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DISTILLATION PRODUCTS OF STANLEY PLUM OBTAINING

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Summary: *The sort of plum used for distillation is Stanley picked in August 2013 in Gračac, Vrnjačka Banja, Serbia. 200 kg of ripe fruit was fermented with 40 dm^3 of potable water. Wine was removed from the obtained product, and the solid part was washed with water. The mixture of wine and water, 240 dm^3 was distilled to a soft brandy, where 36 dm^3 was obtained with 30 % of the ethanol. After that, this soft brandy was redistilled after 44 dm^3 of potable water was added. By this procedure, 20 dm^3 with 50 % of the ethanol was distillated, which means that the yield was 10 dm^3 of a brandy for 100 kg of plums.*

Keywords: *Stanley plum, fermentation, distillation, distillate, brandy.*

1. INTRODUCTION

Serbia is a country well known for a large number of autochthonous plum sorts, the most famous are "požegača" and "crvena ranka". However, due to the problems with dry weather and pollution, now the most common is the imported Stanley sort. It is a high quality industrial sort, very useful and important in food industry – dried fruits, marmelades and fruit juices, as well as a high quality brandy. Domestic productions of the plum brandy are also well known and popular [1]. Unfortunately, this popular domestic procedures are often flawed by the inadequate equipment and low hygienic conditions, resulting with a product of the low quality.
The development of new distilleries of higher capacity would raise the quality of local plum brandy, so they could be successful on both domestic and international market. Contribution of the "know–how" on obtaining of the high quality of plum fruit distillate, plum brandy, is presented in this study. The distillation process was followed by measuring of the ethanol concentration, and the aim was obtaining of a high quality distillate and the presentation of concentration profile of the ethanol in a fractions of distillate and in a residue.

2. STANLEY PLUM

Stanley is the USA plum sort, dating 1912. It becomes ripe in the second half of August and in September, and it is generally resistant to dry, hot weather and viruses. The attractive appearance, with large fruits of dark blue color adds to the quality and high yield adds to its popularity. According to standards, brandy is the alcoholic beverage with at least 25 %, and at most 80 % of the ethanol. It is produced by fermentation and then distillation of a substrate, fruit, vegetables or cereal [2, 3].

3. PLUM BRANDY PRODUCTION

The production of plum brandy starts with fruit picking, their fermentation, then distillation and leaving the distillate to rest for sometime in order to obtain a quality product. The fruit is picked when it reaches the technological ripeness, with the optimal concentration of sugar and fruit acids, which can be confirmed by chemical analysis and morphological appearance. The fermentation, anaerobic degradation of carbohydrates to the ethanol and the carbon−dioxide is catalyzed by selected sorts of yeasts. The mechanism of the carbohydrate conversion is a complex one [4, 5]. In dry years, like 2013, the high level of sugar, fruit acids, and microelements enables successful fermentation by the yeasts which exist on the fruit skin, and such method can be carried out in a domestic production. The next phase, distillation, is based on mixture separation based on a different boiling points. The parameter which describes the concentration of the certain component in the mixture is the rectification coefficient $K_{ir}= K_i/K_r$, where K_i and K_r are coefficient of vaporization of components i and r. For multicomponent alcoholic beverages, it is the relation between ethanol (r) and other components (i). Components with $K_{ir}>1$ have higher volatility than the ethanol, and those with $K_{ir}<1$ have lower volatility than the ethanol. As it is empirically determined, the latter fraction usually damages a flavor and quality of beverage and should be removed from distillate. As too many components influence on K_{ir}, it has no standard value. Knowing the boiling points of different components, the fractions can be successfully separated. The so−called soft brandy, obtained by first distillation, is then redistilled, which is the key to obtaining a high quality brandy with an attractive flavor as a product [6]. The freshly made brandy is then laid to rest in a glass bottles or wood barrels, mostly made of the oak. Leaving the brandy in wood barrels leads to the faster loss of volatile components, but also of methanol which is harmful and deteriorates the brandy quality. The oxidation and partial decomposition of some components leads to the formation of various tasteful secondary aromas, like vanillin, which can only raise the quality of the beverage. That is why more than 10 years old brandy, left in a wood barrel, is often of a supreme quality.

4. EXPERIMENTAL

The sort of plum used for distillation is Stanley picked in August 2013 in Gračac, Vrnjačka Banja, Serbia. 200 kg of ripe fruit was fermented with 40 dm^3 of drinking water. It was fermented for 24 days on 16−18 °C. The anaerobic conditions are obtained by adequate closing of the fermentation barrels. After the fermentation was complete, the wine was drained and the solid residue was washed with water added to the wine, resulting in 240 dm^3 of liquid mixture ready for distillation. The distillation process is divided in two steps – soft brandy production and redistillation. The distillation was carried out in a boiler 120 dm^3 heated by solid fuel, Figure 1.

