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Editor-in-Chief: Prof. Dr.Sc. Petko Iliev - tel: 0893 492 350

Editor: Assoc. Prof. Dr Svetlozar Stefanov - phone: 0878 362 245

Editor: Prof. Dr Julian Vasilev, vasilev@ue-varna.bg

Scientific Secretary: Assoc. Prof. Dr Anastasia Konduktrova - tel: 0882 164 846

Prepress: Julian Vasilev

9000, Varna, 1, Dr. L. Zamenhof Str.

email: eknigibg@gmail.com

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Sincerely: Prof. Dr. Sc. Petko Iliev

An accounting view of the dual nature of convertible bond as a financial instrument

Petko ZAHARIEV[1]

[1] University of Economics, Varna, Bulgaria
petko_zahariev@ue-varna.bg

Abstract. The article aims to present two different historically developed points of view in the accounting treatment of convertible bonds in the issuer's accounting - as a uniform financial liability (a typical debt instrument) and as a hybrid and non-uniform financial instrument containing two components - a financial liability and an element of equity. In the course of the research, the ever-increasing role of convertible bonds as a financial instrument in corporate practice, both worldwide and in Bulgaria, is emphasized, as well as some main characteristics that distinguish them from the standard debt financial instrument. The study is limited only to the accounting of corporations as debt issuers, as well as to the statutory regulations of only the two main accounting bodies-FASB and IASB. A methodology for evaluating the two components is also presented, as well as some aspects of accounting depending on the decision to exercise or not the right to convert. The study utilizes aim methods such as research and analysis of publications from the scientific community, as well as the relevant accounting regulations developed by the FASB and the IASB. In conclusion, in a historically presented discussion, the author accepts the generally accepted FASB Accounting Standards Codification and International Accounting Standards understanding of the hybrid nature of this specific financial instrument, consisting simultaneously of two different elements requiring separate measurement, reporting, and disclosure. The article has a necessary practical-applied usefulness, considering the increased interest both in the world and in Bulgaria in this specific way of corporate financing.

Keywords: convertible bond, financial liability, equity component, USGAAP, International Accounting Standards
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1. Introduction

Over the past few years, in the corporate practice of developed countries, there has been an increased interest in the issuance of convertible bonds as a way of cheaper corporate financing and a number of other comparable advantages of this special financial instrument.

Boosted by a combination of a stronger-than-expected US economy and the prospect that monetary conditions will improve in the second half of the year, US companies with investment-grade ratings have raised more than a whopping $265 billion convertible debt as of March 2024 (Monteiro, T. 2024).

According to other sources-„Financial Times" (Clarfelt, H., Megaw, N., 2024) a growing number of US corporations are once again turning to the issuance of convertible debt in their quest to lower corporate debt levels and maintain them for the foreseeable future. The increased activity of US companies in issuing convertible bonds is confirmed by the data of a rise in 2023 of 77%, which largely restores this market to the average values before the Covid-19 pandemic and after its stagnation in 2022. All expectations are that increased interest in this specific financial instrument will continue into 2024 as it shifts away from smaller and emerging technology companies and towards significantly larger and established names in US corporate practice. Underlying this assumption is the expectation that the Federal Reserve will hold its interest rates higher and for a longer period of time than the investment community and financial analysts had predicted a year earlier.

According to Reuters (Howcroft, E. 2024), increased appetite for corporate debt issuance is also seen in Europe, especially among companies financed by venture capital, which in the post-Covid 19 years received unreasonably high market valuations. Due to the decrease in the volume of so-called risk financing, the issuance of convertible bonds proved to be a suitable way to finance these companies, and this led to a sharp increase in the issuance volumes of convertible debt, from 1.7 billion dollars in 2022 to 2.5 billion dollars in 2023.

Apart from the indicated world trend, in the last 10 years in Bulgaria, there have been cautious attempts by some Bulgarian companies to finance their activities through the issue of convertible debt - "Sofia Commerce Pawn Shops" AD (2013), "Central Cooperative Bank" AD (2013), "Industrial Holding Bulgaria" AD (2013), "Monbat" AD (2017), "Sugar Factories" AD (2022), "Doverie United Holding" AD (2023), "Texim Bank" AD (2023), and „Opportunity Bulgaria Investment" AD (2024).

The renewed interest in the hybrid financial instrument-convertible bond provokes the need to study it as a specific accounting object from the point of view of the issuing companies, including its characteristics, and the presence of different historically formed approaches for its current reporting and disclosure in the financial statements.

2. Literature review and implementation

Convertible bonds are financial instruments that allow their holders to either hold the security until maturity, when they will receive back its nominal value, or to exercise the early (before maturity) conversion option, receiving equity instruments in exchange for debt (shares or rights to acquire shares). The possibility of choice gives reason convertible debt is considered a "hybrid" financial instrument (Epstein, Barry J. et al. 2002).

The financial management team's decision to repay the bond loan by exercising the conversion privilege - established as a clause in the bond indenture (deed of trust) most often rests on considerations related to an assessment of the features of the hybrid type of securities-convertible bonds[1] (APB Opinion № 14 *Accounting for Convertible Debt and Debt Issued with Stock Purchase Warrants*, 1969):

a) The interest rate on the convertible bonds is lower than the one the issuer has set for the non-convertible bonds. The reduced interest rate is a result of the value of the conversion option. In other words, the issuer of a convertible instrument "buys down" the interest rate by selling the investor the conversion option embedded in the debt or equity host instrument (6.1A Chapter overview of convertible debt accounting—before adoption of ASU 2020-06, PWC);

b) As a rule, the initially established price in the bond contract at which the exchange will be carried out is higher than the market price of the shares at the time of the operation;

c) Often, the issuer adds to the conversion clause in addition to the speech an option (right, opportunity) to buy back its ordinary shares, which it will provide in exchange for bonds;

d) The buyer of such bonds usually pays a premium over the conversion price;

e) As a financial reporting object, convertible bonds have a smaller dilutive effect on the indicator "Earnings per share" compared to ordinary shares.

When convertible bonds are issued, the bond indenture (deed of trust) must specify the conversion factor relative to the ordinary shares for which a bond can be exchanged. If one bond is exchanged for 10 ordinary shares with a nominal value of BGN 1 each, the conversion ratio will be 1:10 but may be systematically reduced until maturity, when the unexercised conversion privilege will be canceled.

The price at which the conversion will take place is calculated as a ratio between the nominal value of the convertible bonds and the number of ordinary shares received, which can also be derived from the conversion ratio.

This price is too fixed firmly in the bond indenture (deed of trust), but in practice, it differs from the other three convertible bond valuations known to financial and accounting theory:

a) *The investment value* is the valuation of the convertible bond if the latter did not contain a convertible bond but possessed all the other features of a debt instrument of the same degree of risk and quality. Mathematically calculated, it is equal to the present value of the periodic interest payments, plus the present value of the principal of the bond;

b) *The conversion value* of the bond can generally be determined by multiplying the number of common shares received as a result of the exchange and the market price of one common share at the time of the transaction. If a bond with a nominal value of BGN 10 is exchanged for 2 shares with a nominal value of BGN 5

[1] Below in the text convertible bonds and convertible debt will be used as synonyms, as are related terms „ordinary shares" and "common stock".

each, but with a market price of BGN 5,50, the conversion price of the bond will be BGN 11 (2 x BGN 5,50). The difference between the conversion price of the bond and its actual market price will be the conversion premium that the investor will pay for the received conversion right;

c) The relationship between the above-mentioned valuations of pure convertible bonds is evident in *the market price* of the convertible bond, which may be different from both the conversion price and the bond's investment value. The market price of the convertible bond, however, cannot be lower than its investment value, since the former is equal to the investment value, plus the value of the conversion right. The market value cannot be lower than the conversion price, because, in a fair exchange, the convertible bond cannot be worth less than the common stock for which it is exchanged.

From these purely financial aspects of the conversion and valuation of convertible bonds, an accounting-oriented dispute arises: *whether convertible debt securities should be treated by the issuer only as debt or whether part of the proceeds received from the bond issue should be recognized as an element of equity.*

The first point of view is expressed in the view that debt and conversion privilege are inescapably linked in the issue price of the bond and should not be valued separately because the bondholder cannot sell one part while keeping only the second. A similar understanding was adopted in some of the early sources of USGAAP (e.g., APB Opinion No. 14 *Accounting for Convertible Debt and Debt Issued with Stock Purchase Warrants*, 1969), which, ignoring the thesis of the hybrid nature of convertible bonds, does not recognize the division of their substance into a debt and equity component and treats convertible bonds only as a debt instrument. From the position of the Bulgarian accounting regulations, we consider that the approach is currently also adopted by Bulgarian National Accounting Standard No. 1 *Presentation of the Financial Statements* (item 16.13) through the requirement for separate presentation of the convertible bonds in row position "*Bond loans"* of section "*Liabilities"*, i.e., as a typical and rather homogeneous liability, without even hinting at the disclosure of the capital component within equity.

On the other hand, the accounting community supporting the **opposite point of view** claims that in the substance of this type of securities, there are two different elements, each of which must be recognized in accounting. That part of the issue value applicable to the conversion privilege will be recorded to the credit of account 105 *Premiums, related to capital*, and the difference (nominal value) should be recognized as a debt, which will be reflected in account 153 *Debt instruments*[1].

