A C T A   A L I M E N T A R I A   P O L O N I C A
Vol. VII (XXXI), No. 3-4   1981

TADEUSZ TUSZYŃSKI
BOLESŁAW BACHMAN

CHERRY DISTILLATES. PART I. THE EFFECT OF VARIOUS YEAST STRAINS ON THE COMPOSITION OF DISTILLATES OBTAINED FROM FERMENTED CHERRIES

Department of General Chemistry and Food Technology, Agricultural University, Kraków
Department of Technology of Fermentation and Microbiology, Technical University, Łódź

Key words: cherry fruit, wine yeasts, fermentation, crude spirits

Fruits of juiced cherry were fermented using ten different strains of wine yeast. The fermented mashes were subjected to two-stage distillation and the crude spirits obtained were chemically and sensorilly estimated. Yeasts belonging to strain Cherry 8 and Burgund 9 were found to be the most useful for mash fermentation. The chemical composition of the crude spirits obtained differes mainly in the groups of esters and fusel oils.

In terms of their chemical composition and flavour properties, fruit distillates *) are similar to wine distillates. Some of them are characterized by a very specific aroma, e.g. cherry and pear distillates, which makes that vodkas produced from these distillates have a very high standard. Production of a qualitatively good vodka of this type by means of a natural fermentation of fruit and, then, distillation of the mash obtained calls for a selection of technologically appropriate parameters of fermentation, distillation and maturation.

The important role in the process of fermentation and shaping of the final sensorial properties of fruit distillates is played by yeasts [19, 20, 21, 22, 23, 24].

Wine yeasts [4, 5, 6, 8, 9, 18, 25, 27] were mostly used for the fermentation of mash obtained from various fruit. According to Dittmann [1],

*) The product obtained from the distillation of fermented cherry mash has been called crude spirit, and the central fraction obtained from a corrective distillation of this spirit-cherry distillate.

fermentation of clean and sound fruit can be spontaneous without any addition of pure yeast culture. Kreipe [6] os of the opinion that fermentation of fruit should be carried out using exclusively a pure culture of wine yeast with an addition of nutritives substances to yeast in an amount of 10-15 g/100 kg fruit.

Yeasts of the majority of strains produce similar aromatic components but the proportions of these components are differrent [2, 7, 24, 26, 28].

The purpose of this study was select appropriate strains of yeast for the fermentation of cherry mash and to determine their effect on the final composition of distillates obtained from fermented mash.

METHODS

Juiced cherries (Serocka cherry) were used for the experiments. Fermentation was carried out in room temperature with the use of must, pulp and whole fruits. Cherry must alone was used during tests related to a preliminary selection of yeast. The size of samples amounted to 1 to 5 dm^3 must and 15 to 30 kg of whole fruit or fruit in the form of pulp.

Must was fermented in 2 to 10 dm^3 glass flasks protected with safety funnel tubes, and the remaining samples in metal containers, enamelled or glass fermenters of a 20 to 40 dm^3 capacity. The surfaces of mash subjected to fermentation in metal tanks were protected from the top with winidur plates with a 10% clearance in the form of drilled holes, and with a lid.

Various strains of wine yeasts were used for fermentation to an amount of 5% vol. in relation to must and pulp and 7% in relation to the weight of whole fruits. In the initial stage, the pure yeast culture was grown in brewer's wort and next in cherry must.

Ammonium dibasic phosphate to an amount of 0.1 g/dm^3 must and pulp and 0.15 g/kg of whole fruit was used as a nourishing substance. During fermentation, mixing took place every 12 h. After mixing the basic parameters of the process were controlled. The fermentation time was equal for all preliminary samples and amounted to 20 days. In the following stage of the tests, fermentation was considered to be completed when the density of the fermenting solution did not change or when the respective changes were small (0 to 0.2°Blg/24 h).

The fermented mash was then distilled and the crude spirit obtained was subjected to corrective distillation. Distillation was done in an conventional copper apparatus and corrective distillation in an apparatus whose ascending part was made of copper and the descending one of glass. The 110 mm dia column was packed with ceramic Raschig rings. The height of packing was equivalent to 2.2 theoretical plates (for the etanol — water system).

The parameters of corrective distillation have been worked out on the basis of the distillation of initial samples made in a glass apparatus comprizing a flask, a column packed with Raschih rings, a cooler, receivers and an electric bath with autotranformer.

During corrective distillation, the switching on of the receiver to the tail fraction took place when the received liquid strength attained 52% vol. 2.5% heads and approx. 86% intermediate fraction (of cherry distillate) were obtained in terms of alcohol 100°, compared to the initial amount.