Figure 1: Distillation boiler

The boiler was filled with 120 dm^3 of distillation mixture and heated. First fraction, about 0.2 dm^3 was discarded. The process was continued with 9 fractions, each about 2 dm^3, which were tested by the standard for the concentration of ethanol by the n-Richter Tralkles T15 C device. After measurement, the fractions were mixed giving the distillate which concentration of the ethanol was measured again.

5. RESULTS AND DISSCUSION

The results of the measurement of ethanol concentration are given in Table 1. The phase diagram [7,8] was made based on the equilibrium data from which the concentration of ethanol in the boiler can be read from the concentrations in fractions, presented in Figure 2. Based on the data from Table 1, the concentration profile curves c = f(v) for the basic distillation were made, and they are presented on Figure 3 and the concentrations in different phases in Table 2.

Table 1: Equilibrium data for the ethanol–water system for basic distillation

Temperature, °C	Ethanol liquid, % v	Ethanol vapor, % v
100.062	0	0
97.216	3.170	33.878
95.099	6.204	45.669
93.260	9.111	53.042
91.677	11.898	58.141
89.173	17.141	64.704
87.353	21.987	68.715
86.005	26.477	71.423
83.827	36.385	75.585
82.496	44.759	78.165
81.555	51.931	80.094
80.836	58.142	81.684
80.268	63.572	83.073
79.813	68.361	84.338
79.446	72.616	85.523
79.152	76.421	86.659
78.918	79.844	87.770
78.734	82.940	88.873
78.592	85.753	89.985
78.485	88.321	91.126
78.406	90.674	92.319
78.345	92.839	93.596
78.292	94.836	94.999
78.227	96.685	96.568
78.192	97.387	97.244
78.148	98.069	97.942
78.092	98.731	98.646
78.059	99.055	98.994
78.023	99.374	99.335
77.985	99.689	99.665
77.961	100	100

