chromatography identified 24 volatile aromatic compounds in the analyzed samples.

The table reveals variations in the concentrations of high alcohols - specifically, 3-methylbutanol-1, 2-methylpropanol-1, and propanol-1, furthermore, the overall quantity of these compounds is notably elevated in brandy spirits derived from "Oenoferm C2" yeasts. Of significance is the peak concentration of propanol-1 in the "Oenoferm Bouquet" brandy spirits samples, contributing a fruity nuance, 23.5 mg/100 ml EtOH in the case of "Kangun" variety and 21.3 mg/100 ml EtOH in the case of "Meghrabuyr" ones.

During the aging of brandy spirits, tannins assume a crucial role in the generation of aldehydes, serving simultaneously as antioxidants that deter oxidation. The regeneration of aldehydes is further facilitated by semi-membranes, their partial hydrolysis yielding various monomeric compounds such as sugars (hexoses, pentoses, etc.). Within the aging process of brandy spirits, specific transformations involving pentoses, methyl pentoses, and hexoses lead to the production of aldehydes belonging to the furan series - namely, furfural, methylfurfural, and oxymethylfurfural. These aldehydes significantly contribute to the development of the taste and aroma profiles of brandy. Additional sources of aldehydes encompass the intricate processes of oxidation-reduction and melanoidin formation involving amino acids (Sarishvili, et al., 1998).

Acetaldehyde emerges as the predominant aldehyde in the examined samples, reaching its highest concentration in spontaneously fermented brandy spirit samples at 8.23 mg/100 ml EtOH. Notably, in brandy wine spirits distilled and aged from "Kangun" grapes, this content was recorded at 7.9 mg/100 ml EtOH and for "Meghrabuyr", at 7.9 mg/100 ml EtOH. "Oenoferm Bouquet" brandy spirits exhibited elevated levels of furfural and methylfurfural. Specifically, in the "Kangun" sample, concentrations were 1.9 mg/L for furfural and 0.2 mg/L for methylfurfural, while for "Meghrabuyr", the levels were 1.6 mg/L and 0.15 mg/L, respectively. Esters, essential components of volatile aromatic substances, play an irreplaceable role and are generated during processes such as ester formation, melanoidin formation, decomposition, and oxidation-reduction conversions. Acetic acid ethyl ester dominates in all samples, renowned for its pungent aroma. The highest concentration is observed in samples obtained through spontaneous fermentation. Notably, other esters - propionic acid methyl, hexanoic acid ethyl, octanoic acid ethyl, dodecanoic acid ethyl, and tetradecanoic acid ethyl esters - are abundant in "Oenoferm Bouquet" brandy spirits, both in "Meghrabuyr" and "Kangun" samples (Harutyunyan, et al., 2018).

Table. Qualitative and Quantitative Composition of Volatile Aromatic Substances in Brandy Spirits from "Kangun" and "Meghrabuyr" Grape Varieties*

N	Volatile substances, mg/100 ml of anhydrous spirit	Kangun				Meghrabuyr			
		Sp.	Bouquet	FC 9	C 2	Sp.	Bouquet	FC 9	C 2
3	Butanol-2	0.08	0.03	0.062	0.017	0.09	0.09	0.054	0.05
4	Butanol-1	0.95	0.85	0.66	1.4	1.22	0.96	0.78	1.43
5	Propanol-1	19.8	23.5	21.0	20.3	20.9	21.3	17.8	15.9
6	2-methylpropanol-1	66.9	85.2	84.8	82.5	74.6	83.9	82.3	79.6
7	Isoamyl spirit	290.6	342.6	299.0	360.5	302.3	359.6	326.6	368.6
8	Hexanol-1	3.56	3.52	3.63	3.95	4.55	3.56	4.52	4.89
9	Octanol-1	0.04	0.036	0.04	1.16	0.068	1.2	0.045	1.26
10	Phenyl ethanol-1	65.9	98.6	42.6	100.5	60.8	89.6	66.6	100.6
11	Acetic acid methyl ester	0.58	0.65	0.39	0.5	0.56	0.69	0.45	0.52
12	Acetic acid ethyl ester	44.5	45.7	40.5	45.2	40.9	45.9	41.9	42.3
13	Propionic acid methyl ester	ND	ND	ND	ND	ND	ND	ND	ND
14	3-methylbutanol-1	0.9	1.89	1.0	1.3	1.2	2.2	1.6	1.7
15	Hexanoic acid ethyl ester	0.18	0.19	0.16	0.16	0.25	0.38	0.37	0.345
16	Ethyl lactate	25.6	18.9	23.6	20.9	45.6	36.5	34.5	25.9
17	Ethyl ester of octanoic acid	0.6	0.49	0.33	0.35	0.36	0.69	0.98	0.99
18	Dodecanoic acid ethyl ester	0.48	0.68	0.64	0.42	0.36	0.56	0.46	0.23
19	Tetradecanoic acid ethyl ester	0.45	0.69	0.59	0.26	0.22	0.36	0.12	0.21
20	Acetaldehyde	8.23	7.65	6.36	6.8	7.88	6.9	5.25	5.40
21	1,1-diethoxyethane	1.3	ND	ND	ND	ND	ND	ND	ND
22	Furfural, mg/l	1.1	1.9	1.4	1.5	0.9	1.6	1.4	1.3
23	MethylFurfural, mg/l	0.11	0.2	0.1	0.1	0.09	0.15	0.08	0.08
24	Methanol, mg/l	0.56	0.69	0.8	0.78	0.9	0.89	0.78	0.9

*Composed by the authors.

Conclusion

Our study delved into the sensory indicators of brandy spirits, distilled from wine materials sourced from "Kangun" and "Meghrabuyr" grape varieties, and aged for three years. The qualitative-quantitative composition of volatile aromatic substances was meticulously examined through gas chromatography. The fermentation options considered for the research involved "FC 9" from the Danish "Lalvin" company, "Oenoferm C 2" and Saccharomyces cerevisiae yeasts from the German "Erbslöh" company. The data obtained reveals that the brandy spirits fermented with "Oenoferm Bouquet" yeasts exhibited the highest concentrations of volatile aromatic substances, a finding consistently affirmed through sensory evaluations during tasting sessions.

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