Alcohol in cherry mash was determined and complete fermentation tests were carried out acc. to Pieper [10, 11]. Lees and alcohol yield were determined acc. to Nosko [9]. The materials, fermented mash, crude spirits and distillates were made in compliance with Polish Sandards [13, 14, 15, 16, 17].

RESULTS AND DISCUSSION

Table 1 presents a characteristic of the materials used for the experiments. Fig. 1 and 2 present examples of changes in the content of apparent extract during the fermentation of cherry must using various strins of wine yeasts. Mash fermented with the use of yeasts strain Wiśnia 8, Burgund 39 and Tokay 13 were characterized by the highest degree of final fermentation efficiency (1.8 to 2.5% extract residue), a small content of residual sugars (0 to 0.62 g/dm^3) and a high alcohol yield from 100 kg sugars (58 to 59 dm^3). The largest amount of extract (apparent final extract — 4.0 to 5.5%) remained in mash fermented with yeasts strain Vulk 39 and Chambertin 14.

In addition, yeast strains such as Sherry 38, Bingen 5 and Vulk 39 distingushed by a comparatively long period of initial stage of fermentation — 30 to 48 h. Yeasts of the strain Malaga Wiśnia, Chambertin and Tokay were characterized by the shortest time of initial stage of fermentation (5 to 15 h). Mash fermented with yeast of the strain Wiśnia, Burgund and Tokay were characterized by similar changes in the extract. The period of adaptation of these three strains of yeast — as shown by diagrams — was shortest (ca 8 h). After that time, it was possible to note already external symptoms of fermentation together with a reduction of the content of extract in the mash. Fermentations carried out with these strains of yeast were spontaneous and the period of vigorous fermentation occurred mostly between its third and tenth day.

As shown by diagrams (Fig. 1 and 2) yeasts belonging to the strains under test fermented cherry mash only to approximately the 17th day of fermentation with the exception of yeasts belonging to strain Johannisberg, Bordeaux and Vulk which fermented of the sugars over the whole

Table 1. Characteristic of the material

Basic material	Organoleptic characteristic	Extract % weight	Total sugar in terms of invert sugar g/dm^3	Total acidity in terms of apple acid g/dm^3	Volatile acidity in terms of acetic acid g/dm^3	Kernels in fruits		Saccharose g/dm^3	pH
						pieces in 1 kg	% weight		
Juiced cherry	fruits of different size and of different degree of maturity, aromatic	15.7 to 15.8	129.2 to 130.0	13.50 to 13.55	0.06 to 0.07	360 to 365	10.0 to 10.6	4 0 to 6.0	3.65 to 3.75
Cherry must	aromatic, dark-red colour	15.6	128.0	13.05	0.08	—	—	6.0	3.50