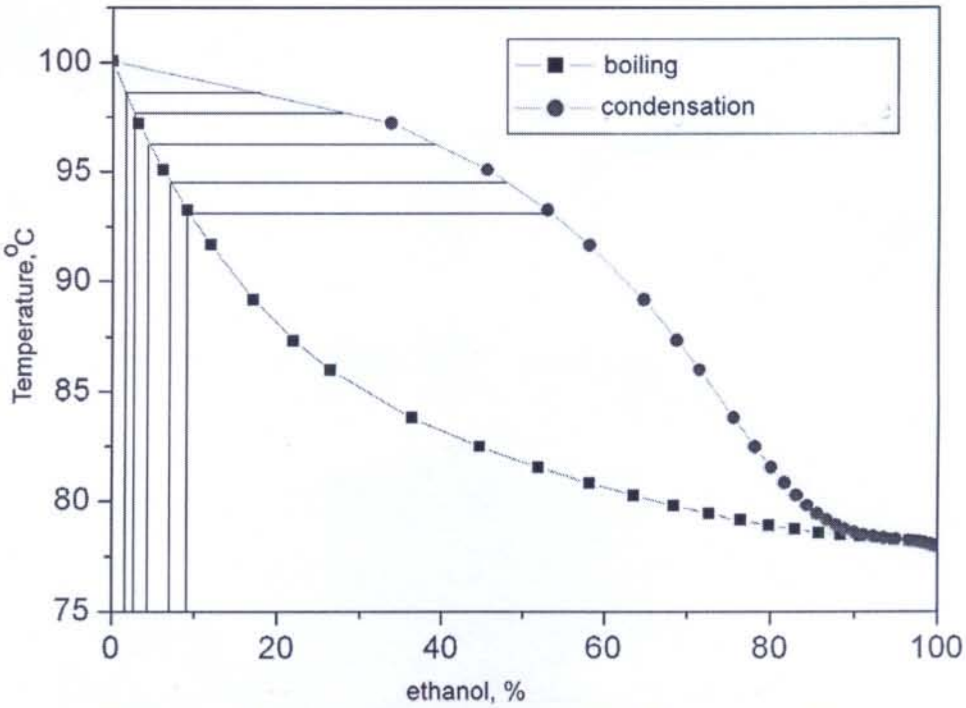

Figure 2: Phase diagram ethanol–water for the basic distillation

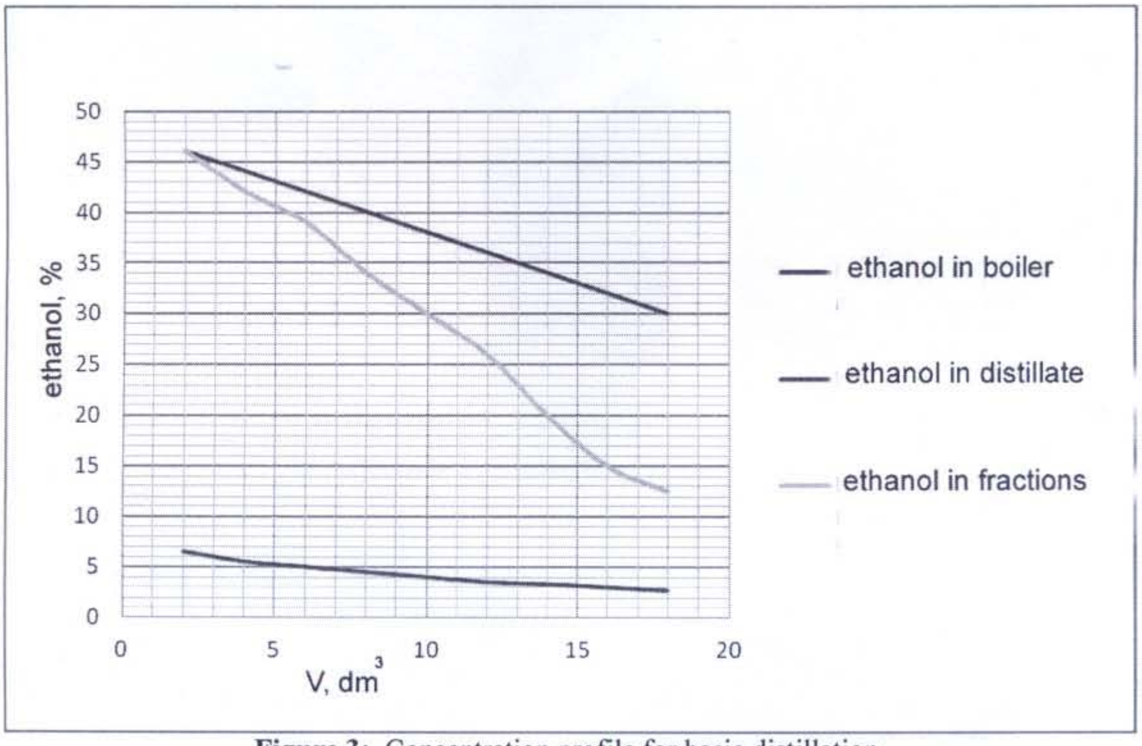

Figure 3: Concentration profile for basic distillation

The distillate obtained (so–called soft brandy) was 36 dm^3, it was dilluted with 44 dm^3 of potable water and then redistillated in the same boiler. The first fraction of 0.3 dm^3 was discarted, then 8 fractions were separated, about 5 dm^3, and the concentration of ethanol was measured. The fractions were successively mixed giving the distillate in which the concentration of ethanol was measured again. Based on the concentrations of the ethanol in fractions, the concentrations in boiler were read from the phase diagram for redistillation, Figure 4. The concentrations of ethanol in the boiler, fractions and distillate are given in Table 3. Based on Table 3, the corresponding concentration profile curves were made, c = f(v), Figure 5.

Table 2: Ethanol concentrations for basic distillation

V (dm^3)	Ethanol in boiler, %	Ethanol in fractions, % v	Ethanol in vapor, % v
2	6.50	46.00	46.00
4	5.50	42.00	44.00
6	5.00	39.00	42.00
8	4.50	34.00	40.00
10	4.00	30.00	38.00
12	3.50	26.00	36.00
14	3.30	20.00	34.00
16	3.00	15.00	32.00
18	2.70	12.50	30.00

