UNIVERSITY OF PLOVDIV "PAISII HILENDARSKI"
FACULTY OF ECONOMIC AND SOCIAL SCIENCES
DEPARTMENT "MANAGEMENT AND QUANTITATIVE METHODS
IN ECONOMICS"

# Stefan Deyanov Georgiev

# CHANGES IN THE QUALITY AND ECONOMIC INDICATORS IN WINE PRODUCTION WHEN USING ENZYME PREPARATIONS

# ABSTRACT

of a dissertation for the award of an educational and scientific degree "doctor"

by field of higher education: **3. Social, economic and legal sciences**
professional direction: **3.8. Economy**
PhD Program: **Economics and Management (industry)**

Research supervisor: Associate Professor Dr. Tania Petrova Yankova-Lilova

Plovdiv
2023

The dissertation has a total volume of 292 pages. Of these: introduction, three chapters, summaries, conclusions and contributions - 121 pages; bibliography of used sources – 7 pages, table of contents – 2 pages, list of abbreviations – 8 pages; scientific publications – 1 page; declaration of originality – 1 page; appendices – 151 pages. In support of the exhibition are included: 4 diagrams, 187 tables, 44 diagrams. The bibliography used is represented by a total of 113 sources, of which: in Bulgarian (65), in English (27), in Russian (4), in French (3) and 14 Internet sources.

There are  total  three publications on the topic of the dissertation work: independent articles and studies and one co-authored article.

**Scientific jury:**

Prof. PhD Galina Mircheva Ilieva
Prof. PhD Toni Bogdanova Mihova
Prof. PhD Valentina Ljubenova Nikolova-Aleksieva
Associate Professor PhD Margarita Ljubenova Ruseva
Associate Professor PhD Hristo Spasov Spasov

Author: Stefan Deyanov Georgiev

Title: Changes in the quality and economic indicators in winemaking when using enzyme preparations

The dissertation work was discussed and directed for defense at the departmental council on 28/04/2023 by the Department of "Management and Quantitative Methods in Economics" at the Faculty of Economic and Social Sciences at Plovdiv University "Paisii Hilendarski".

The defense of the dissertation work will take place on 07.07.2023 in ….. a.m., at ……………………… of Plovdiv University "Paisii Hilendarski".
The materials for the defense are available to those, who are interested, at  Plovdiv University "Paisii Hilendarski", 24 "Tsar Asen" Str., "Development of the academic staff and doctoral programs" department, and on the university's website (www.uni-plovdiv.bg).

# GENERAL CHARACTERISTICS OF THE DISSERTATION

## 1. Relevance and significance of the dissertation work

Advances in technology, the constant accumulation of new knowledge, dynamics in consumer demand and preferences have their impact on the industrial development of winemaking, the business environment and market realities. For the Bulgarian industrial wine producers, it is vitally important to be able to maintain their positions in the market at the present moment with competitive behavior.

There are several directions in which Bulgarian wine producers can direct their activities in order to withstand the difficult market and economic conditions and guarantee their future upward development. An important place among these directions is occupied by the research approach and the development of innovative technologies aimed at strengthening competitiveness.

Over the past few decades, one of the most significant innovations in winemaking technology has been the introduction of enzyme preparations. Their use in the production of wine is today perceived as imperative and without an alternative. However, their undeniable importance in practice is accompanied by a lack of sufficient research and systematized data on the changes they cause in the quality and economic indicators of wine production.

## 2. Object and subject of the dissertation work

**The object** of the study is the use of enzyme preparations in winemaking.

**The subject** of the research is the changes in the quality and economic indicators in wine production when enzyme preparations are used.

## 3. Purpose and tasks of the dissertation work

**The main goal** of the dissertation is to investigate the changes in the quality and economic indicators in winemaking related to the use of enzyme preparations.

To achieve the main goal, seven stages of the research are outlined, each of which is related to solving a task:
1) To make a literature review on the topic of the dissertation, aimed at selecting indicators for determining the economic efficiency of a wine enterprise, choosing approaches for analyzing investments and the investment process in the researched industry, evaluating and analyzing an investment project.
2) After reviewing the modern theoretical approaches for evaluating the quality of red wines, to select the significant indicators on the basis of which the present study will be conducted.
3) To develop a conceptual model for revealing dependencies between the quality indicators of the produced wines and the economic condition of the enterprise.
4) To investigate the changes in the quality indicators in wine production related to the use of enzyme preparations.
5) To examine the dependence of economic on quality indicators.
6) To analyze the changes in quality and economic indicators as a result of the use of enzyme preparations.
7) To summarize, systematize and approve the obtained results.

## 4. Main hypothesis and sub-hypothesis of the dissertation work

**Main hypothesis:** *Not for all types and qualities of wine it is economically justified to use enzyme preparations in their production.*

In connection with the reasoned decision-making regarding the acceptance or rejection of the main hypothesis, the following sub-hypotheses are formulated:

**Sub-hypothesis 1:** *The use of minimal doses of enzyme preparations worsens the quality and economic indicators of the produced wines.*

**Sub-hypothesis 2:** *The use of maximum doses of enzyme preparations necessarily means an improvement of the quality and economic indicators of the produced wines.*

**Sub-hypothesis 3:** *Increasing the quality of produced red wines with the participation of enzyme preparations leads to an increase in the main economic indicators of the produced wines and the enterprises of the wine industry.*

## 5. Research methodology

In the development of this dissertation work, all the requirements of the regulatory framework have been taken into account and a combined research strategy has been used, which includes the application of both quantitative and qualitative methods.

For the needs of the research, a questionnaire survey was conducted using the "face-to-face" method with pre-selected respondents among industry specialists and shop owners.

Weighting coefficients were introduced to determine the importance of influence and a point system was developed to assess belonging to a category.

Experimental data obtained after a study and comparison of the effect of the application of industrial enzyme preparations in different methods of vinification of red grapes were used. The values of indicators determining the quality of the produced red wines were measured and stored in a database.

The relationship between the changes in the quality indicators and the changes in the economic indicators caused by them has been established.

An analysis and evaluation of the economic effect of the production activity of the winery, the investment in real assets and the overall efficiency of an investment project was carried out.

## 6. Perceived Limitations
1) The empirical study covers a specific group of wines - the reds and a specific grape variety - Mavrud.
2) The data used in the study were collected as a result of author's laboratory experiments with enzyme preparations, conducted in the period 2000-2023.
3) The analysis of the average samples was carried out in the chemical laboratories of the "Wine and Beer Technology" and "Biochemistry and Molecular Biology" departments at the Higher Institute of Food Industry (now the University of Food Technology) - Plovdiv and in the laboratory of "Biologically active substances" at the Institute of Organic Chemistry with the Center for Phytochemistry - Bulgarian Academy of Sciences (IOCCP - BAS).
4) The experiments were carried out under the supervision of Associate Professor PhD Stefcho Kemilev and Prof. PhD Ivan Pishtiiski.
5) The names of the used industrial enzyme preparations (IEP) have been replaced by the abbreviation enzyme preparation (EP) and the corresponding number, and this was done in order not to damage the image of the product and the manufacturer.

6) Among the multitude of quality indicators of the produced wine, only those that significantly affect the final price of the product or other economic indicators of wine production should be carefully selected and analyzed. This means that indicators for which the initial analysis found that they do not have a significant impact, and also indicators for which data cannot be collected, will not be reported here.

7) For the needs of the economic analysis, only the variants whose results are equivalent or better than the control ones are subsequently used.

8) The data used for the conducted economic research are based on the activity of specific medium-capacity wine enterprises operating in Southern Bulgaria, one of which is of the classic type, and the other of the innovative type.

*Note:* In the exposition, the two enterprises will be referred to as Enterprise 1 and Enterprise 2, respectively.

When determining the economic indicators of the enterprises, in connection with the approval of the proposed conceptual model, only the technological equipment, internal factory transport and the laboratory of the enterprise are considered by the FTA. The value of the land and the architectural part are not included in the calculations due to the large differences in prices and the insignificant impact on the quality of the manufactured products.

**7. Sources of information provision in the dissertation work**
- Literary research of Bulgarian and foreign scientific publications;
- Study of previous studies, specialized scientific publications, Internet sources;
- Primary data from own empirical research:
  - Conducted a survey among established specialists from the branch;
  - Laboratory experiments with enzyme preparations;
  - A survey was conducted among the owners of companies that realize significant sales of wines in the country.