The accounting treatment of a convertible debt instrument is based on the specific conditions under which the instrument was originally issued, as one of the most important parameters influencing the specific accounting treatment is how and against what the convertible debt is settled (redeemed). Without claiming to be exhaustive, we consider the possible options to be two-entirely in equity instruments (shares or stock options) or in a combination of equity instruments and cash.

Internationally, a significant harmonization of the conflicting views on the essence of convertible bonds can be found. For example, in August 2020, the FASB issued ASU 2020-06 *Debt with Conversion and Other Options (Subtopic 470-20) and Derivatives and Hedging - Contracts in Entity's Own Equity (Subtopic 815-40).* The new standard is effective for companies that are US SEC filers (except for Smaller Reporting Companies) for fiscal years beginning after December 15, 2021, and interim periods within that year, and two years later for other companies (*New convertible debt accounting guidance*, updated August 2020, PWC).

The ASU 2020-06 simplifies the accounting for certain financial instruments with characteristics of liabilities and equity. The FASB reduced the number of accounting models for convertible debt and convertible preferred stock instruments and made certain disclosure amendments to improve the information provided to users. In addition, the FASB amended the derivative guidance for the "own stock" scope exception and certain aspects of the EPS guidance (6.1A Chapter overview of convertible debt accounting—before adoption of ASU 2020-06, PWC).

In § 221 Para. 1. Section 1 of the German Companies Act (AktG), a convertible bond is defined as a security with which the issuer grants the investor an exchange or purchase option to convert the bond purchased into shares at a predefined point in time. The financial instrument thus embodies a hybrid contract, consisting of a bond and an embedded option contract (long call) (Menk, M., Mies, M. 2016).

IAS 32 *Financial Instruments: Presentation* anchors the understanding of the convertible bond as a complex (composite) financial instrument that contains both a liability and equity element and is a combination of a host contract (an obligation to repay the principal at maturity) and an embedded derivative (equity conversion option).

[1] For the purposes of the research, the numbers and names of accounts from the Sample Chart of Accounts, developed by the Department of accounting of Varna University of economics will be used.

As it is known, IAS 32 *Financial Instruments: presentation*, introduces as a criterion for distinguishing between a financial liability and equity the fact whether the issuer (the reporting entity) has an obligation to pay cash or some other financial asset or not. However, compound financial instruments such as convertible bonds should be divided into equity and liability components, as the equity component is measured as the difference between the fair value of the compound instrument and the fair value of the liability component (*Financial Instruments with Characteristics of Equity, Proposed Amendments to IAS 32, IFRS 7, and IAS 1* Exposure Draft November 2023, IFRS).

The standard does not address the valuation of financial assets, financial liabilities, and equity instruments and does not recommend a specific method for assigning a book value to the liability and equity elements contained in the complex financial instrument, as the question of the valuation of the components is rather in the regulation of IFRS 9 *Financial Instruments*. In practice, the following methods can be used:

a) Assigning a value to the more difficult-to-assess component (as a rule, this is the capital instrument) equal to the remainder after deducting the value that is determined separately for the easier-to-assess component from the value of the instrument as a whole. Under this approach, the issuer of a convertible bond first determines the carrying amount of the financial liability by discounting the stream of future interest and principal payments at the prevailing market rate for a similar liability that does not contain an equity component. The carrying amount of the equity instrument represented by an option to convert the instrument into common stock can then be determined by deducting the carrying amount of the financial liability from the value of the instrument as a whole. It should be noted that this approach remains fundamental after the latest amendments to IAS 32: *International Financial Reporting Standards (IFRSs) as of 1 January 2005 inclusive IASB Explosion Drafts, IFRIC Draft Interpretations, Discussion Papers and other IASB and IASC Foundation materials.*

b) Evaluating the components "liability" and "equity" separately, and to the necessary extent their proportional adjustment, so that the sum of the components is equal to the value of the instrument as a whole.

The hybrid nature of the convertible bond requires a **non-traditional treatment of some usual costs** accompanying the financial instrument under consideration, in particular the costs of the issue and the costs of interest payable by the issuer.

Issue costs and interest costs should be split between the two different components of the complex financial instrument. For that part of the costs applicable to the capital component of the convertible bond, the equity approach should be applied, and they should be reflected in a reduction of equity, while the part of the costs corresponding to the financial liability should be recognized in a reduction of the financial result through an adjustment of the interest expense, analogous to the amortization of the discount.

The realization of a gain or loss on conversion cannot always be expressed in a clear form that allows this financial result to be disclosed in the income statement, and, in practice, the accounting treatment of this financial result will vary depending on how it can perform the conversion itself. In this case, we would suggest three main approaches for repaying a bond loan through conversion:

a) Purchase of own shares and their exchange for convertible bonds. The company can carry out these operations as an investor and buy the package of shares necessary for the conversion at the current exchange rate or by exercising its right to buy back a part of its own shares from the shareholders themselves at a price fixed in the company's articles of association (if the ordinary shares are of the "redeemable" type). In both cases, the shares, purchased by the company will be valued at the purchase price actually paid on the date of purchase, based on the number of shares required for the conversion and their nominal value;

b) Use of shares representing part of a treasury package (*Treasury stocks*). Here, when writing off the replaced capital instruments, the starting point should be the reporting value of each share from the package, regardless of the fair price of the remaining similar shares in circulation on the date of the exchange;

c) If the company decides that the option to buy back its own shares through the market is unprofitable (in case its market rate is currently very high), it could organize a new issue of additional shares to distribute to its bondholders. The issuance of new ordinary shares, which, at the specified conversion ratio, will be granted in exchange for the voided bonds, will not lead to an adequate increase in the net stockholders' equity (for example, by increasing the cash proceeds from the issue), but only to an internal dislocation of capital structure - the increase in the share capital will be at the expense of the repaid bond loan. The exchange is based on the issue value of the new shares, which must correspond to the conversion value of the bonds.

The accounting procedures regarding the issue of convertible bonds and their subsequent exchange for ordinary shares are as follows:

1. The first step in determining the present value of the debt is related to the calculation of the applicable discount factor. For this purpose, the tables containing calculated discounting factors for the present value of BGN 1 principal and corresponding interest annuity, discounted with discount rate " Y " for " t " number of periods, can be used;

2. Complying with the requirements of IAS 32 *Financial Instruments: Presentation*, we can determine the book value of the capital component of convertible bonds-the conversion option as the difference between the proceeds of the issue and the present value of the debt;

3. After these operations, the issuer's debt on account 153 *Debt instruments* will be presented at the nominal value of the bonds, the value of the capital component reflected on account 105 *Premiums, related to capital* or on account 115 *Premium reserve* will represent the book value of the option to convert into common shares. It should be noted here that it is appropriate to open two analytical accounts to the chosen one of the above accounts:

- An analytical account with the sample name "*Premiums from the issue of capital instruments*", which will reflect the premiums from the issue of shares, as well as all subsequent operations with them;

- Analytical account with the sample name *"Capital component of convertible bonds - conversion option"*, which will reflect only the operations of origination and write-off of the capital component of the bond, regardless of whether the conversion option is exercised or not. The credit balance of the account will express the book value of the not yet exercised conversion right and may be disclosed together with the credit balance of the above analytical account in one item or in a separate item in the equity section of the balance sheet with the name "Equity component of convertible bonds";

4. The "financial liability" component after its initial recognition must be reported at amortized value, for which the issuer develops an amortization plan;

5. If all investors exercise their conversion right, the issuer should write off the book (amortized) value of the debt at the maturity date, compiling accounting articles to reflect the accrued interest for the relevant interest periods and the systematic amortization of the discount/premium at the expense of the accounting interest expense, to write off the last unamortized part of the discount/premium, which remained unrecognized due to the early repayment of the debt before maturity, and to write off the nominal value of the debt;

6. The conversion of bondholders into shareholders of the company, in turn, requires two more accounting procedures:

- If the ordinary shares distributed to the bondholders are registered, it is necessary, after their entry in the book of shareholders, that the issuer reflect the change of information on the account 101 *Fixed capital* analytical accounts for the new shareholders;

- After the option to convert the bonds into shares has already been exercised and the conversion feature of the bonds should be written off, it is appropriate to carry out a corresponding transformation on the kept analytical accounts to account 105 *Premiums, related to capital*, resp. account 115 *Premium reserve.*

In the event that, by the maturity date, the bondholders do not exercise their right to convert, the debt of the issuer (principal and regular interest payments) will be serviced normally, for which the standard accounting items related to the usual repayment of the bond loan should be drawn up. After the expiry of the conversion period, the conversion option is canceled due to its non-exercise, and with this option, it is necessary to draw up an accounting article to change the nature of the information on the relevant analytical accounts. This is explained by the fact that by not taking advantage of their right to convert, the bondholders in practice give up capital that they "donate" to the company through the conversion privilege carried by their bonds, unexercised until the maturity of the bonds. For this reason, for example, in the USA, the conversion right canceled at maturity is called "*Donated capital"*, but it can also be disclosed through other balance sheet items: *Additional paid-in capital*, *Capital surplus*, etc. (Epstein, Barry J. et al. 2002).

Unlike International Accounting Standards, US GAAP considers situations where, after the issuance of the convertible bonds, individual conditions of the conversion may be changed (modified). The use of "sweeteners" aims to stimulate bondholders to decide on the faster exercise of their conversion right, which in turn is related to reducing interest costs or optimizing the "debt/equity" ratio in the accounting of the issuer.