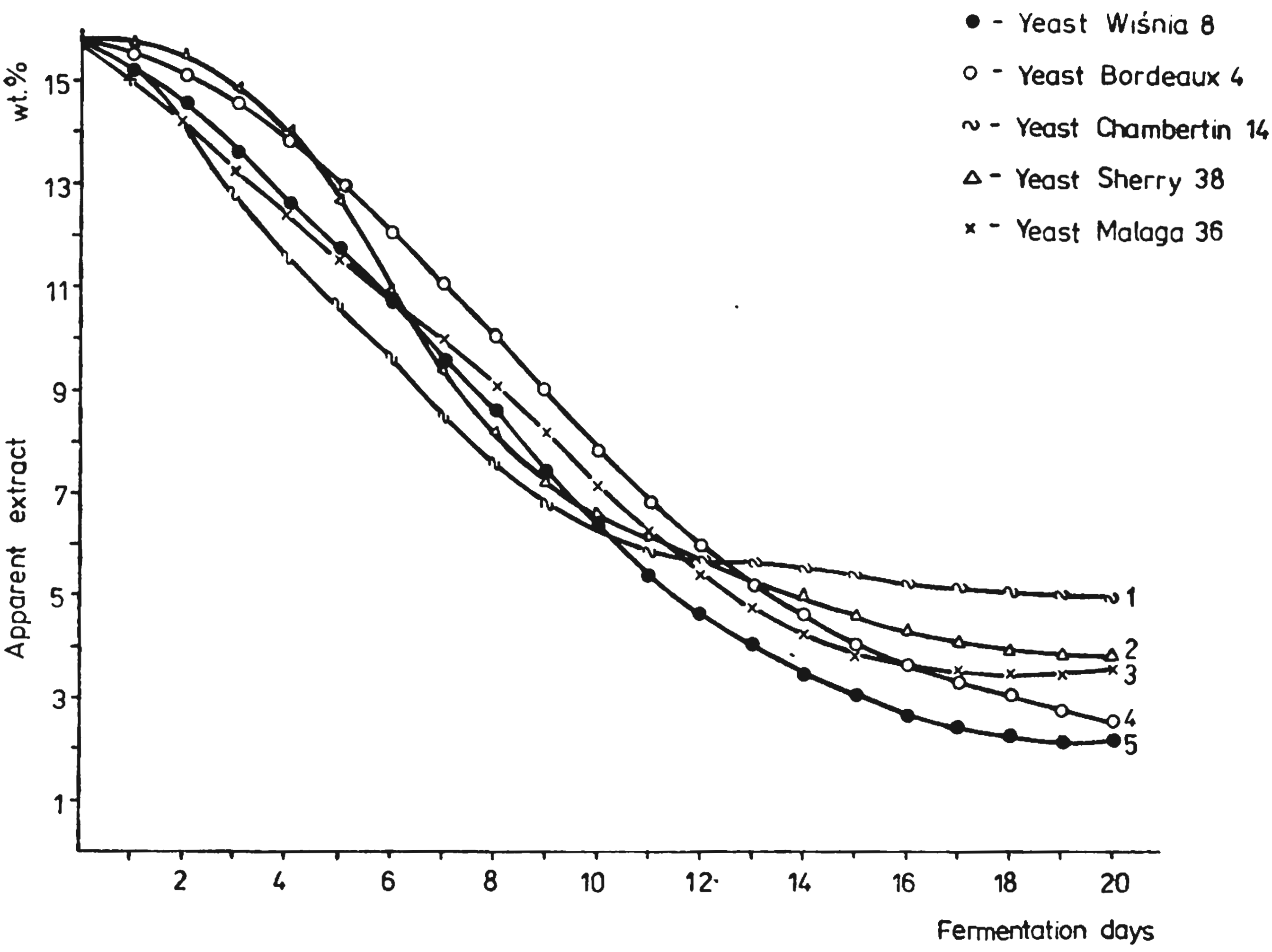

Fig. 1. Changes of apparent extract content during fermentation of cherry must

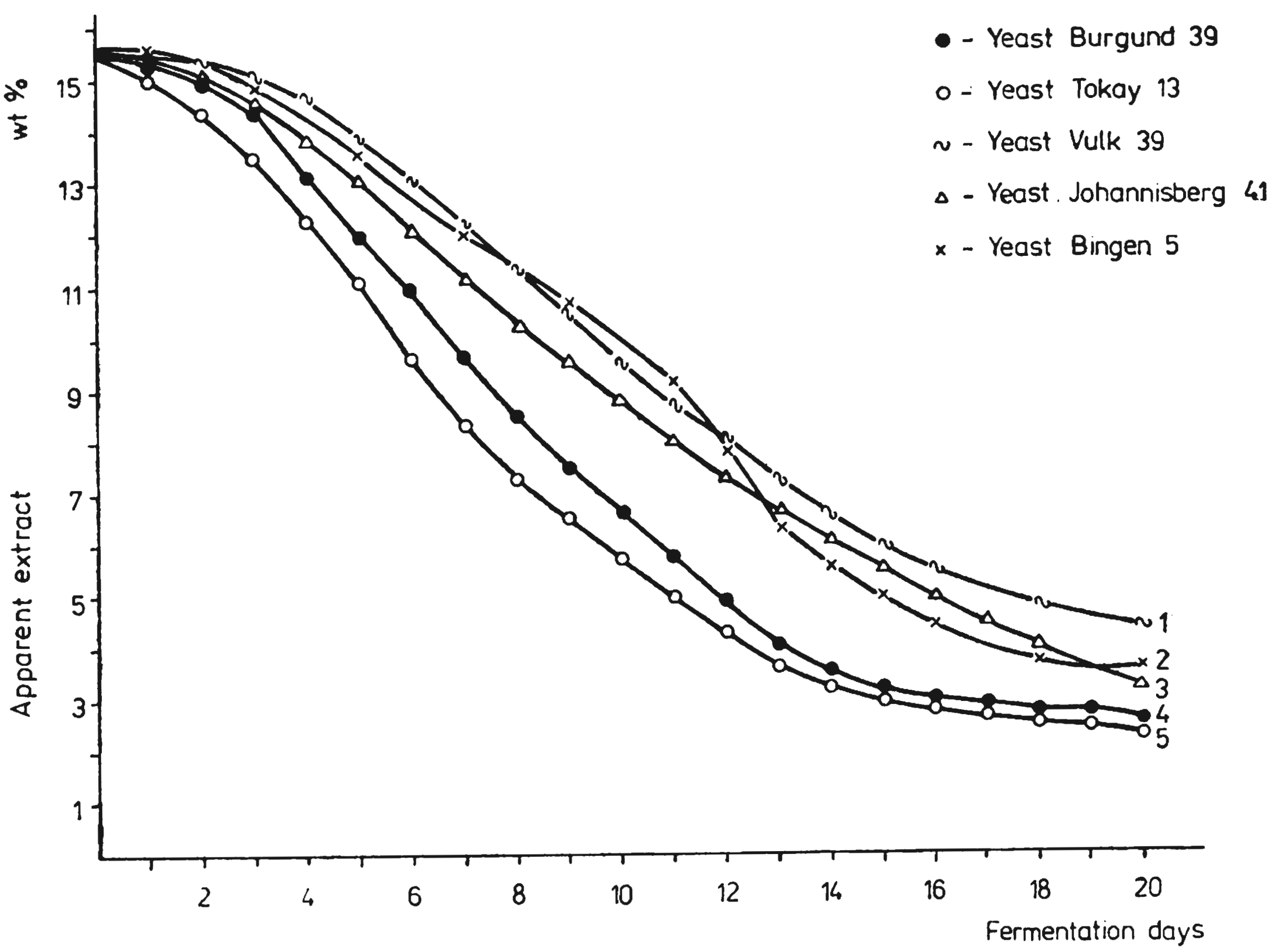

Fig. 2. Changes of apparent extract content during fermentation of cherry must

Table 2. Characteristics of mashes after fermentation using yeasts from Burgund strain*

Type of sample	pH	Residual sugar g/dm^3	Apparent extract % weight	Alcohol % vol.	Total attenuation test	Total acidity, g/dm^3 apple acid	Volatile acidity g/dm^3 acetic acid	Sediments % weight**	Calculated alcohol yield from 100 kg sugars in dm^3 100°	Fermentation yield, %
Cherry must	3.59	0.40	2.05	6.90	negative in 8 samples	11.75	0.11	1.0	58.3	90.7
Cherry pulp	3.85	0.62	1.90	7.00	negative	10.75	0.26	12	58.6	91.2
Whole cherries	3.68	0.38	2.23	6.90	negative in 7 samples	12.20	0.07	14	58.0	90.0

*) The table lists the results of ten samples

**) Part of sediments and kernels/residual part centrifuged, grinded, water washed and dried, estimated in % weight) twenty day period. Microbiological contamination was found in some of the mashes, mostly caused by bacterias and moulds. Microbiological inspection pointed to a lesser contamination of mashes which were fermented with yeasts of strains Burgund and Wiśnia.

Contamination, mostly by acetic and lactic bacteria, was found in the majority of samples in which the fermentation time was long.

Table 2 presents a characteristic of mashes fermented by means of Burgund yeast. Fig 3 and 4 illustrate the changes in the parameters of cherry pulp fermentation and in those of whole fruits fermented by means of Wiśnia yeast.