## I. STRUCTURE AND CONTENT OF THE DISSERTATION

The dissertation has a total volume of 292 pages. It contains: introduction, three chapters, summaries, findings and conclusions, contributions, bibliography, table of contents, list of abbreviations, scientific publications, declaration of originality, appendices. In support of the exposition are included: schemes, tables and diagrams.

## CONTENTS

## II. BRIEF DESCRIPTION OF THE DISSERTATION

### INTRODUCTION

The introduction argues for the relevance and significance of the dissertation's issues. The object and subject of research are defined. Formulated: goal and tasks, hypothesis and sub-hypotheses of the dissertation work. The methodology and limitations of the dissertation research are indicated.

### CHAPTER 1. THEORETICAL FRAMEWORK AND CONCEPTUAL MODEL FOR EMPIRICAL RESEARCH OF ECONOMIC AND TECHNOLOGICAL ASPECTS IN WINE PRODUCTION

The first chapter of the dissertation presents the theoretical framework of the study and is aimed at the implementation of the first three tasks. It is for this reason that the chapter is structured in three parts.

First part is related to the implementation of the first research task. It contains a literature review and review of basic theoretical statements related to economic aspects in winemaking.

In the second part, the second research task is carried out. A literature review and review of modern theoretical statements related to the technological aspects of winemaking is carried out.

Third part, the third set task is also solved. A conceptual model is developed to reveal dependencies between the quality indicators of the produced wines and the economic condition of the enterprise.

### 1.1. Economic aspects in wine production

The changes in the quality indicators of the wine are the basis for all subsequent analyzes and evaluations of the economic effect of the production activity of the winery, of the investment in real assets and of the overall efficiency of an investment project.

In practice, there is a lack of academic studies devoted to the influence of enzyme preparations on economic indicators in winemaking. Directing the focus of this study to the economic aspects of the use of enzymes in winemaking, it will be possible to establish when and for which types of wines the use of enzyme preparations is financially justified.

#### 1.1.1. Efficiency of the enterprise's activity

The efficiency of production and economic activity is an important aspect for the economic success of any enterprise. In order for the activity of an enterprise to be effective, it must achieve a certain balance between costs and revenues, manage its resources far-sightedly. In the fundamental economic theory, it is pointed out that efficiency reflects the cause-and-effect relationships in a quantitative and qualitative aspect between the results achieved and the costs and resources used to obtain them.

"Effect" in economic literature means a certain consequence of the company's activity, but the effect is not identical to the achieved result. The result of the production and

economic activity of the enterprise is expressed in aspects such as the production of goods, the implementation of sales, the provision of services, etc., all of which are measurable in value[1]. Achieving a certain result does not mean an effect is achieved. The effect must always have a positive sign and is achieved only when the result exceeds the costs incurred and the resources used:

$$\text{Effect} = \text{Result} - \text{Cost}$$

*Types of economic efficiency*

Regardless of whether it is the current or the investment (innovation) activity of the enterprise, two main groups of indicators are used to determine the economic efficiency:

1) Absolute (total) economic efficiency. It is determined independently at each stage of production and economic activity.
2) Comparative (relative) economic efficiency.

*Basic indicators for determining economic efficiency*

Taking into account both the regulatory framework and the universality of the indicators, as well as the modern trends in their development, the following indicators are preferred for determining the economic efficiency in wine production.

1) On the absolute (general) economic efficiency:
   - Return on equity (ROE):

   $$\text{ROE} = \frac{FR}{E} \cdot 100,$$

   where FR – financial result, E – equity;
   - Return on capital employed (ROCE):

   $$\text{ROCE} = \frac{FR}{RC} \cdot 100,$$

   where FR – financial result, RC – raised capital.
   - Profitability of assets (ROA) – characterizes the productivity of the company's assets (long-term, short-term assets, as well as their elements).

   $$\text{RA} = \frac{\text{Realized Annual Profit}}{\text{Value of Assets}}.$$

   - Return on sales (ROS):

   $$\text{ROS} = \frac{\text{FR}}{\text{SR}} \cdot 100,$$

   where FR – financial result, SR – sales revenue.
   - Labor productivity (LP):

   $$\text{LP} = \frac{\text{Value of the produced (realized) output}}{\text{Amount of labor input}}.$$

   - Capital efficiency (CE):

   $$\text{CE} = \frac{\text{Realized (expected) income}}{\text{Capital size}}.$$

   - Absolute capital efficiency (ACE):

   $$\text{ACE} = \frac{\text{Increase in profit}}{\text{Value of capital that caused this increase}}.$$

   - Absolute term of capital redemption (ATOCR):

   $$\text{ATOCR} = \frac{\text{Capital}}{\text{Amount of planned (realized) annual profit}}.$$

---

[1] Ivanov, Iv. and others. Enterprise economy. Stara Zagora, 2005.

- Productivity of capital (assets) (POC):

$$POC = \frac{\text{Value of output}}{\text{Amount of capital (assets)}}.$$

- Capital Intensity (CI):

$$CI = \frac{\text{Amount of capital (assets)}}{\text{Value of output}}.$$

- Duration of one revolution (DOOR):

$$DOOR = \frac{\text{AAOSTTA} \cdot 360}{\text{Net amount of sales revenue}},$$

where: AAOSTTA – average availability of short-term tangible assets.

- Number of revolutions (NOR):

$$NOR = \frac{\text{Net amount of sales revenue}}{\text{AAOSTTA}}.$$

- Employment of short-term tangible assets (EOSTTA):

$$EOSTTA = \frac{\text{AAOSTTA}}{\text{Net amount of sales revenue}}.$$

### 1.1.2. Investments and investment process

*Investments*

Investments are one of the main factors for the successful development of economic activity in a market environment. According to Reilly[2], an investment is an ongoing commitment of funds for a period that will compensate the investor for the time the funds are committed, expected inflation, and the uncertainty of future payments.

*Investment process*

Alexandrov[3] and others. indicate that a successful business is directly related to the expenditure of financial resources to create, maintain or expand the business as the main content of the investment process. It reflects the desire of economic entities (savers) to invest their assets (their money) in activities that increase their assets (money) and hence the wealth of the owners (shareholders).

### 1.1.3. Analysis and evaluation of the effectiveness of investment projects

The implementation of an investment project is a complex decision based on careful analysis and evaluation of effectiveness. To this end, there are two fundamental groups of methods based on the concept of the change in monetary value over time. Indicators from these methods have a unified application in making business investment decisions. There are different authors' interpretations of these indicators in different economic spheres.

*Static methods*

1) Cost comparison method
2) A method of comparing profitability

---

[2] Reilly, F., Analysis of Investments and Management of Portfolios. Cengage Learning, 2015, ISBN 1473704790, 9781473704794.

[3] Alexandrov, St. and others. Financial management of the company. Sofia, Labor and Law, 2000. ISBN 954-608-039-X

This method is one of the most important and generalizing for the static assessment of the efficiency of economic activity. It is also a major component of any financial statement analysis document[4].

Fundamental to this method is the requirement to choose the investment with the highest rate of return. It can be represented by the formula:

$$\mathbf{ARR} = \frac{\text{Average annual net profit}}{\text{Average investment amount}}.$$

3) Payback period (PBP)

The purpose of the method is to indicate for what period of time the investments made will be recouped (paid off) through the revenues from operating the site[5].

The investment redemption period can be represented by the formula:

$$\mathbf{PBP} = \frac{\text{Initial Investment Value}}{\text{Annual Net Cash Flow}}.$$

The investment is profitable if the redemption period is shorter than the maximum expected by the investor.

***Dynamic (discount) methods***

1) Net Present Value (NPV)

Net present value is the main and leading indicator for evaluating investment projects. The essence of the method is expressed in bringing all cash receipts and payments to their value at the initial moment of the investment process.

The formula for determining the net present value in a general form can be presented as follows:

$$\mathbf{NPV} = -\,IC_N + \sum \frac{C_t}{(1+r)^t},$$

where:

$IC_N$ – the value of the initial investment;

$C_t$ – the net income (flow) for the relevant year of the project activity;

r – discount rate;

t – sequence of the respective year.

When choosing two or more options, choose the one with a higher net present value.

2) Internal rate of return

The internal rate of return - IRR is the second main indicator for evaluating investment projects. It represents the discount rate at which the net present value of the project becomes equal to zero.

The formula is used to calculate the internal rate of return:

$$-\,IC_N + \sum \frac{C_t}{(1+IRR)^t} = 0.$$

Internal rate of return (IRR) should always be used in conjunction with other indicators to evaluate investment projects, so that the user can determine its credibility in the context of other indicators[6].

---

[4] Brief, R. P., and Lawson, R. A. The Role of the Accounting Rate of Return in Financial Statement Analysis. American Accounting Association. 1992,vol. 67, issue 2, pp. 411–426.