Modification of the terms of the conversion may include an increase in the exchange ratio (which in turn results in a reduction of the originally determined conversion price), additional issuance of warrants, options, and other equity derivatives, or the payment of cash or cash equivalents in addition to the conversion price.

The main accounting issue that can be defined here is what impact on the issuer's financial result the improvement of the conversion conditions has and when this impact should be reflected in the financial statements of the debtor. We believe that the debtor should recognize a financial result when the equity instruments granted in exchange for debt have a fair value at the time of the exchange other than the conversion price determined under the original conversion terms of the issue. In the event that the fair price of the shares provided in exchange is lower than the balance sheet (amortized according to IAS) value of the debt, a profit (income) should be recognized, and in the opposite case, a corresponding loss (expense).

3. Conclusion

The renewed interest in the hybrid financial instrument-convertible bond provokes the need to study it as a specific accounting object from the point of view of the issuing companies, including its characteristics, and the presence of different historically formed approaches for its current reporting and disclosure in the financial statements. The financial management team's decision to repay the bond loan by exercising the conversion privilege established as a clause in the bond indenture (deed of trust) most often rests on considerations related to an assessment of the features of the hybrid type of securities-convertible bonds. The accounting treatment of a convertible debt instrument is based on the specific conditions under which the instrument was originally issued and how the instrument is settled upon conversion. The hybrid nature of the convertible bond requires a non-traditional treatment of some usual costs accompanying the financial instrument under consideration, in particular the costs of the issue and the costs of interest payable by the issuer.

In response to the question*: of whether convertible debt securities should be treated by the issuer only as debt, or whether part of the proceeds received from the bond issue should be recognized as an element of equity* and regardless of the presence of two historically arising and opposing points of view, in the last more than 50 years, a significant harmonization of the understanding of the financial instrument under consideration has been found in the regulations of the leading accounting bodies FASB and IASB, accepting its hybridity and duality, requiring separate valuation, reporting, and disclosure.

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Repurchased own shares-asset or reduction in equity?

Petko ZAHARIEV[1]

[1] University of Economics, Varna, Bulgaria
petko_zahariev@ue-varna.bg

Abstract. The main goal of the study is to discuss the different points of view regarding repurchased own shares as a reporting object, emphasizing the author's opinion on this matter. Based on the study of different points of view advocated by the different accounting systems and in the system of European commercial law, the conclusion of ambiguity in their accounting treatment in a historical aspect is reached, and in conclusion, the capital approach is advocated as a modern and consistent one. The study is limited only to the accounting of corporations as stock issuers, as well as to the statutory regulations of only the two main accounting bodies-FASB and IASB. In the course of the research, special attention was also paid to the managerial and financial considerations motivating the act of share buyback, as well as to some limitations and disadvantages of this financial operation. The thesis advocates that the choice of option for reporting and presentation of the repurchased shares is largely based on the specifics of the relevant legal system (a continental or European (Romano-Germanic) legal family based on the continental legal system or a family of common law based on common (Anglo-Saxon) law and precedent and its relationship with the adopted accounting model. The study utilizes methods of observation, investigation, comparison, induction, and deduction, research and analysis of publications from the scientific community, as well as the relevant accounting regulations developed by the FASB and the IASB, and a number of sources of European commercial law. In a practical aspect the research would be useful for business practice, reflecting the importance of share buybacks by corporations both globally and nationally.

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1. Introduction

In general, it is considered that the acquisition of own shares by the company threatens both creditors and shareholders as it reduces the so-called internal property equivalent of one share (*book value*), which leads to a discrepancy between the size of the registered capital and the actual shareholder property. Therefore, the repurchase of own shares, regardless of the purpose pursued, is prohibited or restricted by some modern commercial laws (for example, British commercial law, see *Companies Act*, 2006, section 658). In Bulgaria, the repurchase of own shares is regulated mainly in Art. 187/a/-Art. 187/e/ of the Commercial Law and special provisions regarding the reduction of capital and the purchase of own shares by public companies are contained in the Law on the Public Offering of Securities.

Share buybacks have been a controversial topic in the US for a long time and even banned for half a century. During the severe economic crisis of the early 1930s, regulators banned such programs because they would manipulate the market. It was not until the deregulation of financial markets under US President Ronald Reagan, which in the view of Wall Street "broke the shackles" of the stock markets, that share buybacks were allowed in late 1982.

In 2023, companies are spending more than ever to buy back their own shares - this boosts share prices but increases debt. Markets currently suffer from a problem: there is far more money than opportunities to spend it. Increasingly, public corporations are solving this dilemma by simply buying back their own stock—often on credit. This tightens supply, allows stock prices to rise, and also increases Almost all companies finance their

expensive programs with bonds and thus, with debt. This trend is unlikely to change as long as corporate bond yields are lower than dividend yields. With each share withdrawn, corporations save money for dividends - and consistently - year after year and earnings per share (Investor.bg 2023).

Stock buybacks, once an American oddity, are taking the world by storm. It hit a global record in 2023 of $1.3 trillion, three times the amount 10 years ago (Manager.News 2023). Although US companies remain the biggest buyers, this type of transaction has quickly gained popularity in mainland Europe and the UK since the start of the pandemic. That's why US President Joe Biden included a new 1% tax on buybacks in last year's Inflation Reduction Act (IRA). Now he wants to quadruple it. And redemptions can be abused. When officials at the U.S. Securities and Exchange Commission (SEC) looked at buybacks in 2018, they found that insider selling increased immediately after the announcements, allowing executives to profit from rising stock prices. The SEC finally did something about it by creating a new rule that will require companies to disclose at the end of each quarter their daily share buybacks, why they did them, and whether executives bought or sold stock around the buyback (Investor.bg 2021).

The buyback of own shares is a popular financial operation among public companies in Bulgaria, which in recent years had a number of procedures for the buyback of own shares. Among them are "Neochim" AD, "Bulgarian Stock Exchange" AD, "Alterco" AD ("Shelley Group" AD), "Monbat" AD, "Sopharma" AD, "Industrial Holding Bulgaria" AD, "Albena" AD, "Agria Group Holding" AD, "Gradus" AD, "Trace Group Hold" AD, "Corado-Bulgaria" AD, "Stara Planina" Hold AD, "Sirma Group Holding" AD, "Lomsko Pivo" AD, "Sofia Commerce - Pawn Shops" JSC, and others (Darik Business Review 2023; Banker 2019).

The heightened interest in the repurchased own shares provokes the need to study it as a specific accounting object from the point of view of the issuing companies, including its characteristics, and the presence of different historically and geographically formed approaches for its current reporting and disclosure in the financial statements.

2. Literature review and implementation

2.1. Financial and managerial considerations motivating the buyback of own shares

Without claiming to be exhaustive, we believe that the buyback of own shares is dictated by a number of financial and management considerations, the most important of which are the following:

a) The purchase of shares by the company is the usual way, which is used to reduce the capital as a result of its size being unreasonably large;

b) In developed countries, corporations buy back packages of their shares to bring the value of the financial indicator "Earnings per share" within favorable limits and to increase the current market price of their shares in circulation. The announcement of a decision to buy back own shares is considered to sharply raise the current market price of all shares of the company in circulation. This reaction is traditionally explained by two reasons. On the one hand, it is due to investors' understanding that the company has foreseen future growth in its earnings that the market has not yet felt and will switch to financing from internal low-cost sources of financing (retained earnings and reserves), reducing its excess capital base. On the other hand, it can be judged that the company's shares are artificially undervalued for the purposes of the buyout, i.e., the internal property equivalent of a share does not correspond to the actual financial position, which is better than expressed in the current market prices at the time of redemption.

Regardless of the above, the data from buybacks in Bulgaria, analyzed by some authors (Valkov, P. 2016) leads to the conclusion that no strong dependence can be drawn between the movement of stock prices before the buyback launch period and the subsequent one-year period and that it cannot be said with certainty that the buyback procedures are related to the dividend policy of the individual companies.

c) The company with a favorable net cash position but with currently inadequate investment opportunities may buy back part of its shares, preferring this operation to the payment of dividends in the future. If it distributes the redeemed shares to the remaining old shareholders, the company will save its investors tax payments on cash dividend income, while also preserving a good liquidity position;

d) Small corporations usually resort to buybacks of their own shares to reduce the possibility of takeovers by rival companies through buyouts. The only reasonable way for a threatened company to protect itself from a takeover is to temporarily restrict third parties access to its shares on the free capital market through the buyout;

e) The company can buy back part of its own shares to form a treasury package to use in cases of business combination. In this case, the purchased block of own shares is considered a means of exchange when the payment for the transaction is made by counter-exchange of blocks of shares between the two companies;

f) The company may buy back its own shares to form a package for the purposes of various employee share ownership plans, to reward certain categories of employees. or to distribute it to existing shareholders in lieu of dividends.

2.2. Accounting treatment of the repurchased own shares

From an accounting point of view and according to the company's intention, the term "repurchased own shares" is considered in two aspects:

- as the equivalent of part of the shares in circulation, bought back to reduce the share capital;
- as a package of own shares that the company holds to use for various purposes (*treasury stock*).

