TECHNOLOGY AND BIOCHEMISTRY OF WINE

VOLUME 1

JÁN FARKAŠ

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TECHNOLOGY AND BIOCHEMISTRY OF WINE

Foreword

The *Technology and Biochemistry of Wine* is a comprehensive survey of the science and technology of wine-making. It reflects the extensive experience of the author, derived both from research and from practical work.

An earlier version of this book was published in Czechoslovakia in 1973, and was awarded the 1974 prize of the International Viticultural and Winemaking Organization in Paris and the prize of the Slovak Literary Fund in Bratislava.

This new English translation contains up-to-date technological information concerning the production and treatment of wines. The microbiology, biochemistry and enzymology of wine-making are well covered. Recent advances are covered in the chapter devoted to the biotechnological aspects of the fermentation process. This chapter also contains a discussion of the regulation of the fermentation process and the stages of malo-lactic fermentation.

New physico-chemical methods of identifying turbidity are discussed and the sections on clarification and stabilization are most valuable.

A separate chapter is devoted to the use of wine raw materials for the production of non-alcoholic drinks, distillates, and also the utilization of pomace-cake and yeast sediments. This shows how waste products from wine production can be used, which is important from not only an ecological but also an economic viewpoint.

The chapter "The World of Wine" provides a survey of the types of wine produced in the viticultural areas of the world. This is complemented by informative maps and includes a section on the quality of the wine and its labelling in these areas. The chapters "The Importance of Wine in Human Nutrition" and "Sensory Evaluation and the Quality of Wine" are also very illuminating.

Overall the book gives a comprehensive picture of worldwide wine production.

Professor Farkaš is an outstanding scientist and teacher in the field of

wine production, and I believe that this English translation of his book will be greatly welcomed by research workers, and graduate and postgraduate students, as well as all those involved in the wine production process. Experts from the catering and wine trade will find many points of interest, as will consumers.

Professor Dr Rudolph Bretschneider
Czechoslovak Academy of Sciences

Preface

Wine retains its general popularity and reputation due, among other things, to its quality, confirmed at many international exhibitions, and enhanced by technological progress in wine production.

The present book is a contribution to the understanding of the technology and biochemistry of wine. It is a complex work giving answers to many questions which can arise during the production, treatment, evaluation and acquisition of good quality wine.

It contains both general information on viticultural areas of the world and on the types of wine produced in them, concentrating mainly on world famous wines of controlled and acknowledged quality, and on the determination of their quality. It also covers the importance of wine in human nutrition from the point of view of thousands of years of tradition and of new findings concerning the nutritive and hygienic value of wine.

The mainstay of this book are the latest discoveries in the technology, microbiology and biochemistry of wine; the text is based both on my own knowledge, acquired during many years of investigation and practice in this field, and on knowledge from world literature.

The general progress and development of natural sciences, especially microbiology, chemistry and biochemistry, have permitted a better knowledge of the processes taking place during fermentation, formation, maturing and storage of wine, and thus greater possibilities for purposefully intervening in these processes.

Individual chapters of the book link together and give an overall view of the whole of wine production. The basic raw material for the production of wine, i.e. grapes, is analysed primarily. Progressive methods of production of white and red wine are discussed together with recent advances in the microbiology, biochemistry and enzymology of wine and also the processes of controlling fermentation by yeasts, or malic-lactic fermentation. The book gives a survey of new views on the biochemical oxidation-reduction processes taking place at individual stages in the production of wine, i.e. its formation, shaping, maturing and ageing, and it

indicates the possibilities of influencing them and of the introduction of new progressive methods for improving the quality of wine.

New knowledge and procedures are also described in the chapter on the identification of turbidities in wine, and in the chapter on the treatment and clarification of wine. Mild methods are stressed, accelerating purification and decelerating maturing and ageing, which mean that bottled wines keep their optimum quality, sparkle and bottle maturity for a longer period than with former methods. At the same time the number of operations is reduced and a considerable economic and ecological improvement is also achieved.

Further chapters are devoted to the production of special, tokay, sparkling and dessert wines. Considerable attention is given to the sensory evaluation and control of wine, prevention of turbidity and the correction of faulty and diseased wines.

The main aim of the book is to ensure production of the best possible wine from given raw materials. I have endeavoured to give an account of the present state of science and research, so that the book deals with the theoretical basis of wine production, as well as discussing the possibilities of solving particular problems, and providing advice for use in practice.