[5] Al-Ani, M.K. A strategic framework to use payback period in evaluating the capital budgeting in energy and oil and gas sectors in Oman. International Journal of Economics and Financial Issues, June 2015, Vol. 5, Issue 2, pp.469-475. LicenseCC BY

[6] Patrick, M., French, N. The internal rate of return (IRR): projections, benchmarks and pitfalls. Journal of Property Investment and Finance, 2016, Vol. 34, Issue 6, pp. 664-669. https://doi.org/10.1108/JPIF-07-2016-0059

3) Income-expenditure ratio

The income-expenditure method under consideration is a modified form of the two basic discounting methods mentioned so far. It is based on matching the sum of all discounted cash inflows to the sum of all discounted cash outflows.

$$\mathbf{BCR} = \sum \frac{DR_t}{DC_t} = \frac{\sum \frac{R_t}{(1+r)^t}}{\sum \frac{C_{t1}}{(1+r)^t}},$$

where:

$DR_t$ and $DC_t$ are the discounted income and expenditure cash flows for the corresponding year t;

$R_t$ and $C_{t1}$ are the sums of income and expenses (flows) for the corresponding year t;

r is the discount rate.

Another indicator of this method, which is used for the needs of economic analysis, is the profitability index PI. It is represented by the formula:

$$\mathbf{PI} = \sum \frac{DR_t}{IC_N} = \frac{\sum \frac{R_t}{(1+r)^t}}{IC_N},$$

where:

$IC_N$ is the sum of initial investment costs.

4) Annuity method

The basis of this method is periodic and uniform, it means in equal installments, payment of a specified sum of money over a specified period of time. Its purpose is to determine a net annual annuity that reflects the economic benefit of the investment.

5) Payback Period (PBP$_D$)

The "Payback period" method can also be presented in a discount version, which avoids the disadvantages of static methods and improves the quality of the analysis. It is represented by the formula:

$$\mathbf{PBP_D} = \frac{IC_a}{S_a},$$

where:

$IC_a$ – initial investment costs;

$S_a$ – equal annual annuity amounts.

### 1.1.4. Conclusions and summaries

As a result of the literature review aimed at the economic aspects in wine production and in connection with the implementation of task 1, the following conclusions were drawn:

1) The efficiency of production and economic activity is a basic factor for the economic success of any wine enterprise[7].
2) In order for the activity of a wine enterprise to be effective, it must manage its resources far-sightedly by achieving a certain balance between costs and revenues[8].

Taking into account both the regulatory framework and the universality of the indicators, as well as the modern trends in their development, the following indicators are preferred for determining the economic efficiency in wine production: cost efficiency ratio; revenue efficiency ratio; return on equity; profitability of borrowed capital; return on assets;

---

[7] Estrada, M. D., Park & Chin, A. Measuring Wine Industry Efficiency with Wine Industry Network Evaluation Model (WINE-Model). September 2017, SSRN Electronic Journal, 10.2139/ssrn.3040105.

[8] Ugaglia, A. J-M., Cardebat & Jiao, L. The French Wine Industry. The Palgrave Handbook of Wine Industry Economics, 2019, pp.17-46. https://doi.org/10.1007/978-3-319-98633-3_2 .

profitability of sales revenue; labour productivity; capital efficiency; absolute term of redemption of the capital; capital intensity; productivity of capital; duration of one revolution; number of revolutions; employment of short-lived tangible assets.

3) Investments are one of the main factors for the successful development of economic activity in a market environment. The emphasis is on investing in real assets and in the investment process in the wine enterprise.

4) The analysis and evaluation of the efficiency of investment projects in wine production should be carried out using both main groups of methods:

    4.1. Static methods: a method for comparing the profitability and payback period of investments.

    4.2. Dynamic (discounting) methods: net present value; internal rate of return; annuity method; revenue-cost ratio and payback period.

## 1.2. Technological aspects in winemaking

### 1.2.1. General information about the structure, composition and development of grapes

Grapes are a berry fruit with high nutritional value. Apart from fresh consumption, it is used as a raw material for the preparation of various products such as wine, wine distillate, grape juice, grape concentrate and grape honey. From an oenological point of view, the skins of the grapes have the strongest influence on the degree of coloring of red wines. The fleshy part is the most important structural element of the grain. Upon reaching technological maturity, the fleshy part makes up 75-85% of the total mass of the grain. The largest percentage of its content falls on the grape juice (must), from which (after alcoholic fermentation) wine is obtained.

### 1.2.1. Factors influencing grape quality

The quality of the wine produced is highly dependent on the quality of the grapes. The three main factors determining the quality of grapes are: grape variety, natural factors and agricultural techniques.

*Grape variety*

Different varieties of grapes differ not only in the general appearance and shape of the grain, leaves and sticks, but also in their chemical composition[9]. A distinct type of wine can only be obtained from a specific grape variety with an appropriate composition.

*Natural factors*

Natural factors are actually a whole group uniting many diverse factors. These include the influence of the soil, the topography, the substrate used, temperature, humidity, sunshine, the occurrence of diseases, insects, hail, frost, etc.

*Agricultural machinery*

An important factor for the quality of the grapes are the agrotechnical measures used in viticulture - pruning, fertilizing, watering, etc.

---

[9] Lazarov, I. Retrospective analysis of grape selection in Bulgaria. In: Agricultural Science. 1998, No. 2, pp. 37-45.

### 1.2.2. Red wine technology

*"Wine is a product obtained exclusively as a result of full or partial alcoholic fermentation of crushed or uncrushed fresh grapes or grape must from fresh grapes"*[10,11]. This is the official definition of the International Organization of Vine and Wine (OIV), and it is adopted in the legislation in force in our country. From a physicochemical point of view, wine is a water-alcohol heterogeneous mixture in which more than 1,100 components are found (by structure and concentration).

The considered above gives reason to claim that *wine is a biochemical product of the cellular metabolism of the vine plant and wine yeasts and bacteria, and its composition and properties are geographically and historically determined*[12].

### Classification of wines

The extremely complex composition of the wines suggests their great variety. From this follows the conclusion that there is no such summarizing indicator that can classify all wines. Therefore, they are classified according to a number of signs into categories, types and sorts.

1) According to the color: white, rosè, red;
2) According to quality (degree of excellence):
   - Table wines (TW);
   - Quality wines produced in a specific region. In turn, they are:
     - Wines without a Protected Designation of Origin (PDO)/Protected Geographical Indication (PGI);
     - Varietal wines without PDO/PGI, (RTV – regional table wines);
     - Wines with PGI (DOC – wines with guaranteed designation of origin);
     - Wines with PDO (DOCG – wines with guaranteed and controlled designation of origin);

For quality wines, the one proposed by Pandeliev et al.[13] can be used in Indication for labeling and commercial presentation of wine (ILCPW).

### Technological features of red wines.

Red wines are produced only from red grape varieties with colorless or dyed (colored) juice.

The most characteristic feature of the red wine technology is that the fermentation takes place together with the hard parts of the grapes – skins, seeds and parts of the seeds. At the same time, the *maceration* process takes place simulaneously with the fermentation, i.e. extraction of certain substances from the hard parts of grapes. The grape variety is crucial for the quality of red wines.

### Importance of extraction processes for the production of red wines

Due to the fact that the alcoholic fermentation of red wines takes place in the conditions of continuous contact of the must with the solid parts of the grapes, processes of extraction of the ingredients from the solid parts of the grapes take place simultaneously

---

[10] Pandeliev, Sl. and others. Practical advice on viticulture and winemaking. Sofia, 2005. ISBN 954-05-0430-9
[11] Law on wine and spirits, pub. SG No. 45 of 2012, final change SG No. 51 of 2020
[12] Pandeliev, Sl. and others. Practical advice on viticulture and winemaking. Sofia, 2005. ISBN 954-05-0430-9
[13] Pandeliev, Sl. and others. Practical advice on viticulture and winemaking. Sofia, 2005. ISBN 954-05-0430-9

with the fermentation of the sugars. Among the groups of extractive substances, phenolic substances are important for the quality of red wines.

*Methods of making red wines*

Depending on the recirculation of the solid and liquid phases, both at the same time or only the liquid phase, there are different methods of grape must fermentation.
- Traditional methods (classical methods)
- Modified methods

*Microbiology of wine*

The microbiology of winemaking aims at the study of those microorganisms that develop on the raw materials, auxiliary materials, semi-finished products and in the finished products in the wine industry[14]. The processes that result in the production of different types of wine are also an object of research[15]. The microbiology of winemaking also considers harmful microorganisms and the processes occurring as a result of their vital activity.