The accounting treatment of repurchased own shares depends on the action of three variable factors related to the **choice of price**, **method of repurchase,** and **purpose** pursued with the act of repurchase:

- When the company believes that its shares are momentarily undervalued in the market, the most appropriate way to realize the buyout is by entering the market as an ordinary investor through an investment intermediary. In this case, the acquisition price of the treasury package will consist of two parts: the current market price of the purchased shares at the time of the operation and the expenses incurred in the purchase (the remuneration of the intermediary of the purchase and the like);
- The company can buy back part of its shares directly from the shareholders by offering them a redemption price containing a premium over the nominal value and rule - above the current market price;
- If the company's right to buy back part of its shares at a certain time and a certain price is stipulated in the articles of association, the redemption is carried out at this price, regardless of the current market quotation, but always close to it and never lower than the nominal value.

In connection with the purchase of own shares to reduce the share capital, almost all accounting systems do not provide for the purchased own shares to be reflected in a separate account, since, as a rule, after the purchase, they are almost immediately invalidated. The withdrawal of a certain number of shares from circulation is considered a return of the original equity investment and should be reflected in the nominal value of the shares repurchased and then canceled.

If the company decides to reduce its share capital through the redemption of shares with a redemption clause (*redeemable or callable stock /shares*), the redemption is carried out at the fixed purchase price, and since it is usually higher than the nominal value, the company must reflect this negative difference for it in one of the following ways:

a) The negative difference should be treated as a discount from issues or as a reduction of a previously reflected premium arising from the issue of the same class of shares. This option was advocated in Opinion №6 *Status of Accounting research bulletins*, APB, and earlier it was regulated by the provisions of the effective until 2001 National Chart of Accounts in Bulgaria;

b) To disclose the negative difference as a kind of capital loss (to be treated as a financial expense). The approach is adopted from British accounting theory and practice (*Companies Act 2006)*;

c) The difference to be distributed based on the percentage ratio between the purchased own shares and all shares in circulation at the time of the operation between the discount account and the financial expense account. This option is also perceived in Great Britain as an alternative.

Unlike share buybacks to reduce share capital, the accounting treatment of repurchased shares held as treasury or reserve of securities is significantly more complex. The difficulty comes from the indeterminacy of the concept of "repurchased own shares held as a reserve" and from the existence of two approaches to this concept.

The first approach is based on the understanding that the company cannot treat the repurchased own shares as its own assets. It is logically inconsistent to believe that by holding part of its shares for a long time, the company can announce an investment in itself, when in fact it is exactly the opposite - there is a reduction in net shareholder property. In this sense, the company cannot own a part of itself, much less exercise the rights carried by its own shares. Proceeding from this argument, logically excluding the transformation of the company into its part-shareholder, it should get rid of these shares by selling them or withdrawing them from circulation, reducing its basic capital.

The approach treating repurchased shares not as a real asset, an item of property but as a reduction in the net value of capital is prevalent in American accounting theory. In the spirit of this understanding, the purchased own shares should be disclosed not as an asset, but as a passive item in the balance sheet with a negative sign, regulating the size of the fixed capital. The specified method of disclosure was adopted through the effective 2002-2007 balance sheet scheme in Bulgaria as well. It is also currently advocated in some European countries, for example, Poland (*Commercial Corporate Code*, 2000).

While accepting the logic of the first approach, **a second approach** treats the repurchased treasury stock as a fully real asset. This view was adopted in the 1960s in the USA, in the recommended version of the balance sheet in Article 9 of the Fourth Council Directive 78/660/EEC of 25 July 1978 based on Article 54 (3) (g) of the Treaty on the annual accounts of certain types of companies (in force until 18.07.2013), in a number of European countries (Italy - *Civil Code*, Art. 2424; Luxembourg, Netherlands - Art. 385(5) of *the Civil Code and Manual for annual reporting RJ 240.107*; Ireland-*Companies Act*, 1986; *General Accounting Plan* of 1990 (PGC-90) and

Companies Act (Texto refunded de la layde sociedades anynimas, 1989; Denmark; France, etc.), as well as from the current balance scheme in Bulgaria. In support of this approach is the presence of a special account 512 *Purchased own shares* from group 51 *Short-term financial assets*[1], as according to some authors (Brezoeva, B. 2017), the mark must be used when the moment of the buyback of the shares and their invalidation (or sale) is not in the same accounting period.

It can be considered that, in a historical aspect, the approach is predominant in Bulgaria - it operated during the period 1991-2002, after 01.01.2008 and currently - according to the Bulgarian National Accounting Standard No. 1 *Presentation of financial Statements*, effective from 01.01.2008. Considered in this way, this reporting object should be disclosed in a separate active balance sheet item with the example name "Treasury shares".

If the repurchased shares are disclosed as an asset, the Second EEC Council directive on the formation, maintenance, and change of the capital of public limited liability companies (*Second Council Directive 77/91/ EEC*), 1976, art. 22, paragraph 1/b/ (in force until 03.12.2012) required the mirror creation with the same amount of non-distributable capital source (reserve) in the balance sheet. A similar understanding is advocated by the Fourth Directive of the EEC Council, through the balance scheme recommended in Article 9, and is practically applied through the legislation of individual European countries (Ireland, Luxembourg, Spain, Denmark, France, etc.).

The author believes that the approaches discussed above are not only historically but also geographically grounded. An argument in the opposite direction is a previous study by the author (Zahariev, 1995), in which, although in a more general sense, a close relationship between the various legal systems in the field of commercial law and the accounting regulations based on them is defined. Here we are talking about the two main legal systems: a continental or European (Romano-Germanic) legal family based on the continental legal system, which in turn was founded on Roman law, and a family of common law based on common (Anglo-Saxon) law and precedent. From this point of view, the approach of treating the repurchased shares as an asset, an element of property in the countries of the continental legal circle, is quite understandable, insofar as the spirit of continental commercial law is aimed at maximum protection of creditors by including in it non-real assets that in fact, they represent the exact opposite—a decrease in the net worth of capital. Of course, it is also explainable why the so-called capital approach is adopted in the accounting regulations of countries traditionally associated with legal family based on common (Anglo-Saxon) law and precedent.

In an international aspect, the capital approach is consistently advocated for the treatment of the considered reporting object. For example, according to IAS 32 *Financial instruments: Presentation* at the acquisition or subsequent sale of own capital instruments, any difference between the acquisition price (the book value) and the nominal value, in case of withdrawal from circulation and reduction of the fixed capital (resp. sale price, in case of resale) of the purchased shares is applied to the account of the own capital but not as a reduction of current financial result. For accounting purposes in this case, accounts 106 *Capital-related deductions*, 105 *Capital-related premiums*, or 115 *Premium reserve*, which are credited in the case of a positive difference and debited in the case of a negative one. According to FASB ASC 505-30-30-8 *Retirement of Treasury Shares*, an account *Additional contributed capital* (*Additional paid - in capital, Capital surplus, Capital in excess of par value*), allowing in the case of a shortfall in the account balance, the uncovered difference to be charged to retained earnings / resp. uncovered loss (Epstein, Barry J. et al 2022; U.S. GAAP Codification of accounting Standards, FASB-Codification Topic ASC 505-30 *Treasury Stock;* PwC, *Financing transactions* 2022). The amount the company may allocate for additional paid-in capital is determined by dividing the number of shares to be retired by the number of shares issued and shares outstanding on the date of retirement.

Some authors (Mary S. Hill, Richard P., George W. Ruch 2018) describe two methods of accounting for stock repurchases: (1) "treasury stock repurchases", in which the company holds the reacquired shares as treasury stock, and (2) "retirement repurchases", in which the company retires the reacquired shares. Specifically, when accounting for a stock repurchase as a retirement repurchase, the company reports any amount paid in excess of the original issuance price of the reacquired shares as a reduction of retained earnings. In contrast, when accounting for a stock repurchase as a treasury stock repurchase, the company reports the full amount paid as a reduction to total shareholders' equity as "treasury stock," which is a contra-equity account.

From his side, FASB ASC 505-30-30-8 *Retirement of Treasury shares* describes two acceptable methods of accounting for the excess of repurchase price over par or stated value when a corporation's stock is retired: Allocating the excess between additional paid-in capital and retained earnings or charging the excess entirely to retained earnings (Joanne M.Flood, Wiley 2015).

[1] For the purposes of the research, the numbers and names of accounts from the Sample Chart of Accounts, developed by the Department of accounting of Varna University of economics will be used.

When accounting for the costs related to the above transactions with capital instruments, the capital, not the cost approach is applied; these costs are accounted for as part of the transaction and are reflected in a reduction of equity, net of corporate tax (Hristov, V. 2015). Such treatment requires that the redemption costs be reflected in a separate regulatory capital account (for example, in account 106 *Capital- related deductions* or 107 *Expenses on the issue and repurchase of shares*), the balance of which should be indicated in a passive, decreasing item in the equity section of the balance sheet. In the presence of a created premium reserve, it is permissible for the costs of the buyout and the discounts during the buyout to be taken in full as a reduction of the reserve, regardless of its size. As a result of this operation, the premium reserve may also have a negative value, represented by a "minus" sign in the capital section of the balance sheet, although such a possibility is not foreseen according to the applicable national standards in the Republic of Bulgaria (Bulgarian National Accounting Standard No. 1 Presentation of Financial Statements, Item 15.6).

To satisfy the requirement to disclose the impact of the operation on the purchase of own shares on all categories of capital, *two options can be used to present* the costs of acquiring the own shares in the financial statement:

a) on the face of the balance sheet in a separate line, when it comes to the company's own shares, which is not a subsidiary;

b) disclosure in the notes to the financial statement, when it comes to expenses incurred by subsidiaries for the acquisition of the subsidiary's own shares.