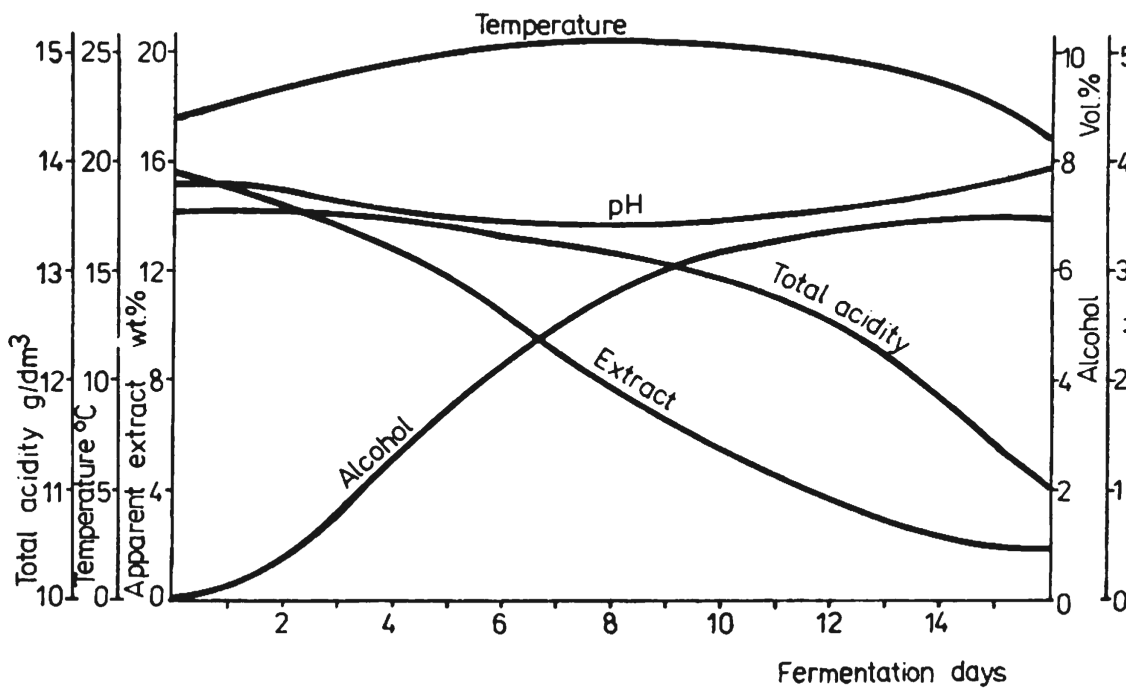

Fig. 3. Changes of parameters during fermentation of cherry pulp

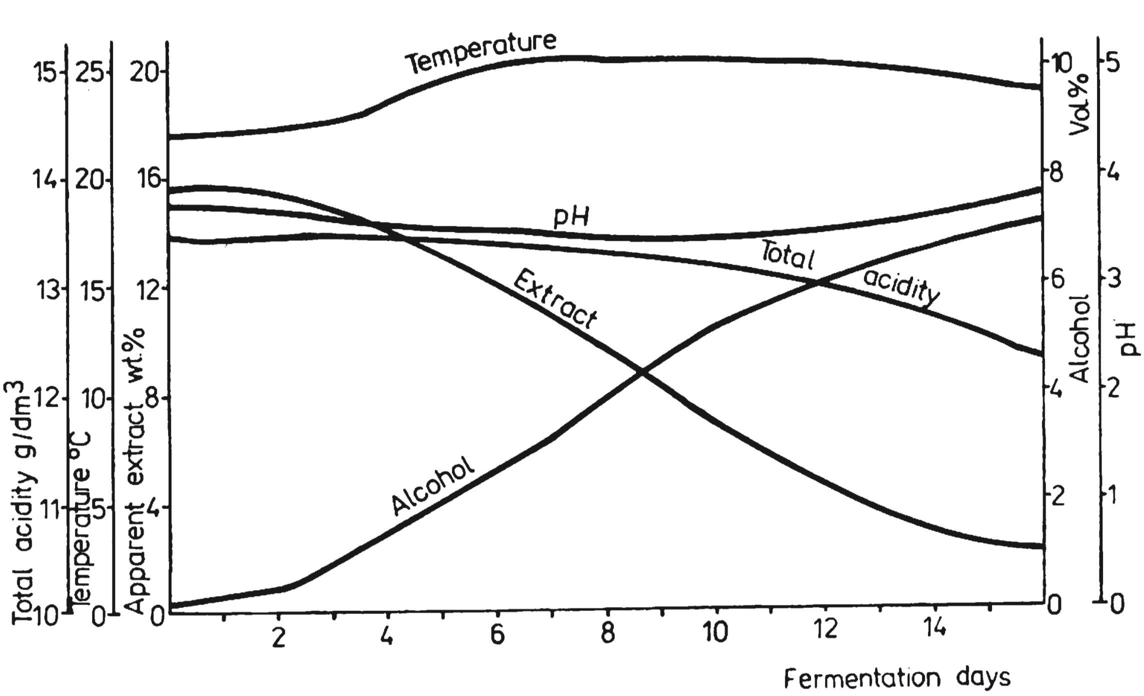

Fig. 4. Changes of parameters during the fermentation of whole cherry fruits

The samples in which whole fruits were fermented displayed a similar course of changes in the main parameters of the fermentation process like mashes with squashed fruit (cherry pulp) and in samples in which must was fermented.

A ca 7% increase of the amount of yeat compared to the weight of fruit allows for a successful fermentation of the fruit of unsquashed cherry. Cherry fruits are characterized by a comparatively loose structure of the skin and pulp [3]. Thus, by appropriately selecting the fermenter height to dia ratio it is possible to guarantee a rapid passage of the extract components to the solution, i.e. a correct course of the fermentation process. In order to provide good conditions for a "self-pressing" of fruit, it is necessary to use fermenters having a height to dia ratio of $H/D \geqslant 2.5$.

Under the above conditions, correct final fermentation was achieved during 16 to 18 days. As a rule fermentations conducted with unsquashed fruit were microbiologically cleaner than fermentation in samples which was prepared on the basis of musts and squashed fruit. The spirits and distillates obtained from latter samples were characterized by a more typical odour.

Table 3 presents a characteristic of crude spirits obtained from various strains of yeast.