### 1.2.3. Enzyme preparations in winemaking

*Chemical nature of enzymes*

The protein nature of enzymes has been irrefutably proven, as well as that they are not always made up of only proteins. A majority of them (over 50%) include a non-protein component in their composition.

*Mechanism of enzyme action*

It is known that for a chemical reaction to take place, it is necessary for the reacting molecules to meet and hit each other. If all meetings are productive, then the reaction should proceed with a bang, which practically rarely happens.

*Enzymes in winemaking*

Enzyme preparations used in winemaking belong to the following groups: pectolytic, proteolytic and cytolytic.

### 1.2.4. Conclusions and summaries

Summarizing everything that has been said so far, the most important conclusions will be drawn, which are the final result of the implementation of task two.
1) The quality of the wine produced depends on the quality of the processed grapes.
2) The production of high-quality red wine requires a grape variety with a high anthocyanin content.
3) A Bulgarian grape variety for the production of high-quality red, dry wines, especially suitable for long-term storage in oak barrels and aging in bottles in the Plovdiv region, is the Mavrud variety.
4) The three main factors that determine the quality of grapes are: variety, natural factors and agricultural techniques.
5) To guarantee varietal purity of the selected grape variety, optimal natural factors and compliance with the requirements of agrotechnical measures, it is necessary that the grapes come from a proven producer - the varietal vineyard of the Agricultural University - Plovdiv, located in the land of  Brestnik village.

---

[14] Bambalov, G. Microbiology of winemaking. Plovdiv, ed. "Hr. G. Danov", 1981.
[15] Tonchev, T. Special microbiology. Plovdiv, ed. "Hr. G. Danov", 1966.

6) The main distinguishing feature and criteria for categorizing red wines are their color and taste.

     6.1. The main carriers of the red color of wine are anthocyanins, which are flavonoid phenolic compounds. Anthocyanins readily interact with polymeric phenolic compounds of wine and the resulting polycondensation products are more stable than free anthocyanins.

     6.2. For red wines, the phenolic flavor should dominate.

And in conclusion, from all the conclusions drawn, it can be summarized that the groups of indicators, having a decisive importance for the quality of red wines, should be considered. These are the groups of phenolic compounds and of the spectral characteristics of red wines.

## 1.3. A conceptual model for empirical research methodology

The methodology of empirical research is a key point in the research process. It sets the path to arrive at new knowledge and conclusions based on real observations and measurements.
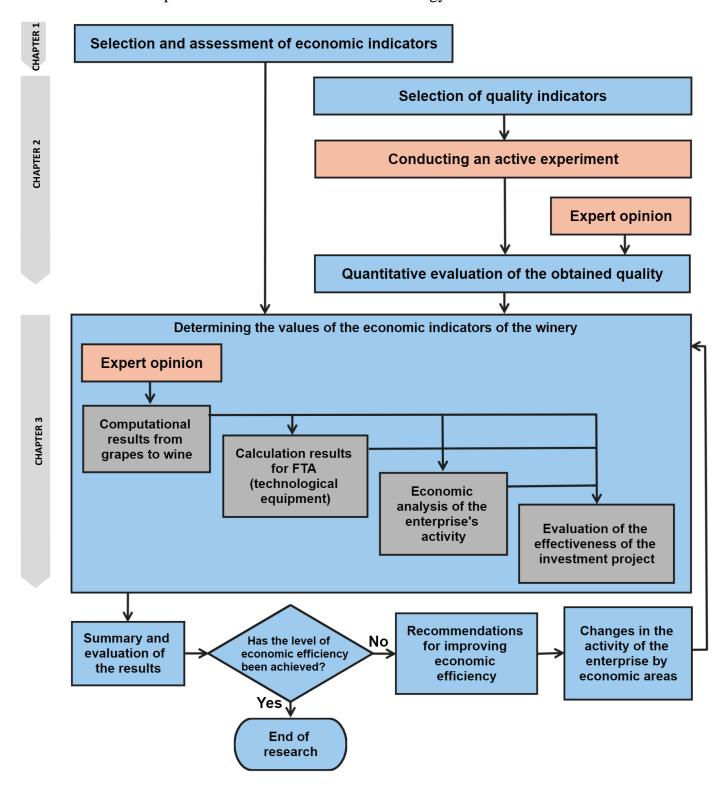
The main components of a methodological framework necessary to conduct the overall research will be outlined. The construction of the conceptual model chronologically follows the logic of the stages of the research process.

The presented in Scheme 1.4. conceptual model for the methodology of the present dissertation aims to provide a systematic and scientifically based approach to the study of the economic parameters of wine production depending on the use of enzyme preparations and the chosen technology. The model visualizes the logical connections and dependencies between the fundamental stages that are passed through in order to reveal the influence of enzyme preparations on the quality of red wines produced and, accordingly, on the economic indicators of production.

The study of the two essential aspects in wine production, relating to quality and economic indicators, goes through the following stages:

1) Selection of indicators with the greatest weight in determining economic efficiency, investing in real assets, evaluating the effectiveness of investment projects in wine production.

2) Selection of indicators for the categorization of wines according to the International Organization of Vine and Wine (OIV) and a proposed methodology for determining their importance.

3) Carrying out an active experiment to study and compare the effect of the application of industrial enzyme preparations in different vinification methods. Accounting for the changes over time of the main parameters having the greatest relevance for the quality of the red wines produced.

4) Evaluation of the quality of the wines, created during the experiment, and the categorization of the variants by type based on expert opinion and the values of their quality indicators.

5) Determining the values of economic indicators in several main areas:
   - Computational results for costs and revenues from grapes to wine at different dosages of using enzyme preparations, according to the quality of the produced wine and the expert opinion on its price;

- Calculation results for the FTA of the enterprise for different technological schemes for the production of red wines;
- Analysis of the activity of wine enterprises in accordance with their type based on a set of previously selected indicators;
- Analysis and evaluation of the efficiency of investments to create different types of wine enterprises in accordance with the technology that has been used.



Scheme 1.4. A conceptual model for evaluating quality and economic indicators in wine production.

6) Total calculation results of economic indicators for the different types of produced wines and the different production technologies. Summary and evaluation of results.
7) Conclusions on the achieved level of economic efficiency and assessment of whether the achieved level is satisfactory.
8) Based on the analysis and evaluation of the economic efficiency, recommendations are formulated that can cover the entire economic activity of the enterprise to overcome unsatisfactory results.
9) Changes are undertaken in the company's activities.
10) Return to point 5 of the algorithm for re-determining the values of the economic indicators.

The presented conceptual model also visualizes the way in which the formulated hypotheses will be checked and makes it possible to make a reasoned decision about their acceptance or rejection. This model provides a theoretical framework, guideline, or prototype for researchers interested in conducting empirical research in winemaking, with a view to developing more detailed and objective findings about the economic aspects of this industry.

## CHAPTER 2. INFLUENCE OF ENZYME PREPARATIONS ON THE QUALITY INDICATORS IN WINE PRODUCTION - EXPERIMENTAL RESEARCH AND QUANTITATIVE EVALUATION

### 2.1. Comparative experimental study on the use of industrial enzyme preparations in red grape vinification

#### 2.1.1. Indicators in the categorization of wines and assessment of their significance

According to the International Organization of Vine and Wine (OIV), the quality of red wines is a function of a set of indicators:

$$f\,(\text{TPC, FPC, ANT, NPC, I, dA\%, } A_{520}^{\%}, A_{420}^{\%}, A_{620}^{\%}, \text{T}),$$

which refer to two main groups - the content of phenolic compounds (total phenolic compounds (TPC), flavonoid phenolic compounds (FPC), anthocyanins (ANT), non-flavonoid phenolic compounds (NPC)[16]) and spectral characteristics (Sudraud color intensity (I) , Glories color brightness (dA%), red component in the color of red wines ($A_{520}^{\%}$), yellow – brown component in the color of red wines ($A_{420}^{\%}$), violet – blue component in the color of red wines ($A_{620}^{\%}$), shade of color according to Sudraud (T)). The different categories of wines have indicators that vary within legally defined limits. The ranges of changes in the indicators of the wine categories presented below are in accordance with the requirements of the OIV and BDS.