In connection with the initial recognition of the repurchased own shares, two main approaches (methods) are known, differing in the methodology for determining the valuation when the repurchased shares are expensed in the relevant accounting account and in the way they are presented in the equity section of the balance sheet (Brezoeva, B. 2017):

- *Par value method*, in which the acquired repurchased shares are reported at nominal (or announced) value. This method is recommended when the repurchase of shares aims at a subsequent reduction of the share capital. In this case, the value of the repurchased shares, which have not been invalidated or sold at the end of the reporting period, is indicated as a negative amount in the adjusting balance sheet item "Treasured own shares" **below** the main balance sheet item "Fixed capital";

- *Cost method*, where treasury shares are accounted for at acquisition cost. This method is considered appropriate when shares are acquired to be sold back in the future. The value of the repurchased share package, not yet sold or canceled at the balance sheet date, is indicated in a separate adjusting balance sheet item **at the end** of the equity section of the balance sheet.

For the purposes of the buyback, a special reserve is created, which the Bulgarian Commercial Law calls "Share buyback reserve" - Art. 187/c/, Item 4, which is analogous to the so-called *Capital Redemption Reserve* from the British Companies Act 2006, Section 733. There are fundamentally different approaches to forming the reserve. For example, Art. 187/c/, Par. 4 of the Bulgarian Commercial law defines it as the sum of the nominal value of all purchased shares, while the British Companies Act 2006 recommends that this reserve be formed only when buying shares with a buyback clause, and its amount is defined as the difference between the proceeds of the new issue, intended to replace the repurchased treasury shares and the par value of the repurchased treasury shares.

Regardless of the adopted technique for determining its amount, the reserve is formed at the expense of retained earnings or other reserves with a general security purpose and can subsequently be used as follows:

- According to Article 187/c/ of the Bulgarian Commercial Law, the reserve can be distributed among the shareholders only in the case of a reduction of the capital with the purchased shares, as well as for the increase of the capital;

- According to the Companies Act 2006 of Great Britain, the reserve can be distributed as new additional shares.

For the first time Bulgarian National Accounting Standard No. 1 *Presentation of Financial Statements*, after its last substantial amendment in October 26,2007 regulates the mandatory indication of the amount of the reserve for repurchased own shares in the liabilities of the balance sheet, Article 2 of Group IV in the Section "A". We believe that such a regulatory arrangement is in full compliance with the changes in Art. 9 and Art. 10 of the Fourth Directive of the Council of the EEC (2006/43/EU) and is entirely in favor of information transparency and usefulness in the disclosure of this specific balance source.

3. Conclusion

The heightened interest in the repurchased own shares provokes the need to study it as a specific accounting object from the point of view of the issuing companies, including its characteristics, and the presence of different historically and geographically formed approaches for its current reporting and disclosure in the financial statements.

The buyback of shares is dictated by a number of financial and management considerations. The accounting treatment of repurchased own shares depends on the action of three variable factors related to the choice of price, method of repurchase, and purpose pursued with the act of repurchase.

From an accounting point of view and according to the company's intention, the term "repurchased own shares" is considered in two aspects: as the equivalent of part of the shares in circulation, bought back to reduce the share capital, and as a package of own shares that the company holds to use for various purposes (treasury stock).

Unlike share buybacks to reduce share capital, the accounting treatment of repurchased shares held as treasury or reserve of securities is more complex. The difficulty comes from the indeterminacy of the concept of "repurchased own shares held as a reserve" and from the existence of two approaches to this concept. The author believes that the approaches are not only historically but also geographically grounded. An argument in the opposite direction is that a close relationship between the various legal systems in the field of commercial law and the accounting regulations based on them is defined-a continental or European (Romano-Germanic) legal family and a family of common law based on common (Anglo-Saxon) law and precedent.

In connection with the initial recognition of the repurchased own shares, two main approaches (methods) are known, differing in the methodology for determining the valuation when the repurchased shares are expensed in the relevant accounting account and in the way they are presented in the equity section of the balance sheet: the "Par value method" and the "Cost method".

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Study of the quality of peaches, nectarines and apricots based on morphological characteristics

Sabka Pashova[1]

[1] University of Economics, Varna, Bulgaria
spashova@ue-varna.bg

Abstract. Fresh fruits (FFs) are nutritionally valuable and are a major part of consumers' daily diets. The requirements towards quality of FFs have been increasing in recent years, and this is provoked by the need to add FFs with certain characteristic of the respective type/variety, properties and nutritional value in the diet. The purpose of this study is to present the morphological characteristics and specific results of the experimental study, linking them with the requirements reflected in the regulatory documents and determining quality of FFs. The object of this study is stone FFs from three harvests 2021, 2022 and 2023: peaches (*Prunus persica*) - Red Haven variety, O'Henry variety; nectarines (*Prunus persica var. Nucipersica*) - Sun grand variety, Golden Grand variety; apricots (*Prunus armeniaca*) - Hungarian variety, Delmas variety, Roxana variety and Silistra compotna variety. The morphological characteristics - shape, weight and dimensions (length, height and width) of the fruits, stones and petioles separated from them are determined according to an established methodology. The results obtained from the measurements were averaged and the diameter of the largest cross-section was calculated. The result is compared with the requirements reflected in Ordinance 16, 2010 and Regulation 543/2011, and quality class of FFs is determined. The following conclusions are drawn on the basis of FFs morphological characteristics: 1. the weight, sizes of fruits, stones and petioles of each variety are determined.; 2. the FFs quality was determined: peaches variety Redhaven and variety O'Henry are *quality class Extra*; nectarines variety Sungrand and variety Goldengrand are *quality class Extra*; the apricots variety Hungarian, variety Roxana, variety Delmast and variety Silistra Compotna are *quality class Extra*. The focus of future work may be directed at: calculation of the number of wastes from the certain fruit variety that will be generated after their processing.; introduce the possibility to manage and use the separated wastes obtained after processing FFs.

Key words: stone fruits, dry fruits, frozen fruits, morphological characteristics, quality fruits
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1. Introduction

Fresh fruits are nutritionally valuable and are a major part of consumers' daily diets. They are used both for fresh consumption and for processing: drying, freezing, production: fruit (compotes) and fruit-sugar preserves (jams, jams, marmalades and jellies); fruit juices, nectars and mousses; highly alcoholic beverages (brandy, liqueurs, etc.) and as an additive to pastry, sugar and confectionery products. The composition of fresh fruits contains in balanced quantities, sugars, organic acids, phenolic substances, mineral salts, vitamins, aromatic and dyeing substances, which are specific to the individual representatives of the fruit, and their amount is determined by the variety, soil and climatic conditions, the proposed cultivation technology, etc.

The requirements of consumers for the quality of fresh fruits have been increasing in recent years, and this is provoked by the need to include fruits with characteristic of the respective type, properties and balanced nutritional value in their daily diet. The dynamic modern conditions, the competition of fresh fruits offered to consumers produced in Bulgaria and abroad, as well as the increased requirements for them on the markets in Europe and globally pose the current problems related to the quality, ecological and biological purity of fruits. The growing requirements for the quality of fresh fruits, as well as their increased consumption in conditions of global changes and crises, pose various problems related to investing more funds in the perennial crops sector in order to expand the scope of the sector, the production of fresh fruits and the development of an effectively

working system for their qualification. This necessitates the presentation of modern approaches to the methodology for research and evaluation of fruit quality.

In the scientific literature, there are separate studies in which the morphological characteristics of some varieties of apricots are presented, no similar studies have been found for peaches and nectarines. The researchers do not discuss and link the results of the studies of the morphological characteristics of fruits with the quality of fruits, mechanical composition and technological suitability of fruits for their intended use. There are no publications presenting a relationship between the results obtained after applying the morphological characteristic and the regulated requirements in the normative documents summarizing the quality of peaches, nectarines and apricots.

Therefore, the purpose of this study is to present the morphological characteristics and specific results of the experimental study, linking the results with the requirements reflected in the regulatory documents and determining the quality of the studied fruits.

The object of this study are fresh fruits - peaches, nectarines and apricots from three harvests 2021, 2022 and 2023: peaches (*Prunus persica*) with representatives of the Red Haven variety, the O'Henry variety; nectarines (*Prunus persica var. Nucipersica*) with representatives of the Sun grand variety, the Golden Grand variety; apricots (*Prunus armeniaca*) with representatives of the Hungarian variety, the Delmas variety, the Roxana variety and the Silistra compotna variety. This choice is dictated by the fact that these are fruit species with traditions in cultivation on the territory of our country, of great importance for the domestic and foreign markets, and the processing industry. Some of the studied varieties of the different representatives of peaches, nectarines and apricots are well known and preferred by consumers. The fruits in botanical ripeness, with typical size, shape, color and taste properties, were taken during the three years from the same producers from Northeastern Bulgaria, guaranteeing their variety. The fruits are well developed, without damage and have a satisfactory degree of ripeness.

The implementation of the formulated research goal presupposes the implementation of the following tasks:

1. To study the theoretical aspects regarding the origin, distribution, production, import and export of peaches, nectarines and apricots.
2. To study the quality of some important varieties of peaches, nectarines and apricots, grown in our country and offered to consumers based on the morphological characteristics of the fruits.