The total content of acids showed small differentiation depending on strains of yeasts used for fermentation. Volatile acids and esters were found in relatively large amounts in spirits obtained from yeasts of the strains Bordeaux, Chambertin and Vulk. The largest amount of esters was produced by yeasts strain Wiśnia, Bordeaux, Burgund and Bingen, and of fusel oils by yeasts Chambertin, Sherry and Malaga. The largest amount of methanol were found in spirits obtained from mashes fermented with Chambertin and Malaga yeasts (0.70 to 0.85% vol.). The content of aldehydes and hydrogen cyanide did not display and major differences depending on the strain of yeast used for fermentation. The sensoric evaluation shoved that the most appropriate odour (cherry-almond odour with a pronounced smell of esters and fusel oils) characterized crude spirits obtained from samples fermented with Wiśnia yeasts (5 points) and Burgund and Tokay yeasts (4 to 4.5 points).

The diagram (Fig. 5) shows changes in the content of methanol, ethanol and esters, aldehydes, fusel oils and acids in consecutively received fractions during the fractioning of crude cherry spirit.

The curve illustrating changes in methanol concentration has two peaks, first a smaller peak in the initial stage of distillation and the second corresponding to fractions from 6 to 9.

An equally interesting course has been noted for the ester curve having three peaks: the first and the highest corresponding to fractions 1 to 2, the second — to fraction four, and the third — to fractions 7 to 9. As shown by the diagram, fusel oils attained one peak between the fourth

Table 3. Characteristic of crude spirits obtained from cherry must

Yeast applied	Total acidity	Volatile acidity	Total esters	Volatile esters	Aldehydes	Fusel oils	Methanol, % vol.	Hydrocyanic acid mg/dm³ 100°	Flavour evaluation, scale 1 to 5
	mg/100 cm³ 100°				g/dm³ 100°				
Cherry 8	106.5	16.2	147.7	32.0	0.33	3.90	0.34	47.2	5.0
Bordeaux 4	102.0	20.3	145.5	58.4	0.57	5.43	0.58	50.1	3.5
Chambertin 14	72.5	40.5	131.6	62.5	0.80	6.93	0.83	58.0	3.0
Sherry 38	90.2	20.7	100.4	43.5	0.74	6.70	0.47	44.0	4.0
Malaga 36	79.4	21.1	127.5	40.4	0.66	5.55	0.70	52.7	3.5
Burgund 39	88.7	14.3	141.0	33.4	0.49	4.02	0.40	45.0	4.5
Tokay 13	102.8	17.4	138.0	27.1	0.37	3.65	0.42	44.6	4.5
Vulk 39	125.5	29.8	113.0	50.3	0.55	5.02	0.35	48.2	3.0
Bingen 5	115.6	34.7	140.7	38.9	0.48	4.08	0.41	32.9	4.0
Johannisberg 41	97.4	19.5	94.6	27.3	0.52	4.10	0.37	22.8	4.0