For each indicator, additionally for the purposes of the study, a weighting factor has been introduced to take into account its significance in the categorization of red wine. To determine the values of the weighting coefficients, a survey was conducted with 7 specialists from the industry. Their selection is not random, but is made from among well-established engineer-technologists, distinguished by both high theoretical training and practical knowledge and skills. It turned out that the number of such experts was very

---

[16] Freundenberg, K., Weinges, K., Jn. Chemestry of flavonoid compouds. Pergamon Press., 1962.

limited, which determined the small number of respondents. According to their expert opinion, the importance of the two main groups of quality indicators is distributed respectively 60% for the content of phenolic compounds and 40% for the spectral characteristics of the wines (the survey from Appendix 1 was used), i.e. based on this, the group weighting coefficients $w_1 = 0.60$ and $w_2 = 0.40$ were determined. Respondents (via the survey in Appendix 2) gave their opinion on determining the importance of the sub-indicators within each group. After averaging the expert assessments of the respondents, the weighting coefficients were calculated and expressed in decimal fractions both for each group (w1 and w2) and for the sub-indicators within the group ($w_{ij}$, $i = 1,2$; $j = \overline{1,4}$). The resulting values of the weighting coefficients are indicated at the end for each indicator in the following listing. A point system was introduced, by which $100.w_i$ per number of points are allocated for each group, and within each group, an ascending correspondence of the number of points from 1 to $100.w_{ij}$ is determined in ascending order of the typification of the wines.

### 2.1.2. Description of the conducted experiment

An active author's experiment was conducted to study and compare the effect of the application of industrial enzyme preparations in different methods of vinification of grapes of the Mavrud variety. The obtained indicators determining the quality of the produced red wines were studied.

### 2.1.3. Materials and methods

The point describes the materials and methods used for the research.

### 2.1.4. Scheme of trial options

In order to carry out a comparative study of the indicated enzyme preparations, under different vinification regimes, 4 series of experimental variants were realized. They are indicated respectively: series A – extraction in the mode of blocked alcoholic fermentation; series B – extraction in simulated alcoholic fermentation mode; series C – extraction in the mode of ongoing alcoholic fermentation; series D – extraction in the mode of ongoing alcoholic fermentation.

Within each separate series, 7 variants have been developed - one control without enzyme treatment and one variant for each tested enzyme. In series A, B and C, the EPs used are with the maximum dose, and series D with the minimum EP dose.

## 2.2. Summary of experiment results

### 2.2.1. Basic data on grapes

The Mavrud variety is one of the most valuable local red grape varieties, from which some of the highest quality dry red wines are made. To obtain the necessary input data for the experiment, the following analyzes were carried out: mechanical composition and technological content of phenolic compounds of the grape variety, as well as determining the composition of the must from the same.

### 2.2.2. A comparative study of enzyme preparations

The enzyme activity of EP was determined and a comparison was made according to this indicator. Enzyme activity equalization of the preparations used in the experiment was carried out.

### 2.2.3. Experimental results

For each of the experimental series and for each of its variants, changes over time in the content of phenolic compounds and the color characteristics of the wines were tracked.

## 2.3. Quantitative assessment of quality

The main parameters on which the quality of the produced red wine depends were presented in detail, as well as the interval ranges in which these parameters should vary for the different categories of wines. For each quality indicator and also for its ranges of variation, the weighting coefficients obtained on the basis of expert opinion were indicated.

By summing the points of the sub-indicators for each of the types of wine and for each separate group of quality indicators, the intervals between the minimum and maximum number of points that determine the type of wine are established.

By summing the points of the sub-indicators for each of the types of wine and for each separate group of quality indicators, the intervals between the minimum and maximum number of points that determine the type of wine are established.

T A B L E 2.3-3

*Total weight of phenolic compounds and spectral characteristics on the quality of red wines*

| № | Types of red wines | Quantitative weight, points |
|---|---|---|
| 1 | Ordinary wines | 0 - 28 |
| 2 | New red wines | 29 - 30 |
| 3 | Red wines that will be consumed within a year | 31 - 49 |
| 4 | Light wines of origin (Gamza, Shefka, Senzo) | 50 - 59 |
| 5 | Extractive wines of origin | 60 - 74 |
| 6 | Reserve wines (light wines) | 75 - 81 |
| 7 | Reserve wines (extractive wines) | 82 - 93 |
| 8 | Collection wines | 94 - 100 |

Table 2.3-4 presents the range assessment for the quality indicators of the wines, and Tables 2.3.(C).(A) and 2.3.(D).(A) is the summary assessment for the quality indicators of the wines from series C and D .

T A B L E 2.3-4

*Rating range for quality indicators of wines*

| Range | Points |
|---|---|
| min | 18 |
| max | 100 |

In the analysis of the results of the four series of experimental variants, it was found:
1) For series A and C, the highest values of the summary assessment of quality indicators is 79 points. This determines that the maximum possible category of produced wine according to Table 2.3-1 is reserve type (light wines) extractive wines of origin.

2) For series B, the highest value of the summary assessment of quality indicators is 83 points, which determines that the maximum possible category of produced wine according to Table 2.3-1 is the reserve type (extractive wines).

T A B L E 2.3.(C).(A)

*A summary assessment of the quality indicators of the wines of the C series*

| № | Date | Time | Tried options | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $\tau$, d | K-C | 1-C | 2-C | 3-C | 4-C | 5-C | 6-C |
| 1 | 18.10. | 0 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| 2 | 19.10. | 1 | 33 | 29 | 37 | 33 | 25 | 38 | 31 |
| 3 | 20.10. | 2 | 33 | 42 | 55 | 45 | 38 | 45 | 39 |
| 4 | 21.10. | 3 | 63 | 61 | 74 | 66 | 72 | 63 | 62 |
| 5 | 22.10. | 4 | 67 | 66 | 69 | 75 | 62 | 67 | 65 |
| 6 | 23.10. | 5 | 65 | 70 | 70 | 68 | 64 | 65 | 69 |
| 7 | 24.10. | 6 | 68 | 63 | 67 | 71 | 69 | 65 | 64 |
| 8 | 25.10. | 7 | 67 | 70 | 71 | 79 | 69 | 68 | 67 |
| 9 | 26.10. | 8 | 66 | 69 | 74 | 71 | 66 | 69 | 70 |
| 10 | 27.10. | 9 | 68 | 71 | 71 | 68 | 68 | 67 | 67 |
| 11 | 28.10. | 10 | 68 | 67 | 70 | 68 | 62 | 70 | 68 |
| 12 | 30.10. | 12 | 66 | 63 | 64 | 64 | 53 | 66 | 66 |
| 13 | 03.11. | 16 | 52 | 65 | 62 | 62 | 59 | 61 | 60 |
| 14 | 06.11. | 19 | 57 | 58 | 65 | 70 | 55 | 58 | 58 |
| 15 | 14.11. | 27 | 52 | 62 | 64 | 64 | 52 | 55 | 52 |
| 16 | 20.11. | 33 | 49 | 58 | 63 | 62 | 56 | 48 | 54 |
| 17 | 27.11. | 40 | 49 | 58 | 58 | 63 | 55 | 47 | 56 |
| 18 | 05.12. | 48 | 48 | 51 | 56 | 60 | 44 | 44 | 48 |

T A B L E 2.3.(D).(A)

*Summary assessment of the quality indicators of the D series wines*

| № | Date | Time | Tried options | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $\tau$, d | K-D | 1-D | 2-D | 3-D | 4-D | 5-D | 6-D |
| 1 | 18.10. | 0 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| 2 | 19.10. | 1 | 33 | 29 | 26 | 35 | 33 | 24 | 36 |
| 3 | 20.10. | 2 | 33 | 36 | 40 | 34 | 42 | 45 | 40 |
| 4 | 21.10. | 3 | 63 | 51 | 56 | 53 | 59 | 63 | 61 |
| 5 | 22.10. | 4 | 67 | 59 | 62 | 71 | 74 | 74 | 65 |
| 6 | 23.10. | 5 | 65 | 54 | 55 | 60 | 62 | 64 | 65 |
| 7 | 24.10. | 6 | 68 | 63 | 64 | 62 | 67 | 71 | 67 |
| 8 | 25.10. | 7 | 67 | 57 | 64 | 63 | 67 | 63 | 68 |
| 9 | 26.10. | 8 | 66 | 51 | 59 | 62 | 63 | 65 | 64 |
| 10 | 27.10. | 9 | 68 | 55 | 56 | 60 | 59 | 62 | 63 |
| 11 | 28.10. | 10 | 68 | 53 | 61 | 53 | 60 | 57 | 55 |
| 12 | 30.10. | 12 | 66 | 50 | 55 | 60 | 53 | 53 | 57 |
| 13 | 03.11. | 16 | 52 | 56 | 51 | 58 | 57 | 57 | 58 |
| 14 | 06.11. | 19 | 57 | 50 | 55 | 54 | 64 | 57 | 61 |
| 15 | 14.11. | 27 | 52 | 48 | 55 | 61 | 58 | 60 | 59 |
| 16 | 20.11. | 33 | 49 | 52 | 47 | 57 | 58 | 61 | 61 |
| 17 | 27.11. | 40 | 49 | 51 | 51 | 57 | 57 | 53 | 60 |
| 18 | 05.12. | 48 | 48 | 44 | 44 | 51 | 53 | 46 | 51 |

3) For series D, the highest value of the summary assessment of quality indicators is 74 points, and this determines that the maximum possible category of produced wine according to Table 2.3-1 is the type of extractive wines of origin.