The book will be a great help to research workers and scientists, but also to all those who are involved in the production and treatment of wine, and it will also be a suitable textbook for students, not to mention its service to amateurs and consumers of wine.

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1 The World of Wine

THE QUALITY OF WINE AND ITS LABELLING

The quality of wine is the sum of its properties, which are definable. The wine is evaluated according to several criteria. One of the most important is the sort of vine or its species. The following varieties are considered best: Traminer, Sauvignon, Pinots noir and gris, Chardonnay, Cabernet Sauvignon, Riesling and others. A further important criterion for evaluating the quality of wine is the region in which the vines were cultivated. Important regions include Burgundy, Bordeaux, Sauternes, the Rhineland, Tokay and the Carpathian regions. However, the technology applied in the production of wine has an important role too.

The rapid development of grape culture for wine and wine production in developed wine-producing countries has made the labelling and evaluation of wine on the basis of the varieties and regions insufficient, so that new methods of evaluation and labelling have been sought to permit the evaluation of very good quality wines.

According to Schoonmaker (1974) the super quality French wines are labelled as "Grand", indicating that they are faultless, equilibrated and distinct. "Grand cru" is a label of super quality connected with the region of origin (Médoc, Chablis etc.). The "Grand" wines represent less than 1% of the world production. They are never cheap, but they are worth their price.

In France, the National Institute for the Labelling of the Quality of Wine (INAO – L'Institut National des Appellations d'Origine) has been established. This institute nominates a committee of judges for sensory evaluations who control primarily the quality of special quality wines and issue certificates. According to Schoonmaker (1974) the strictness of the committees has been increasing, especially since 1935. The National Institute issues two types of certificates:

1. Appellation Contrôlée (certificate of control);
2. Appellation d'Origine (certificate of origin).

1. The purpose of the certificate of control is to guarantee the origin and quality of a certain wine. The conditions for each wine labelled with such a certificate are set by a ministerial decree, which gives the time of harvest, the region, the village or the situation of the vineyard, and the permitted sorts of vines. The minimum alcohol content and the maximum harvest per hectare are also given.

2. The certificate of origin is issued for wines with a controlled origin. It contains such data as the region, name of the district, and sometimes the name of the place or even the name of the estate. For example: Bordeaux region, Médoc, Graves, Saint Emilion, Sauternes district, with the name of place from this area, for example Saint-Julien, and with the name of the estate, for example Château Lafite, Château Haut-Brion, Château Mouton-Rothschild, etc.

In France the certificates of quality are classified into three categories, while very good quality wines have their quality indicated on the label in small initial letters.

(a) Certificate of control (Appellation d'Origine Contrôlée, AOC or AC) which is obtained on the basis of the decree for individual wines. There are more than 250 wines of controlled quality in France at present.

b) Superior quality delimited wines (Vin Délimité de Qualité Supérieure, VDQS), which can also be given this label on the basis of a ministerial decree. Wines in this category sometimes get promotion to AC status (VDQS covers 'minor' wines).

(c) Wines with a simple certificate: these wines are intended for the home market (France) and are not for export. These are 'country wines' (Vin de Pays) and wines for current consumption (Vin de Consommation Courante).

Since 1963 the Italians have been trying to control and label the quality of their wines in the same way as the French. They founded a national committee for the protection and control of the quality of wine. On the basis of their origin, these wines are classified into three categories:

(a) Wines with a certificate of simple origin (denominazione di origine semplice, DOS).

(b) Wines with a certificate of controlled origin (denominazione di origine controllata, DOC).

(c) Wines with a certificate of controlled and guaranteed origin (denominazione di origine controllata e garantita, DOCG).

The requirements for the production of wine, its care and labelling

are laid down by a special decree. The strictest requirements are set for issuing the certificate DOCG. From 1966 to 1972 certificates for about 100 sorts of wine were issued.

In the German Federal Republic high quality wines are classified into two categories:

(a) Quality wine from a certain area (Qualitätswein bestimmter Anbaugebiete, QbA).

(b) Quality wine with a predicate (Qualitätswein mit Prädikat, QmP).

Quality wines with predicate are: Kabinett, Spätlese and Auslese; and wines made from individually selected grapes – Beerenauslese and Trockenbeerenauslese. Eiswein is made from grapes left on the vines until mid-winter and sometimes beyond, when they are harvested and pressed while still frozen, thus releasing the highly concentrated juice and leaving behind the water content. These names may be used only when accompanied by the number of the official analysis.