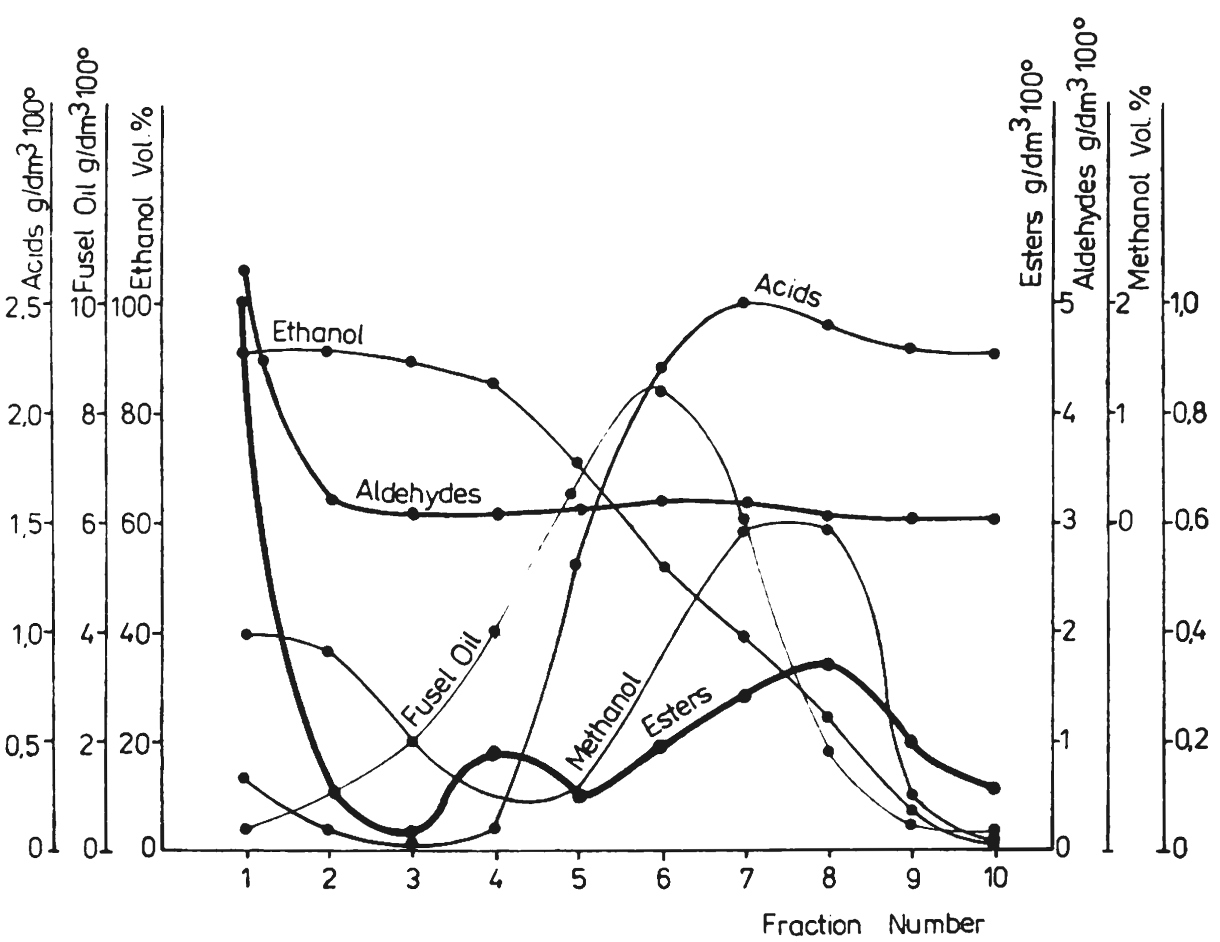

Fig. 5. Changes of composition during the distillation of crude cherry spirits; The 2.5 cm³ crude spirits which contained 22% vol. ethanol were fractionated and 10 fractions of 100 cm³ each were received

seventh fraction. The final fractions (8 to 10) contained a small amount of fusel oils.

The aldehyde curve has been the smoothest course. The largest amount of aldehydes was found in fractions 1 to 2. The highest amount of fatty acids was present in fractions 5 to 10 and the peak was observed in the seventh fraction. It is characteristic that the highest concentration of the majority of various compounds which occur together with ethanol and water in cherry distillates were observed in the final fractions (5 to 9). A more detailed report of tests concerning the chemical composition of cherry distillates will be presented in the second part of this work — in print.

CONCLUSIONS

1. From among the yeasts under test. The best suited for the fermentation of cherry mash are yeasts of the Wiśnia and Burgund 39 strain which bring about a fermentation of mash in 12 to 16 days, to approx. 2.0-3.0% of apparent extract by weight and give a comparatively high alcohol yield from 100 kg sugars contained in fruit (some 58 dm³).

2. Fermentation of cherry fruits in possible in an unsquashed form.

When maintaining in the fermenters an appropriate height to dia ratio (min. 2.5:1) and using an increased dose of yeast starter for fermentation (ca 7% wt) it is possible to achieve in the course of 16 to 18 days a final attenuation close to that achieved in cherry pulp mashes.

3. The chemical composition of crude spirits obtained with yeasts of various strains used for fermentation (Table 3) differs from one another; these differences are particularly clear in the group of esters and fusel oils.

4. Methanol in concentrations 0.2 to 0.8% vol. observed in cherry spirits has an uneven distribution during distillation. The initial and final fractions show certain peaks in terms of content. The final fractions, in addition to a high amount of acids and fusel oils contain fairly large amounts of esters (some 13% of their total content in crude spirit) (Fig. 5).