## 2.4. Conclusions and recommendations from the second chapter

*Analyzes of results*

All options are considered for each individual series. The best experimental results were determined as an absolute value and a relative percentage obtained when compared to the control. Summaries are made for all EP.

*Conclusions and recommendations*

The studied enzyme preparations differ significantly in their enzyme activity and in the total effect of the changes they cause in the composition and in the color of the liquid phase during vinification of red grapes.

From the point of view of the quality of the wines produced and the economic efficiency, the use of only certain EPs, in certain doses and for certain periods of time, and for precisely certain technologies, is justified.

## CHAPTER 3. CHANGES IN ECONOMIC INDICATORS IN WINE PRODUCTION WHEN USING ENZYME PREPARATIONS

To conduct the empirical research, data from the activity of specific medium-capacity wineries operating in Southern Bulgaria were used.

The first of them is of the classic type, which means that it does not use enzymatic preparations, relies on well-known classic technologies for wine production and uses the appropriate technological equipment for this. For brevity in the dissertation, this enterprise will be referred to as Enterprise 1.

The second enterprise that will be considered is of the innovative type. Its production is characterized by the use of enzyme preparations, new technologies and their corresponding technological equipment. It will be referred to as Enterprise 2 for brevity.

## 3.1. Scheme of calculations

### 3.1.1. Input data

The input data for the calculation process are: the percentage of change of the summary assessment for the quality indicators compared to the controls; the processed results of the empirical study, expressed in the types of wines produced; the prices of different types of wines; the material balance of the two enterprises; the balance sheet, income statement and cash flow statement of the two businesses.

### 3.1.2. General description of the computational algorithm

General description of the computational algorithm. The structural units in the enterprises are determined and their cost price is calculated. The average annual amount of working capital for raw materials is calculated; washing and disinfecting products; electricity, as well as their total size. The work of permanent, temporary and general staff is planned and valued. The total cost of the finished product is calculated. The sales revenue is calculated by types of wines produced by the enterprises, as well as the total sales revenue

after VAT and the trade discount. The main 14 indicators for determining economic efficiency are calculated, based on the activity of the two enterprises at minimum and maximum values of their indicators.

The values of the indicators are calculated according to the basic 7 methods for determining the effectiveness of investments.

## 3.2. Determining the values of economic indicators

### 3.2.1. Computational results from grapes to wine

By comparing the enzyme activity and from there determining the used dose of each of the EP, it was found that the price of the preparations is within the limits of BGN 300 without value added tax (VAT). Table 3.2.1-1 presents the increases in the prices of the manufactured products at the minimum and maximum dose of the EP used

T A B L E 3.2.1-1
*Increase in the price of the manufactured product at the minimum and maximum dose of the EP used*

|  | Used dose of EP, g/100 kg of grape pulp (approximately 106 kg of grapes). | Yield of wine from 100 kg of grape mash, $dm^3$ | The price of the EP used at the corresponding dose for 63 $dm^3$ of wine, BGN excluding VAT | The price of the used EP at the corresponding dose with VAT for 1 $dm^3$ of wine, BGN without VAT |
|---|---|---|---|---|
| min | 2 | 63 | 0,6 | 0,0095 |
| max | 5 | 63 | 1,5 | 0,0238 |

Taking into account the technological losses during the processing, storage and bottling of the wines, the actual amount of wine obtained from 100 kg of grape pulp is 58 $dm^3$.

Table 3.2.1-2 shows the prices of EP at different doses for the production of 1 bottle of wine.

T A B L E 3.2.1-2
*Prices of used EP at different dosages*

| № | The price of the used EP at a minimum dose for 1 bottle of 0.75 $dm^3$ of wine, BGN without VAT | The price of the used EP at a minimum dose for 1 $dm^3$ of wine, BGN excluding VAT | The price of the used EP at the maximum dose for 1 bottle of 0.75 $dm^3$ of wine, BGN without VAT | The price of the EP used at the maximum dose for 1 $dm^3$ of wine, BGN excluding VAT |
|---|---|---|---|---|
| 1 | 0,00776 | 0,01034 | 0,0194 | 0,02586 |

The prices of the different types of wines were obtained after a survey (Appendix 3) of the professional opinion of warehouse owners for wholesale trade in wines and other beverages. The survey was aimed at the owners of companies with significant sales of wines

in the country. We received the opinions of 18 respondents, through whose companies approximately 60% of wine trade in Bulgaria takes place. By averaging their responses, the price ranges for a bottle of red wine according to its type were formed.

T A B L E 3.2.1-5
*Quality - price*

| № | Types of red wines | Prices per bottle of wine, BGN with VAT |
|---|---|---|
| 1 | Ordinary wines | $\in[2;3)$ |
| 2 | New red wines | $\in[3;5)$ |
| 3 | Red wines that will be consumed within a year | $\in[5;8)$ |
| 4 | Light wines of origin (Gamza, Shefka, Senzo) | $\in[8;10)$ |
| 5 | Extractive wines of origin | $\in[10;14)$ |
| 6 | Reserve wines (light wines) | $\in[14;20)$ |
| 7 | Reserve wines (extractive wines) | $\in[20;30)$ |
| 8 | Collection wines | $\geq 30$ |

*Note:* The volume of all wine bottles is 0.75 dm$^3$.

### 3.2.2. Calculation results for the FTA of the enterprise

Different technological schemes for the production of red wines are considered, from classic to innovative ones, and for each specific case the relevant production will be sized and the value of technological equipment will be calculated, which has the greatest weight when considering the value of assets.

Regardless of the chosen technology, the minimum working time of a vinifier starts from 3 days, (taking into account that maceration and fermentation are basic technological processes without which wine production is impossible).

T A B L E 3.2.2-3
*Work cycle of a vinifier with different technological schemes*

| № | Duration per cycle | Classic technology, Days | Modified method (Australian), Days | Modified method of carbonic acid - maceration, Days | Proposed technology, Days |
|---|---|---|---|---|---|
| 1 | Charging | 1 | 1 | 1 | 1 |
| 2 | Maceration | 1 | 12 | -- | 1 |
| 3 | Fermentation | 10 | 12 | 37 | 4 |
| 4 | Drain/Replenish/ Insistence | -- | 12 | -- | -- |
| 5 | Emptying | 1 | 2 | 1 | 1 |
| 6 | Service/reserv | 1 | 1 | 1 | 1 |
|  | Total | 14 | 40 | 40 | 8 |

Other conditions being equal, including the quality of the wines produced, the possible cycles of the fermentation equipment (vinifiers) are shown in Table 3.2.2-5.

T A B L E 3.2.2-5
*Maximum possible workload of the vinifiers*

| № | | Classic technology, Days | Modified method (Australian), Days | Modified method of carbonic acid - maceration, Days | Proposed technology, Days |
|---|---|---|---|---|---|
| 1 | Possible cycles for a grape harvest | 2,86 | 1 | 1 | 5 |

It can be seen from Table 3.2.2-5 that with the use of enzyme preparations and the proposed technology, the cyclic (fermentation) capacity of wineries increases by 1.75 to 5 times, depending on the different technologies. This in turn leads to the conclusion that it is possible to increase the volume of wine produced without increasing the cost of additional FTA, or to reduce the cost of FTA and maintain the volume of production. All this leads to significant financial savings for winemakers.

### 3.2.3. Analysis of the activity of wine enterprises

Table 3.2.3-15 shows the minimum and maximum profits for the realization of the production by types of wines produced.