In other countries, for example in Hungary and Czechoslovakia, high quality wines are labelled as follows: Selected Wines, Tokay Selection, Little Carpathian Selection, Archived wines, etc. When a wine is to be included in this group, its quality is observed for several years and strictly controlled.

All the certificates mentioned and the labels of quality are used for natural wines of a high and controlled quality exclusively, which represent 10–20 % of the total wine production. These are white and red wines, and – to a lesser extent – rosé wines. Other white and red wines, among which are some of excellent quality, are labelled by the names of the sort, or by trade marks.

These certificates and labels of quality are not given for special wines, for example good quality sparkling wines, champagne, Sherry, Port, Marsala, Madeira and vermouths, because special procedures are used during their making. The types, however, are specified, and sometimes the areas as well. Tokay wine is one of these. All these wines are supposed to be of excellent quality, and therefore they do not require certificates or labels.

WINE-MAKING TRENDS

The grape vine is a thermophilic plant, cultivated in the temperate zone practically all over the world, as is evident from Fig. 1.1.

The total area of vineyards in the world exceeds 10 million hectares

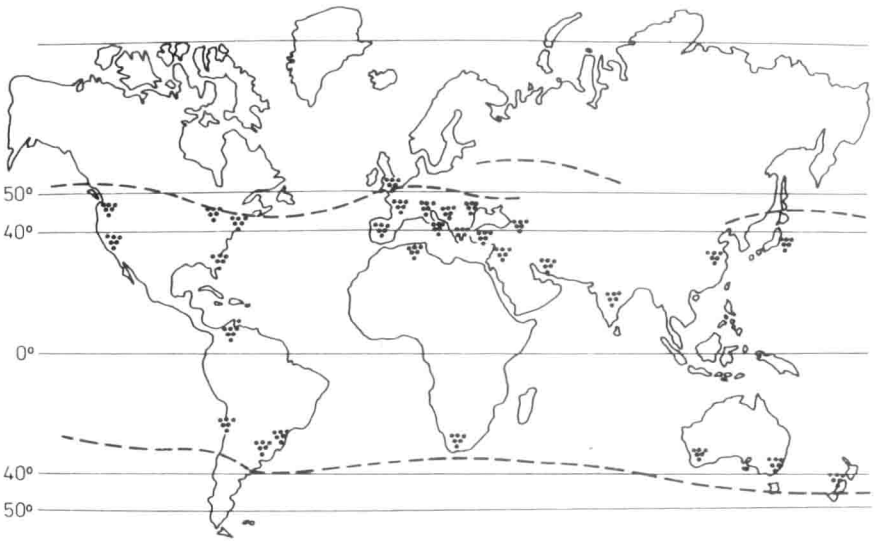

Fig. 1.1. Viticultural areas of the world in the temperate zone

(Table 1.1). The largest vineyard areas are in Europe, with more than 7 million hectares, then in North and South America with more than 900 000 hectares, Africa with more than 400 000 hectares, Asia more than 1.5 million hectares and Australia and New Zealand with more than 60 000 hectares of vineyards.

The area of vineyards is not constant and increases steadily, both due to the foundation of new vineyards and to the reconstruction of old ones, which no longer pay. In addition to this, less good sorts or direct-producer hybrids are eradicated and replaced by cultivated and better sorts. The areas of vineyards in individual countries are often temporarily decreased for reconstruction and the eradication of unsuitable species. Generally, it may be said that the area of vineyards in the world has increased substantially over the past 30 years. The highest percentage increase in the development of grape vine cultivation and wine making took place in the socialist states, especially the Soviet Union and Czechoslovakia, as can be seen in Table 1.1.

The extension of the vineyard area and especially the reconstruction of the superannuated vineyards caused a substantial increase in grape production (Table 1.2), even though the harvests vary in individual years under the effect of the weather. In the years 1967–80 production of grapes

Table 1.1.

Development of the area of vineyards in individual wine producing countries (in thousands of ha)