LITERATURE

1. Dittmann K.: Die Kleinbrennerei 1972, **24** (2), 11.
2. Erdrich K.: Die Kleinbrennerei 1973, **25** (2), 14.
3. Gassner G.: Mikroskopische Untersuchung Pflanzlicher Lebensmittel, G. Fischer Verlag, Stuttgard 1973,
4. Jarosz M., Jarosz K.: Przem. ferm., 1967, **11** (1), 12.
5. Kolb E.: Die Kleinbrennerei 1969, **21** (5) 33.
6. Kreipe W.: Die Kleinbrennerei 1973, **25** (5) 46.
7. Masior St., Czyżycki A.: Przem. ferm., 1967, **11** (12), 449.
8. Mohr H. D.: Weinberg Keller 1979, **26** (7) 227.
9. Nosko S.: Die Branntweinw., 1975, **115** (14) 233.
10. Pieper H. J.: Die Kleinbrennerei 1973, **25** (2) 12.
11. Pieper H. J.: Die Kleinbrennerei 1973, **25** (3) 23.
12. Pieper H. J.: Die Kleinbrennerei 1979, **31** (1) 1.
13. Polska Norma PN-71/A — 79528.
14. Polska Norma PN — 66/A — 79120.
15. Polska Norma PN — 73/A — 79529.
16. Polska Norma PN — 64/A — 04022.
17. Praca zbiorowa: Metody badania żywności, WPLiSpoż., Warszawa 1967.
18. Röchring G., Pieper H. J.: Die Kleinbrennerei 1980, **32** (2), 13.
19. Suomalainen H.: Third Int. Symp. on yeast, Delft. the Haque, 2-6 June, 1969, 97.
20. Suomalainen H.: Die Branntweinw., 1969, **109** (14) 323.
21. Suomalainen H.: J. Inst. of Brew., 1971, **77** (2) 164.
22. Suomalainen H., Nykänen L.: Neeringsmiddelindustrien 1970 (1/2) 1.
23. Suomalainen H., Nykänen L.: Die Branntweinw., 1974, **114** (14) 125.
24. Suomalainen H., Nykänen L., Ericksson K.: Am. J. of Enol. and Viticult 1974, **25** (4) 179.
25. Tanner H.: Die Kleinbrennerei 1972, **24** (3), 19.
26. Tanner H.: Die Kleinbrennerei 1973, **25** (10), 97.
27. Ujszaszi J.: Szeszipar 1979, **27** (3) 84.
28. Windisch S., Strobbe M.: Mitt. Klosterneuburg 1974, **24** (4), 239.

Manuscript received: July, 1980
Authors addressess: 31-120 Kraków, Mickiewicza 21
90-924 Łódź, Gdańska 166

T. Tuszyński, B. Bachman

DESTYLATY Z WIŚNI. CZ. I. WPŁYW RÓŻNYCH RAS DROŻDŻY NA SKŁAD DESTYLATÓW OTRZYMYWANYCH Z PRZEFERMENTOWANYCH WIŚNI

Instytut Podstaw Chemii i Technologii Żywności, AR, Kraków
Instytut Technologii Fermentacji i Mikrobiologii, Politechnika, Łódź

S t r e s z c z e n i e

Otrzymywano destylaty wiśniowe wskutek fermentacji i następnej dwustopniowej destylacji odfermentowanych zacierów. Do doświadczeń użyto wiśni sokowych (Wiśnia Serocka) w postaci owoców całych, miazgi i moszczu. Wielkość pojedynczych prób wynosiła od 1 do 5 dm^3 moszczu oraz od 15 do 30 kg owoców całych lub w postaci miazgi. Fermentację zacierów prowadzono z dziesięcioma różnymi rasami drożdży winiarskich, które dodawano w postaci gęstwy drożdżowej, w ilości od 5 do 7%. Jako pożywkę stosowano fosforan dwuamonu w ilości 0,1 g/dm^3 moszczu i miazgi oraz 0,15 g/kg przerabianych owoców całych. Pierwsza destylacja odfermentowanych zacierów wykonana była w klasycznym aparacie miedzianym, a destylacja korekcyjna w aparacie miedziano-szklanym z wypełnieniem kolumny ceramicznymi pierścieniami Raschiga. Odbierano 2,5% frakcji przedogonowej oraz ok. 86% frakcji środkowej (destylatu wiśniowego) w przeliczeniu na alkohol 100° w stosunku do ilości początkowej.

Stwierdzono, że najbardziej przydatne spośród badanych ras drożdży do fermentowania zacierów z wiśni są drożdże rasy Wiśnia 8 i Burgund 39, które odfermentowują te zaciery w stosunkowo krótkim czasie (12 do 16 dni), do ok. 2,5% wag. ekstraktu pozornego (rys. 1, 2, 3 i 4 oraz tab. 2). Doświadczenia wykazują, że można również fermentować owoce wiśni w postaci nierozdrobnionej — w tym przypadku należy fermentację prowadzić ze zwiększoną dawką drożdży (ok. 7% wag.) oraz w odpowiednio skonstruowanych fermentatorach, w których stosunek wysokości do średnicy będzie nie mniejszy niż 2,5:1 (rys. 4). Skład chemiczny spirytusów surowych otrzymanych z udziałem różnych ras drożdży różni się od siebie głównie zawartością estrów i alkoholi fuzlowych (tab. 3). Destylacja frakcjonowana tych spirytusów wskazuje na stosunkowo wysoką zawartość — w końcowych frakcjach — nie tylko alkoholi fuzlowych i kwasów tłuszczowych, ale również estrów i metalolu (rys. 5).