T A B L E 3.2.3-15
*Calculation of total net sales revenue after VAT and trade discount*

| № | Bottled wine (bottle 0.75 dm$^3$) | Production value, BGN without VAT | Revenue from sales, BGN excluding VAT | Net income, BGN excluding VAT | Net income per product unit, BGN excluding VAT |
|---|---|---|---|---|---|
| | | | Enterprise 1 | | |
| 1 | "Sort 1" wine | 3 568 260,04 | 8 364 318,67 10 455 398,33 | 4 796 058,63 6 887 138,29 | 2,67584 3,84251 |
| 2 | "Sort 2" wine | 2 717 389,42 | 5 227 702,08 8 364 323,33 | 2 510 312,66 5 646 933,91 | 1,40006 4,66667 |
| 3 | Blended pressed wine | 1 101 502,21 | 732 853,33 1 099 280,00 | − 368 648,88 − 2 222,21 | − 0,58687 − 0,00353 |
| 4 | Everything | 7 387 151,67 | 14 324 874,08 19 919 001,66 | 6 937 722,41 12 531 849,99 | 1,64679 2,97466 |
| | | | Enterprise 2 | | |
| 1 | "Sort 1" - Fruit wine | 2 002 210,75 | 8 207 197,83 11 724 568,33 | 6 204 987,08 9 722 357,58 | 6,17434 9,67434 |
| 2 | "Sort 1" - Extractive wine | 1 333 557,54 | 7 809 141,67 11 713 712,50 | 6 475 584,13 10 380 154,96 | 9,67436 15,50770 |

| | | | | | |
|---|---|---|---|---|---|
| 3 | Blended wine "Sort 2 x Sort 1" (61x39%) | 1 183 467,68 | 3 261 967,33 4 077 459,17 | 2 078 499,65 2 893 991,49 | 2,97356 4,14023 |
| 4 | Blended wine "Sort 2 x Sort 1" (85x15%) | 1 099 231,09 | 2 038 729,58 3 261 967,33 | 939 498,49 2 162 736,24 | 1,34407 3,09407 |
| 5 | "Sort 2" wine | 1 098 042,29 | 1 263 136,00 2 105 226,67 | 165 093,71 1 007 184,38 | 0,22873 1,39539 |
| 6 | "Sort 2" - pressed wine | 642 353,33 | 488 568,50 732 852,75 | – 153 784,83 90 499,42 | – 0,36723 0,21611 |
| 7 | Everything | 7 358 862,69 | 23 068 740,92 33 615 786,75 | 15 709 878,23 26 256 924,06 | 3,72902 6,23255 |

### *Basic indicators for determining economic efficiency*

Table 3.2.3-16 presents the calculated values of the preferred 14 indicators for determining economic efficiency, based on the activity of the two enterprises at minimum and maximum values of their indicators.

T A B L E 3.2.3-16

*Calculated values of the preferred 14 indicators for determining economic efficiency*

| | Cost efficiency ratio | | Revenue efficiency ratio | | Return on equity | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| Enterprise 1 | 1,94 | 2,70 | 0,52 | 0,37 | 110,45% | 199,52% |
| Enterprise 2 | 3,13 | 4,57 | 0,32 | 0,22 | 297,61% | 497,42% |

| | Return on capital employed | | Return on assets | | Profitability of sales revenue | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| Enterprise 1 | 93,92% | 169,6% | 0,51 | 0,92 | 48,43% | 62,91% |
| Enterprise 2 | 213,4% | 356,8% | 1,24 | 2,08 | 68,10% | 78,11% |

| | Labor productivity | | Capital efficiency | | Absolute term of redemption of the capital | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max |
| Enterprise 1 | 44,06 | | 1,1 | 2 | 0,91 | 0,5 |
| Enterprise 2 | 43,89 | | 2,98 | 4,97 | 0,34 | 0,20 |

| | Capital intensity | | Productivity of capital | | Duration of one revolution | |
|---|---|---|---|---|---|---|
| | | | | | Min | Max |
| Enterprise 1 | 0,85 | | 1,18 | | 185,65 | 133,51 |
| Enterprise 2 | 0,72 | | 1,39 | | 114,84 | 78,81 |

| | Number of revolutions | | Occupancy of short-term tangible assets | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| Enterprise 1 | 1,94 | 2,70 | 0,52 | 0,37 |
| Enterprise 2 | 3,13 | 4,57 | 0,32 | 0,22 |

### 3.2.4. Analysis and evaluation of the effectiveness of investments in wine enterprises

Calculated and presented in Table 3.2.4-1 are the values of the basic 7 methods for analysis and evaluation of the effectiveness of investments in wine enterprises. Two static and five dynamic methods were used.

T A B L E 3.2.4-1

*Values of the basic 7 methods for determining the effectiveness of investment projects*

| | Comparing Return on Investment (ARR) | | Investment Payback Period (PBP) | | Net Present Value (NPV) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| Enterprise 1 | 1,10 | 2,00 | 0,91 | 0,50 | 389 838,60 | 5 768 807,43 |
| Enterprise 2 | 2,98 | 4,97 | 0,34 | 0,20 | 9 827 013, 67 | 19 968 403,89 |

| | Internal Rate of Return (IRR) | | Revenue-Cost Ratio (BCR) | | Profitability Index (PI) | |
|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max |
| Enterprise 1 | 11,60 | 100,25 | 1,94 | 2,70 | 1,86 | 2,59 |
| Enterprise 2 | 199,17 | 400,54 | 3,13 | 4,57 | 3,01 | 4,39 |

| | Annuity Method (AD) | | Payback Period (PBP$_D$) | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| Enterprise 1 | 374 845,41 | 5 546 939,10 | 0,94 | 0,52 |
| Enterprise 2 | 9 246 041,83 | 18 997 394,18 | 0,36 | 0,22 |

### 3.3. Results and conclusions of the third chapter

1) The first sub-hypothesis was confirmed and it is established that the use of the minimum doses of EP worsens the results compared to the control ones and is economically inefficient.

2) The second sub-hypothesis was confirmed, that the use of maximum doses of enzyme preparations does not necessarily mean an improvement of the quality and economic indicators of the produced wines.

3) EP have been established, the use of which in the maximum dose leads to a significant improvement of the quality and economic indicators of the produced wines.

4) In order to achieve the maximum possible economic results, a measured and accurate use of EP is necessary.

5) Based on the values of the obtained efficiency coefficients of costs and revenues, it can be summarized that the prices of EP are incomparably smaller compared to the economic effect caused by their use.

6) The obtained and described results can be used to create new technologies for the production of red wines, leading to a reduction in the costs of FTA and an increase in the quality of the produced wines .

7) The results of the activity of Enterprise 2 have better indicators of economic efficiency than those of Enterprise 1.

8) During the analysis and evaluation of the effectiveness of the investments in Enterprise 1 and 2, positive evaluations were obtained for all used methods. Enterprise 2 is considered to perform better than Enterprise 1.

Designed enterprises based on the innovative technology, as well as those who use it, can count on a wide assortment and price range of products. They can be confident that they have practically reached maximum results in the use of their main raw material.


## SUMMARY OF RESEARCH RESULTS

The main goal of the dissertation work was achieved, the changes in the qualitative and economic indicators related to the use of enzyme preparations, as well as the interrelationships between them in winemaking, were investigated.
All seven tasks have been solved:

1) As a result of the literature review aimed at the economic aspects of wine production, task 1 has been completed, 14 indicators have been selected for determining the economic efficiency of a wine enterprise, an approach to the analysis of investments and the investment process has been determined, 7 evaluation methods have been selected and analysis of an investment project.

2) A modern reading of the theoretical approaches for evaluating the quality of red wines was made. The groups of indicators crucial for determining their quality are marked. These are the phenolic compounds and spectral characteristics of red wines.

3) A conceptual model has been developed to reveal dependencies between the quality indicators of the produced wines and the economic condition of the enterprise, so the third formulated task receives a solution.

4) In connection with the fourth task of the dissertation work, the changes in quality indicators in winemaking related to the use of enzyme preparations were experimentally investigated.

5) Solving the fifth task, the selected set of economic indicators of enterprises from the wine industry of different types were calculated. Based on the obtained results, a direct dependence of the economic indicators of the production on the quality indicators of some of the produced wines was established.

6) An analysis was made of the changes in the quality and economic indicators depending on the use of enzyme preparations.

7) After summarizing and systematizing all the obtained results, conclusions were drawn regarding the expediency of the use of enzyme preparations in the production of different types of wines. Based on the initial data from the approvals with a classic and innovative type of enterprise, recommendations are formulated for choosing technologies for investments in accordance with previously set goals.

From the results obtained so far in the research, a reasoned decision can be made to confirm or reject the formulated hypotheses and sub-hypotheses.

For Sub-Hypothesis 1: *"The use of minimal doses of enzyme preparations deteriorates the quality and economic indicators of the wines produced"* - the results of the experimental trials of all variants of the D series (Tables 2.2.3.(D).1-11) show that the low doses enzyme preparations lead to low quality of the produced wines and this negatively affects their price. The observed regularity gives reason to accept this sub-hypothesis as true.