Fresh fruits, depending on their structure, are divided into the following groups: seed fruits, stone fruits, berry berries, walnut fruits. The stone fruits of the genus *Prunus i*nclude the following: cherries (*Prunus avium L.*), sour cherries (*Prunus cerasus L.*), plums (*Prunus domestica*), peaches (*Prunus persica*), nectarines (*Prunus persica var. nucipersica*) and apricots (*Prunus armeniaca L.*). A specific feature of this group of fruits is that they are true, simple fruits, formed only by the pistil of the flowers. The pistil is apocarpene, formed by joining of the ends of the carpel. As a result, an abdominal suture (depression) is formed and observed on the abdominal side of the fruit. In the core of the fruit, in place of the seed chamber, characteristic of seed fruits, there is a single-chambered stone in which the seed (nut) is located (Iliev, Vitanov, Yoncheva, Belyakov, 1977; Vasilev, Georgiev, Belyakov, 1982; Mihaylov, 2006; Donchev, Pashova, Zlateva, 2011; Manganaris, Crisosto, 2020).

2. Literature review

2. 1. Origin of some types of stone fruits

The origin of stone fruits is systematized and presented consistently for some of the most preferred representatives by consumers, such as: peach, nectarine and apricot.

Peach. The peach belongs to the genus *Persica*, this fruit species has been known since antiquity, and it is believed that its origin is from China, and not from Persia, where its Latin name originated. Initially, the fruits of the peach were brought to Central Asia and the Mediterranean, and now it is grown on all continents, with the exception of tropical zones. On the territory of our country, the peach was imported even before the New Era. As an industrial fruit crop in Bulgaria, the peach began to be grown after 1950, and over the years its areas have been dynamically expanding. Plantations are created in different regions of the country, with the exception of the higher semi-mountainous and mountainous regions, where the conditions are unsuitable for its cultivation. Bulgaria is located in the southern parts of the temperate climatic zone, where there are very good conditions for growing the peach, and it is an economically very important crop for our country (Petrov, Grigorov, 1981; Ferguson, Hldelorand, Hespendheild, 1987; Mikhailov, 2006).

Nectarine. Nectarine (Prunus persica var. nucipersica) is a variety of peach (Prunus persica) originating in China, which in the past was called the Persian plum. The fruit of the nectarine is smaller in size and mass than that of the peach, another characteristic feature of them is that they have a smooth, not hairy skin, which makes them a preferred fruit by consumers. In the scientific literature, there are two hypotheses about the origin of

nectarine. According to the first, nectarine arose through a mutation from a common peach, and according to the second, they are a separate species, different from peaches (Zhivondov, 1985; Siddiq, Liavoga, Greiby, 2012; Manganaris, Crisosto, 2020).

Apricot. *Prunus armeniaca*, known as the *golden egg of the sun*, grows in colder and drier temperate climates around the world (Leccese, Bartolini, Viti, 2007; Hacıseferoğulları, Gezer, Özcan, MuratAsma, 2007). Information about the origin of the apricot is lost in the distant prehistoric eras. It is believed that the homeland of this fruit species is Southeast Asia with the center of Northern China. In addition to this region, apricot is widespread in wild state already in eastern Tibet, Alma Ata and Central Asia, and this gives scientists reason to believe that this is another center of its origin (Ivanova, 2006; Ali, Mehdi, Lakdan, Dolkar, Stanzen, Singh, Hussain, 2018). According to a group of researchers, the Japanese apricot (*Prunus mume Sieb. et. Zucc*.), also known as Ume, is used for food and as a medicinal product in East Asian countries (Horinishi, Toyama, Watanabe, Ayano, Ozaki, 2022). Apricot kernels found during excavations in Armenia, dating back to ancient times, are grounds to believe that Armenia is also one of the centers associated with the origin of this fruit species (Donev, 2015). This is the reason why the common apricot receives the Latin name Armenica. According to some sources, the traditions associated with the cultivation of apricots in Anatolia date back nearly 2000 years (Asma, 2015).

Later, the apricot was brought to Greece, and from there it spread to other Mediterranean countries and parts of Europe (Malinov, 2003; Khadari, Krichen, Lambert, Marrakchi, Audergon, 2006). In America, apricot became famous in the XVII-XVIII centuries. It was brought by colonizers to South Africa and South America, but did not spread to these areas. It is believed that the apricot penetrated into Bulgaria from Greece (Iliev, Tsolov, Nikolov, Marinov, Babayashev, Belyakov, Karov, Angelova, 1983; Mihaylov, 2006; Manganaris, Crisosto, 2020).

Apricots are an important fruit crop and nutritionally valuable for humans. They are fruits of high nutritional value, as they are rich in polyphenols, vitamins and carotenoids. The fruit is consumed fresh or dried, but is used to make fruit juices, nectars and preserves (Moustafa, Cross, 2019; Dragovic-Uzelac, Levaj, Mrkic, Bursac, Boras, 2007; Taylor, 2008).

a. **Distribution, production, import and export of peaches, nectarines and apricots**

In recent years, there has been an increase in the production and consumption of peaches, nectarines and apricots, and this is probably due to the awareness of consumers about their nutritional value and their beneficial effect on human tone and health, as they are rich in useful substances polyphenols (anthocyanins and hydroxy acids), sugars, vitamins, minerals, etc. (Manganaris, Crisosto, 2020).

The main producers of peaches, nectarines and apricots worldwide are: peaches and nectarines - China, Spain and Italy, apricots - Turkey, Uzbekistan and Iran (Agry.bg, 2018; Moustafa, Cross, 2019; FAO, 2023; Ricardo-Rodrigues, Laranjo, Elias, Agulheiro-Santos, 2023). In recent decades, Turkey has been among the first producers of fresh and dried apricots in the world (Money.bg, 2018; FAO, 2023).

In the EU, the largest producers of peaches, nectarines and apricots are: peaches and nectarines – Spain, Italy and Greece, apricots – France, Italy and Spain (Ivanova, Popov, 2017; FAO, 2023, Cirillo, De Luca, Izzo, Cepparulo, Graziani, Ritieni, Romano, Di Vaio, 2023).

In Bulgaria, separate fruit growing regions are located, which are in different districts, and only the total area of the plantations varies. The state of fruit growing in the country depends on many natural and socio-economic factors, among them are the lack of sufficient funds and investments for consolidation, the introduction of new production technologies, as well as the obsolescence of existing plantations and insufficient funds for the creation of new plantations (Djouvinov, Vitanova, 2002; Mladenova, Georgieva, Serbezova, 2017; Kabadzhova, 2022).

On the territory of our country the soil and climate conditions are favorable for the cultivation and production of high-quality peaches, nectarines and apricots, competitive both on the domestic market and for export. The production of *peaches and nectarines* is concentrated in the following regions: Southeastern, North Central, Northeastern and Southwestern. In the regions presented, the average yield of peaches from the 2022 harvest is 10 537 kg/ha, 8 815 kg/ha, 7 699 kg/ha and 7 535 kg/ha, respectively. The concentration of apricot and zarzales production in Bulgaria is localized in the following regions: North Central, Southeast, Northeast and Northwest. In the presented regions, the average yield of apricots from the 2022 harvest is respectively – 6,517 kg/ha, 6,444 kg/ha, 4,975 kg/ha and 4,609 kg/ha (Fruit production in Bulgaria – harvest, 2022; Slavova, Ivanova, 2022).

In 2021, 202,579 tons of fruit were produced on farms, which is 13.6% less on an annual basis. Compared to 2019, in 2020 and 2021 there was a decrease in the produced quantities of peaches, nectarines, apricots and zarzales, in tons. Compared to 2020, in 2021 there was a significant increase in the produced quantities of apricots and zarzales. The harvested quantities of peaches and nectarines were also significantly higher by 958

tons in 2021 (Agrarian Report, 2020; Agrarian Report, 2021; Agrarian Report 2022; Agrarian Report, 2023) (table 1).

Table 1.

Production of some stone fruits
from harvest 2019, 2020, 2021 and 2022

№	Fruit crops	Average yield (kg/ha)				Production (tons)			
		2019	2020	2021	2022	2019	2020	2021	2022
1.	Peaches and nectarines	10 541	7 474	8 117	9 547	33 878	20 740	21 698	24 182
2.	Apricots and zarzales	6 957	5 177	6 754	6 245	20 244	9 516	20 701	19 040

Source: Annual Report on the State and Development of Agriculture (Agrarian Report '2020; Agrarian Report '2021; Agrarian Report '2022; Agrarian Report '2023), Ministry of Agriculture and Agriculture, Agrostatistics Department

The South-Eastern and South-Central regions have the highest share in the quantity of fruits produced, forming 26,5% and 23,3% of the total production for 2021, respectively, with the production of peaches and nectarines prevailing in the South-Eastern region (65,5%). In the North Central region, 84,7% of the apricots in our country are produced. In 2021, an increase in the average yields of apricots and zarzals by 30,5% was reported, and for peaches and nectarines it was by 8.6% (Agricultural Report, 2022).

The average yields from the 2022 harvest of peaches and nectarines are higher by 17,6% compared to the 2021 harvest. A total of 97% of the fruits produced from the 2022 harvest were sold, with the highest share of production intended for direct sales, including export and in the commercial network - 52%, and the directed quantities for processing were 41%. The lowest is the share of production for own consumption on the farm – 7% (Fruit production in Bulgaria – harvest 2022; Situation on the market of fresh fruits and vegetables in Bulgaria, 2023).