Country	1965	1975	1980	1983
World (total)	10 059	10 236	10 104	9733
Austria	45	50	59	59
Bulgaria	192	187	180	168
Cyprus	38	38*	51	33
Czechoslovakia	27	40	44	46
France	1385	1320	1194	1096
German Federal Republic	83	100	100	101
Greece	229	190	185	171
Hungary	246	206	168	157
Italy	1667	1400	1377	1135
Portugal	354	364	364	364
Rumania	302	331	307	301
Spain	1688	1695	1678	1610
Switzerland	11	13	14	14
USSR	1043	1203		1376
Yugoslavia	286	247	247	243
Europe (total)	7603	7373	7255	6855
Argentina	280	346	316	322
Brazil	69	67	60	62
Chile	113			121
Mexico	13	42	62	60
USA California	197	262		291
Other states	40	40*	40	39
Americas (total)	706	952	934	943
Algeria	346	240**	199	192
Morocco	75	48	60	47
South African Republic	79	113		100
Tunisia	50	39**	36	31
Africa (total)	565	458	432	403
Iran	75	135*	182	186
Israel		8	9	9
Japan	22	28	30	30
Turkey	800	845		794
Asia (total)	1128	1380	1408	1460

* Approximate evaluation

** Data for 1974

Table 1.2.

Development of grape production in individual viticultural countries (in thousands of tons)

Country	1965	1975	1980	1983
World (total)	52 452	57 340	65 136	65 632
Austria	187	320*	410	369
Bulgaria	1334	743		906
Cyprus	122	170*	212	203
Czechoslovakia	44	203	195	290
France	8911	8737	8911	8933
German Federal Republic	645	1087	620	1304
Greece	1484	1536	1603	1768
Hungary	427	813	898	978
Italy	10 675	10 753	13 080	12 697
Portugal		1257[+]	1431[+]	1201
Rumania	900	1182	1312	2192
Spain	4376	5518	6537	5050
Switzerland	124	107	108	206
USSR	3698	5400		6443
Yugoslavia	1120	1049	1573	1610
Europe (total)	36 340	38 801	44 908	44 062
Argentina	2343	2947	3086	3504
Brazil	551	615*		685
Chile	550	960	714	767
Mexico	90	288	550	650
USA California	3605	3936**	5050	4790
Americas (total)	7734	9081	10 338	10 655
Algeria	925	1000*	493	363
Morocco	400	170	156	152
South African Republic	686	858	1061	1155
Tunisia	265	130*	111	115
Africa (total)	2623	2539	2460	2524
Iran	250	680		1420
Israel		749	742	794
Japan	225	265*	382	324
Turkey	3350	3850		3741
Asia (total)	5056	6174	2258	7490

* Data for 1974

** Data for the entire USA

[+] Portugal 1971–1975, 1976–1980

in the world increased from 52.5 million tons to more than 65 million tons of grapes. The largest production of grapes was achieved in Europe, i.e. more than 44.5 million tons, with more than 10 million tons in America, 2.5 million tons in Africa and 2.5 million tons in Asia.

Most of the grapes, up to 85 %, are used for the production of wine and only 6.3 million tons were used for direct consumption, i.e. 1.7 kg per person per year (Ambrosi and Becker, 1978.) From the total production of grapes 650 000–750 000 tons are produced in the form of raisins; 20–30 kg of raisins can be obtained from 100 kg of fresh grapes.

The increase in the production of grapes in the world and in individual vine-growing areas caused the production of wine to increase rapidly, too (Table 1.3; Mauron, 1976). In the years 1964–67 the average world production of wine per year was 277 million hl. In 1969–73 the yearly average was already 301 million hl, in 1975 it was 316 million hl and in 1980 more than 351 million hl. This trend becomes still more pronounced when comparing longer periods. For example, from 1950 to 1954 the annual production of wine was only 211 million hl. In 1970–74 the average production was 314 million hl, which represents a 48.8 % increase.

Europe produced 226 million hl of wine in 1966 and almost 280 million hl in 1980. In Europe a distinct development is observed, especially in socialist countries; the Soviet Union increased production by more than 200 %, Czechoslovakia by 300 %, and Hungary by 200 %, and similar trends are shown by Yugoslavia, Bulgaria and Rumania. The best producers of wine, such as France, Italy and especially Spain (Kalinke, 1976) also increased their wine production substantially.

A distinct increase of wine production was also observed in America, where in 1965 more than 33 million hl of wine were produced, and by 1980 this had increased to almost 53 million hl. The increase was most striking in California, where in 1965 the production exceeded 7 million hl, and in 1980 it was up to 18 million hl.

In contrast, production of wine in Africa dropped sharply, as is evident from Table 1.3, because in some regions, especially in Algeria and Morocco, older vineyards are being eradicated owing to their unsatisfactory sorts and quality of vines, and because new vineyards are being planted.

An increase in the production of wine was also observed in Asia, especially in Japan.

The rapid increase in wine production in the world is accompanied by an increased consumption of wine, which is shown in Table 1.4. It is evident that the countries with a high production of wine also have a high