To determine the validity of Sub-Hypothesis 2: *"The use of maximum doses of enzyme preparations necessarily means an improvement of the quality and economic indicators of the produced wines"*, we direct our attention to the results of experimental trials of series C, variants C-5 and C-6 (Tables 2.2 .3.(C).1-11). They show that there are situations in which high doses of enzyme preparations do not actually increase the quality of the produced wines with their participation and, accordingly, their price. This means that Hypothesis 2 should be rejected.

When deciding on Sub-Hypothesis 3: "*Increasing the quality of produced red wines with the participation of enzyme preparations leads to the possibility of increasing the main economic indicators of the produced wines and enterprises of the wine industry"* the focus is on the results of all variants of series A, B and the first four variants of series C (Tables 2.2.3.(A, B and C).1-11) and the comparison of the values of the economic indicators for the two enterprises. The distinctly better results for the innovative Enterprise 2 give reason to accept this sub-hypothesis.

Based on the decisions taken for the three sub-hypotheses, the acceptance of the main hypothesis can be reasonably confirmed: *"Not for all types and qualities of wine, the use of enzyme preparations in their production is economically justified"*. The confirmation of this assumption shows that the use of enzyme preparations in the production of wines should be approached responsibly and reasonedly, with professional knowledge and skills. High financial results can only be expected if these conditions are met.

## POSSIBILITIES FOR APPLICATION OF THE RESULTS

The proposed conceptual model can be used for analogous studies of the influence of different additives on economic indicators in the production of beverages and foods. The results of the conducted experiment provide a comprehensive view of the effect of EP in the production of red wines. With these results in mind, technological processes can be purposefully managed to achieve a desired result. The obtained results provide opportunities to create economically justified innovative technologies for the production of a wide range of red wines and to design new enterprises based on these technologies.

## DIRECTIONS FOR FUTURE RESEARCH

Directions for expanding the research can be both focused on individual stages of the proposed conceptual model, and covering its overall scheme or adding components to it. The following specific ideas for future work can be indicated, each of which presents new opportunities:

- Forecasting the quality of the produced wines already at the stage of their creation and anticipatory determination of the economic results. Ability to take timely actions and possible corrections.

- Creation of a methodology for planning and forecasting the processes in the production of red wines;

- Valuation of each stage of wine production;

- Development of a concept for guiding the technological processes depending on the economic needs of the enterprise.

## RECOMMENDATIONS FOR THE WINE PRACTICE

1) The use of enzyme preparations in the vinification of red grapes should be carried out with optimal doses and duration, according to the recommendations of their manufacturers and according to the specific conditions of application (grape variety, vinification mode, type of production, environmental factors).

2) In the traditional methods of vinification of red grapes, the use of enzyme preparations is justified from the point of view of the composition of the color in the production of the light type of red wines - new, young, table, for sparkling wines and for short aging in barrels.

3) The method of cold enzymatic maceration of grape must is characterized by the most complete extraction and preservation of anthocyanins, which also means the best color characteristics. The optimal duration of the process varies from 1 to 4 days. For the production of the light type of red wines, the colored must can be separated by straining and pressing and vinified by the "white" method, in order to maximize the expression of fruit tones in the aromas and taste of the wines. For the production of

extractive red wines, it is more appropriate to inoculate the macerated mash with wine yeast and proceed according to traditional methods.

4) In the production of dessert (liqueur) red wines, the method of cold enzymatic maceration of the grape mash, previously distilled to about 6 vol.% alcohol, can be successfully applied. This further speeds up the extraction processes without inhibiting the enzyme preparations used.

## CONCLUSIONS AND CONCLUSIONS FROM THE DISSERTATION

The stereotype of the mandatory and non-alternative use of enzyme preparations in the wine industry is current and significant. In a digital, modern world, constantly creating and developing new technologies, dogmas cannot and should not exist. It is necessary to seek and give answers to a number of questions, and one of the most important is: Why?

Why should enzyme preparations be used? Do enzyme preparations cause changes in the quality indicators of produced red wines with their participation? If quality parameters change, does this cause changes in economic indicators?

The answer to these questions can be found in this dissertation.

The experimental data and the dependencies established during their analysis provide the basis for the following general conclusions on the topic of the dissertation:

1) The conducted experiment gives a complete idea of the action of the enzyme preparations on the grape pulp, as well as an opportunity to analyze the obtained results on the qualitative and economic parameters of their use, practically on the entire typology of red wines.

2) Thanks to the obtained experimental results and the analysis of the changes on the qualitative and economic parameters, new technologies for the production of different types of red wines have been proposed.

3) The studied enzyme preparations differ significantly in their activity and in the total effect of the changes they cause in the composition and in the color of the liquid phase during vinification of red grapes.

- The difference between the activities of the enzyme preparations is different and the last one, EP6, exceeds the first EP1 by 20 times (Table 2.2.2-1).

- According to the total effect of the changes on the quality indicators in the liquid phase, under equal conditions, the EPs are arranged: EP2, EP3, EP4, EP1, EP5 and EP6.

4) Some of the enzyme preparations used in the vinification of red grapes show results worse than or equal to the control ones.

5) Some of the enzyme preparations used in the vinification of red grapes significantly accelerate the extraction of all groups of phenolic compounds from the skins of the

grapes and, as a result, improve the color characteristics of red wines and increase their price.

6) The use of minimum doses of EP worsens quality indicators compared to controls and leads to the conclusion that their use in such doses is ineffective and leads to financial losses.

7) It is mandatory to use EP in the maximum dose, they have a direct impact on the quality, and hence on the price of the wines produced.

8) The correct use of EP - precisely defined EP, in the necessary quantities and time, significantly increase the quality and price of the wines produced, reaching the theoretically possible maximum results.

9) The minimum prices of the EP used compared to the prices of other additives are a factor of key importance for their use.

10) The correct interpretation of the obtained results led to the creation of new technologies for the production of red wines, leading to a reduction in the costs of FTA and an increase in the quality of the wines produced.

11) Designed enterprises based on this technology, as well as those that use it, can count on a wide assortment and price range of products; can be confident that they have reached the theoretical maximum results from the raw materials used.

12) All the 14 main indicators used to determine the economic efficiency show the excellent results of the activity of the two enterprises.

13) The results of the activity of Enterprise 2 have better economic efficiency indicators than those of Enterprise 1.

14) In the analysis and evaluation of the effectiveness of the investments in Enterprise 1 and 2, by all the methods used, it is established that the projects are suitable for investment. Enterprise 2 is considered to perform better than Enterprise 1.

15) Has it been established that the use of enzyme preparations in the wine industry is economically efficient, when, how and why? It has been proven for which types of wines that the use of enzyme additives is necessary to obtain a quality and economic effect.


## MAIN CONTRIBUTIONS OF THE DISSERTATION

1) A conceptual model has been developed for the study of changes in quality and economic indicators in winemaking when enzyme preparations are used. The model was tested using two enterprises of different types from the wine industry.

2) The main indicators determining the quality of red wines have been identified, and a system for a unified quantitative assessment of quality in winemaking has been proposed.

3) Based on expert opinion, an up-to-date system for evaluating the price of red wines according to their quality has been developed.

4) An active experiment was conducted, taking into account the changes over time of the main quality parameters of the produced red wines under different vinification methods.

5) The effect of the application of industrial enzyme preparations on the quality of red wines was compared after analyzing the changes in their quality over time and based on a unified quantitative assessment proposed for the purpose.

6) Based on the values of the economic indicators of enterprises of a specific type of the wine industry, the influence that the quality of the wines produced with the use of enzyme preparations in different vinification methods has on the economic indicators of the production has been studied.

**SCIENTIFIC PUBLICATIONS**

1. Georgiev, St. Trends in the viticultural sector in Bulgaria for the period 2015-2019. In: First Scientific Conference Innovations and Competitiveness. Plovdiv, 2020, ISSN 2738-7534.

2. Georgiev, St. Situation and trends in the development of viticulture and winery in Bulgaria for the period 2000-2020. Agricultural Sciences. 2022, Volume 14. Issue 33. DOI: 10.22620/agrisci.2022.33.010 **(Web of Science)**

3. Georgiev, St., Yankova, T. Waste Products from Wine Production and Possible Paths to a Green Economy. Economic, regional and social challenges in the transition towards a green economy conference proceedings, 30th of September 2021 Plovdiv, Bulgaria. ISBN (online) 978-619-7663-07-5