A significant part of the stone fruits produced in Bulgaria are intended for sale and export outside the country. In this regard, in order to provide a quality product to consumers, it is necessary to comply with the requirements for manufacturers, traders and economic operators. Studies have shown that the consumption of imported peaches is decreasing significantly worldwide, mainly due to consumer dissatisfaction, according to which the fruits offered commercially are tasteless and have an uncharacteristic consistency. The main reason for this is that the fruits are harvested before they are fully ripe so that the properties of the fruits can be preserved during logistics operations (Minas, Tanou, Molassiotis, 2018).

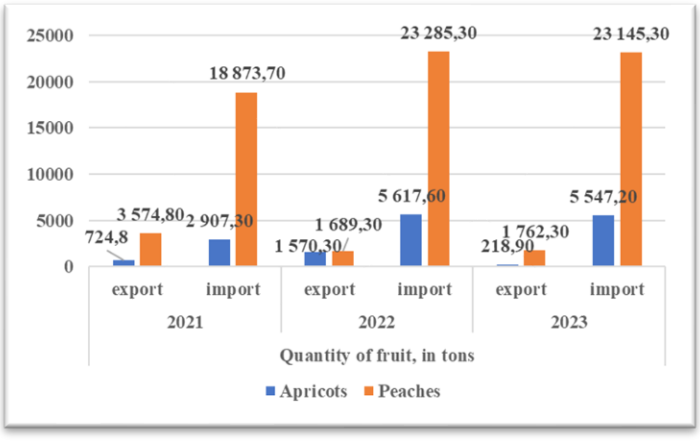

Figure 1. Import and export of peaches and apricots, in tones, to/from Bulgaria in the period 2021-2023

Source: Reference "Import/export of basic fresh fruits and vegetables to Bulgaria in the period 2021 – February 2023; Reference "Import/export of basic fresh fruits and vegetables in Bulgaria in the period 2022 – January 2024

In the period 2021-2023, the quantity, in tons, of imported peaches and apricots in our country is higher than that of exported fruits of domestic production (fig. 1). The highest share of peaches exported from Bulgaria was in 2021, and they were mainly destined for the market of Romania, Belarus, Italy, Spain, Poland and the Netherlands. In 2022, the export of peaches decreased by 1,885.5 tons, and in 2023 the decrease in exports was by 1,812.50 tons.

Imports of peaches and apricots were highest in 2022, with imported fruits coming from Greece, Turkey, North Macedonia, Germany and Spain. In 2021 and 2023, imports of peaches and apricots were lower compared to 2022 (fig. 1) (Reference Import/export of basic fresh fruits and vegetables in Bulgaria in the period 2021 – February 2023, by products and countries; Bulgarian Industrial Association, 2023; Situation on the market of fresh fruits and vegetables in Bulgaria, 2023; Beltramo, Bast, Diliën, de Boer, 2023).

In 2022, there was an increase in the production of peaches and nectarines by 2 484 tones and a decrease in the produced quantities of apricots and nectarines by 1 661 tones compared to 2021. in tones are the highest (table 1). The Bulgarian average annual export of stone fruits in tones is lower than the imports of these fruits (fig. 1). This is evidence of significant changes in production, logistics, trade and traditional ideas about the sector. It faces some important challenges related to the entry of new varieties and species, the opening of new markets, changes in consumer behavior and preferences, etc. Therefore, a critical analysis of the problems in the fruit growing sector is needed in order to identify specific activities aimed at developing and restoring the traditions in the cultivation and production of quality stone fruits intended for consumers in our country and abroad.

Until the onset of democratic changes, Bulgaria was popular as a producer and exporter of apricots, peaches and products from their processing. The economic changes that have taken place since 1990 have adversely affected their production. A major problem is the untimely settlement of the ownership and the way of management of the established plantations, and this leads to the abandonment of perennial crops. As a result, most of them are in poor condition, and another significant part is completely destroyed. The restoration of industrial production of these important fruit crops, which have been proven to have favorable soil and climatic conditions in different regions of our country, will be a very slow and lengthy process (Iliev, Tsolov, Nikolov, Marinov, Babayashev, Belyakov, Karov, Angelova, 1983; Mihaylov, 2006; Kabadzhova, 2022).

The study and analysis of the presented data are evidence that in recent years the production, in tons, of apricots, zarzals, peaches and nectarines has slightly increased. In the period 2021-2023, the number of imported peaches and apricots is higher than that of exported fruits produced in Bulgaria. This is proof that small quantities of fresh fruits produced in Bulgaria are exported, and consumers in our country are offered mainly fresh fruits from imports.

The presented literature review shows that in the studied studies in the field of use properties and quality of peaches, nectarines and apricots, one or a combination of some of the following methods are used: a method for studying plant resources (the morphological characteristic of fruits is determined by applying biometric indicators for fruits and stones), an organoleptic (sensory) method and physicochemical methods. It is noteworthy that most often the composition of the fruit or individual components of it is examined. The rich composition is the basis for their definition as fruits preferred by: consumers for fresh consumption, the processing sector as a raw material for the production of fruit and fruit and sugar preserves, for freezing, for drying and for export (Butac, 2020).

In the studied literature, studies of the composition of individual representatives of stone fruits are most often found. Another group of researchers established the relationship between: morphological and biochemical changes in the fruits of some varieties of stone fruits – apricots (Abbas, Bakhsh, Sumrah, Hussain, Akhtar, 2016; Karatas, Ercisli, Bozhuyuk, 2021); the mechanical and chemical composition of the fruits of some varieties of apricots (Hacıseferoğulları, Gezer, Özcan, MuratAsma, 2007). Some researchers have investigated: the influence of rootstock on the mechanical and chemical composition of some stone fruits (Herrero, 1975); the influence of fruit size on the quality and composition of fruits (Iliev, Vassilev, Georgiev, Grigorov, Petrov, Yoncheva, Mondeshka, Nikolov, 1985); some physical, pomological properties and the composition of specific varieties of stone fruits – apricots (Drogoudi, Vemmos, Pantelidis, Petri, Tzoutzoukou, Karayiannis, 2008; Ahmadi, Fathollahzadeh, Mobli, 2008; Moustafa, Cross, 2019; Karatas, Ercisli, Bozhuyuk, 2021); the influence of the composition on the taste and aromatic properties of stone fruits - peaches (Zhang, peng Xi, wen Wei, yuan Shen, Ferguson, song Chen, 2011; Farcuh, Hopfer, 2023), apricots (Baccichet, Tagliabue, Linge, Tura, Chiozzotto, Bassi, Cirilli, 2023); the relationship between the morphological and biological characteristics of some varieties of stone fruits – apricots (Taiti, Vivaldo, Masi, Giordani, Nencetti, 2023); the differences between domestic and foreign apricot varieties, using detailed analyses of physical, pomological characteristics and biochemical properties of the fruit (Sarıdaş, Ağçam, Ünal, Akyıldız, Kargı, 2024).

The presented literature review shows that there are separate studies in which the morphological characteristics of some varieties of apricots are studied and described. The described results of the conducted

studies are very rarely related to the mechanical composition and technological suitability of the fruits for their intended use. There are no publications presenting a relationship between the results obtained after applying the morphological characteristic and binding the regulated requirements in the regulatory documents, deriving generalizations about the compliance with the requirements and the quality of peaches, nectarines and apricots.

From the studied specialized literature, we found that there are separate studies on the morphological characteristics of some varieties of peaches, nectarines and apricots, specific to the countries to which the individual researchers belong, but so far, no such approach has been presented and applied to assess the conformity and quality of fresh fruits. We believe that the applied approaches and methods for assessing some of the indicators of fresh fruits need some modern additions.

Therefore, an opportunity has been proposed to improve quality studies directly related to the results of morphological characterization. The presence in the scientific literature of some studies in the field of morphological characteristics, composition and some of the properties of peaches, nectarines and apricots is evidence of the relevance of the chosen problem, as well as the fact that researchers are actively working in this direction in different countries.

Despite the existing publications and data on these issues, many of them have not been fully researched:

There are no scientific publications proposing the relationship of the results obtained after applying the methodology for assessment of morphological characteristics with the requirements for the size and weight of fruits for the individual quality class, reflected in Ordinance 16, 2010 and Regulation 543, 2011. The results obtained from the conducted research are not bound to the requirements of modern normative documents and no generalizations are made by the authors about the quality of the studied fresh fruits. Therefore, we believe that the possibility of the following has not been sufficiently explored:

• On the applicability of a quality assessment and the relationship between the results obtained after the application of the morphological characteristic,

• After analysis and summary of the results, and comparison with the regulated requirements in the regulatory documents, to determine the compliance with the requirements and the quality of the tested fresh fruits.

A significant part of the studies carried out present results for one or several varieties of peaches, nectarines and apricots, and the studies are targeted and related to the study of some specific characteristics and properties of the fruits. To date, no approach has been developed, proposed and applied to assess the conformity and quality of fresh fruit based on morphological characteristics. Therefore, we consider it of interest to propose a systematic approach to the study of specific varieties of peaches, nectarines and apricots by morphological characteristics in order to determine the quality of the fruits. This, in turn, is the main argument for the development and conduct of experimental research on the problem, which is in line with the EU requirements, the problems of the circular economy, sustainable consumption and ensuring the quality of fresh fruits offered to consumers.