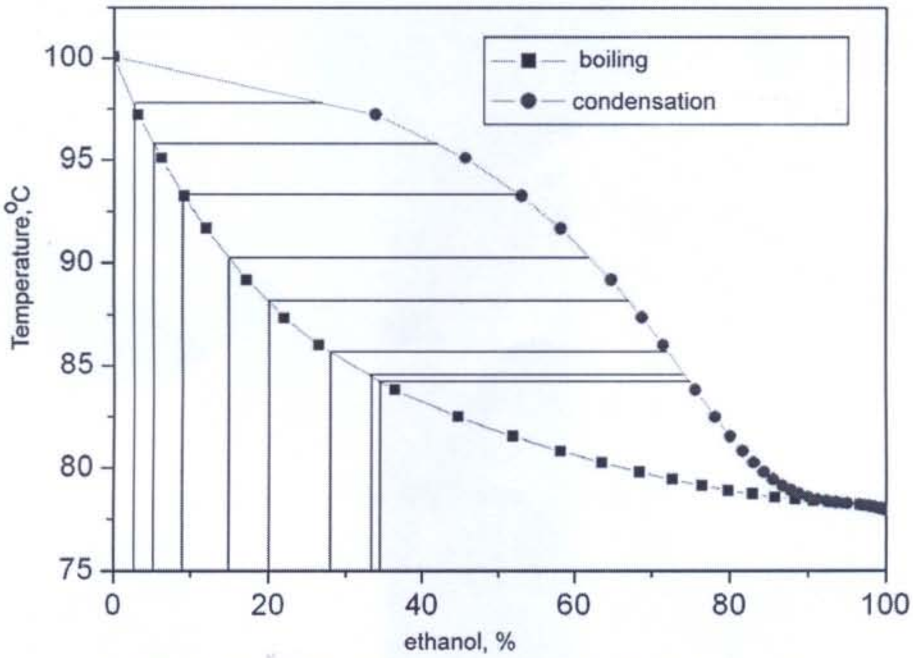

Figure 4: Phase diagram ethanol–water for the redistillation

Table 3: Ethanol concentrations for redistillation

V (dm^3)	Ethanol in boiler, %	Ethanol in fractions, % v	Ethanol in vapor, % v
5	13.50	60.00	60.00
10	11.00	55.00	57.50
15	9.50	48.00	54.33
20	7.50	37.00	50.00

The curves of concentration profile for ethanol in the distillate and in fractions point the decrease of the ethanol concentration during basic distillation and redistillation. The decrease of the ethanol concentration in the fractions is considerably sharper than in the distillate. The range of concentrations for basic distillation and redistillation is defined by the starting concentration of ethanol, which can be seen from the phase diagrams and concentration curves. Based on Table 3, the yield of 10 dm^3 of 50 % of the ethanol is determined for 100 kg of Stanley plum.

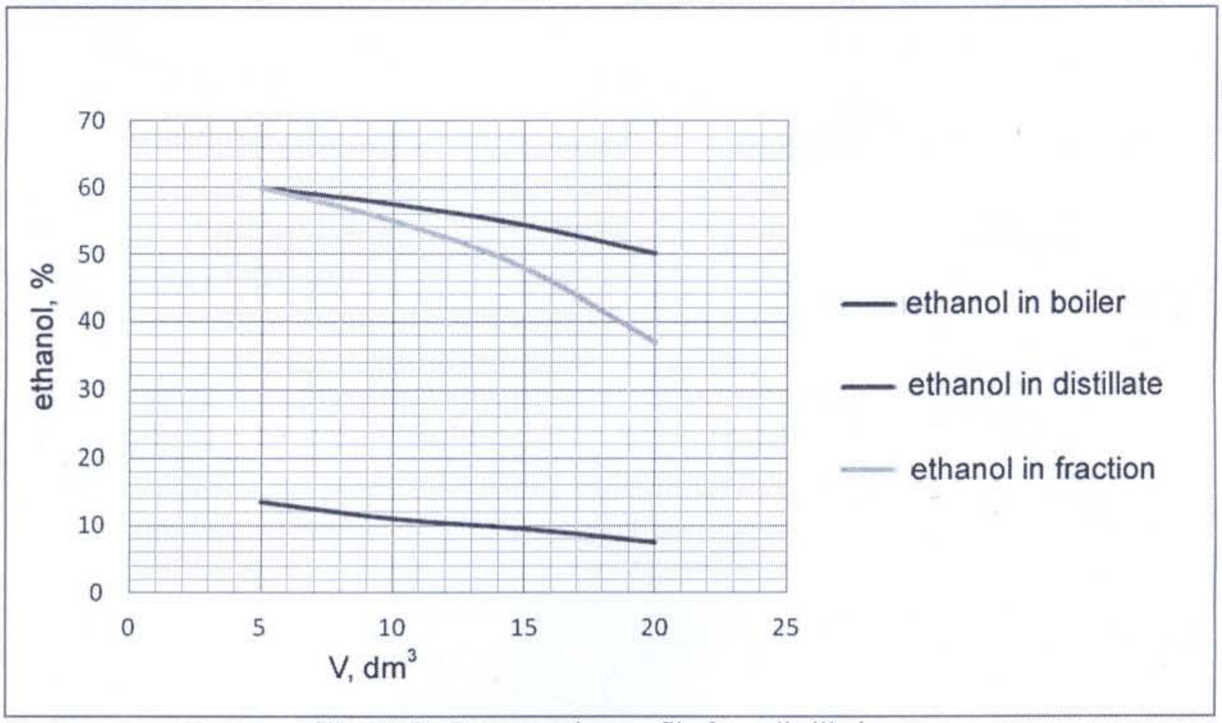

Figure 5: Concentration profile for redistillation

6. CONCLUSIONS

Using the equilibrium data of the water–ethanol binary system for a distillation, the concentration profile of the differential distillation can be determined. The concentration profile of the ethanol in fractions and in the distillate points the fact that the end of distillation can be more precisely determined from the fraction concentrations, as the change of that concentration is much faster at the end of a distillation process. The distillation products of a high purity and high ethanol concentration can be obtained in the classic boiler, so the production of a high quality plum brandy is possible in the domestic production.

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