2.3. Method for determining the morphological characteristics of the fruits and the stone separated from them

The morphological characteristics of stone fruits include the sequential determination of the average size, mass of the fruits and the stones and stalks separated from them (Nedev, Grigorov, Baev, Serafimov, Strandzhev, Kavardzhikov, Lazarov, Nikolov, Dzhuvinov, Popov, Slavov, Iliev, Stoyanov, Kanev, Krinkov, Vishanska, Topchiyski, Petrova, 1980). The size and mass of the fruits are mainly influenced by the climate and the specifics of the region in which the particular variety is grown, as well as by the age, condition and load (amount of fruit) of the tree (Vassilev, Georgiev, Belyakov, 1982).

The morphological characteristics - shape, mass and dimensions (length, height and width) of the fruits and the stone separated from them are determined according to an established methodology (Nedev, Grigorov, Baev, Serafimov, Strandzhev, Kavardzhikov, Lazarov, Nikolov, Dzhuvinov, Popov, Slavov, Iliev, Stoyanov, Kanev, Krinkov, Vishanska, Topchiyski, Petrova, 1980). According to her, the measurements were made on three samples of 50 fruits, of each variety using a caliper and an analytical scale.

In stone fruits, four sides are distinguished: petiole (main), top, abdomen and dorsal. On the abdominal side there is an abdominal suture, which is the place of adhesion of the ends of the carpel. The measurements (also called diameters) of the fruits and the stones separated from them are three: length or height, in mm (the distance between the petiole and the top side), width, in mm (the largest distance between the two sides) and thickness, in mm (the largest distance between the abdomen and the dorsal side) (Iliev, Vitanov, Yoncheva, Belyakov, 1977; Nedev, Grigorov, Baev, Serafimov, Strandzhev, Kavardzhikov, Lazarov, Nikolov, Dzhuvinov, Popov, Slavov, Iliev, Stoyanov, Kanev, Krinkov, Vishanska, Topchiyski, Petrova, 1980). The results obtained from the measurements of the fruits were averaged and the diameter of the largest cross-section was calculated.

The result for the diameter of the largest cross-section is compared with the requirements reflected in Ordinance 16, 2010 and Regulation 543/2011, and the quality class of the fruit is determined.

According to the requirements for quality and compliance control of fresh fruits, only fruits of local production, which are for processing in the country, are not subject to control. According to the provisions reflected in Regulation 543/2011, the peaches, nectarines and apricots examined are classified according to the diameter of the largest cross-section in three quality classes: *Class Extra, Class I and Class II.*

In the case of *peaches and nectarines*, the size is determined by the diameter according to the largest cross-section of the fruit or by the mass of the fruit. The minimum size is: 56 mm or 85 g for Extra class; 51 mm or 65 g for Class I and Class II. In the case of *apricots*, the determination of the size is mandatory for class Extra, class I and class II (table 2).

Table 2.

Classification of peaches, nectarines and apricots by quality, according to the maximum cross-sectional diameter

Quality class	**Minimum diameter, in mm**	
	Peaches and nectarines	**Apricots**
Class Extra	56	35
Class I	51	30
Class II	51	under 30

Source: Ordinance 16, 2010, Regulation 543/2011

The mass of the fruit, stone and stalk separated from them is determined by an analytical balance with an accuracy of the third decimal place. The average result of the measurements obtained for each of the studied indicators (fruit mass, stone mass, peduncle mass) was calculated. The percentage ratio between the individual parts of the fruit (fruit flesh, stone and stalk), which is known in the scientific literature as the mechanical composition of the fruit, is determined.

The results of the morphological characteristics of the fruits present a complete description of the individual species and varieties (mass and size of the fruit, stones and petioles). The drupes and peduncles of the fruit represent a different part of the total mass of the fruit, with some varieties being relatively large and in other varieties it is smaller. Therefore, the percentage of fruit flesh: pits: stalks is controlled for different types and varieties of stone fruits and is extremely important in determining the purpose of the specific type and variety: for fresh consumption, as a raw material for the canning industry or for export.

The results obtained from the morphological characteristics of fruits are important in:

- *description and characteristics of the fruits of individual species and varieties;*
- *determination of the quality and purpose of the specific variety of fresh fruits for fresh consumption, import or export, and as a raw material for the processing industry;*
- *reduction of financial losses and realization of a positive effect from the use of the specific variety of fruits in the processing industry, for the production of fruit, fruit and sugar preserves, fruit juices, nectars, etc.;*
- *calculation of the expected amount of waste from the specific fruit variety (fruit flesh, skin, stone and stalk) that will be generated after their processing or culinary processing.*

3. Research the quality of peaches, nectarines and apricots based on morphological characteristics

3.1. Examination of the quality of peaches and nectarines

The morphological characteristics of the studied varieties of peaches and nectarines are presented in 2 tables and 6 figures.

Peaches of the Red haven variety are an American variety, widespread both in Bulgaria and around the world. The skin of the fruit is yellow-colored, and the stalk is firmly attached to the fruit.

The examined fruits are very large, and the established dimensions are: length 72,8 mm, width 77,9 mm, thickness 78,1 mm and weight 267,56 g. The stone is large, well separated from the fruit flesh and has dimensions of 39,0 mm long, 22,7 mm wide, 29,2 mm thick and weighing 12,95 g. It makes up 4,84% of the mass of the studied fruits (fig. 2 and fig. 3). The results obtained were confirmed by a group of researchers, according to them, the peach pit of this variety makes up 5-10% of the total mass of the fruit, and the composition of the nut was found to contain from 1,2 to 2,4% amygdalin (Bolarinwa, Orfila, Morgan, 2014; Lee, Oh, Shin, 2017).

The peaches of the studied variety have a cross-sectional diameter of 78,0 mm. Therefore, the peaches of the Redhaven variety meet the requirements for quality class Extra (Regulation 543/2011).

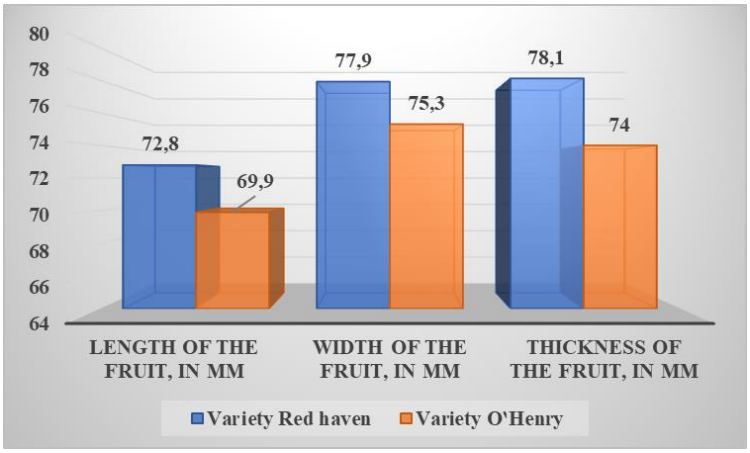

Figure 2. Dimensions of the fruits of Redhaven peaches and variety "O'Henry"
Source: Own research

Peaches of the O'Henry variety are large fruits, and the stalk is short, medium thick, firmly attached to the fruit. The skin is thick, the stone is large, easily separated from the fruit flesh. The fruits are used both for fresh consumption and for processing (canned fruits, fruit and sugar preserves, nectars, etc.). The examined fruits are even in shape and size. From the study carried out, it was found that the mass of the fruits was 201,32 g. The examined fruits were 69,9 mm long, 75,3 mm wide and 74,0 mm thick (fig. 2). The stalk is 8,1 mm long and is shorter than that of Redhaven peaches. The stone is large and well separated from the fruit with a mass of 9,79 g and is 4,86% of the mass of the fruit (fig. 3). The results obtained were confirmed by a group of researchers, according to them, the peach pit of this variety makes up 5-10% of the total mass of the fruit (Bolarinwa, Orfila, Morgan, 2014; Lee, Oh, Shin, 2017). The diameter of the fruit is 74.7 mm. The established morphological characteristics of peaches of the O'Henry variety classify the fruit as class E quality (Regulation 543, 2011).

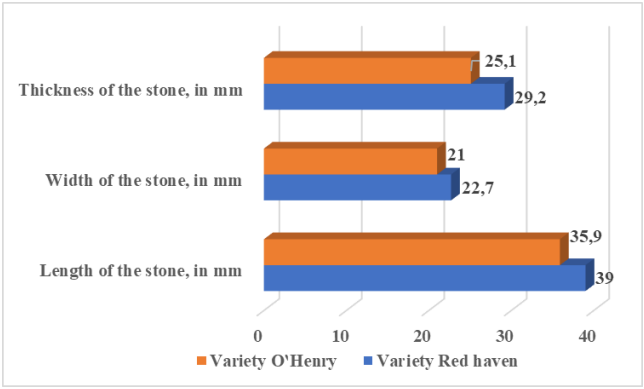

Figure 3. Stone dimensions of peaches varieties Redhaven and O'Henry
Source: Own research

The O'Henry peaches examined were smaller in width and thickness than the Redhaven peaches (fig. 2). This is probably due to the greater amount of fruit on the plants or is a specific species and varietal characteristic, and also influences the climatic conditions during fruit ripening (temperature, precipitation, etc.).

The summarized results for the mechanical composition of the two peach varieties studied are presented in fig. 4. From the fruit study, we found that the percentage of fruit flesh in the fruits of the two large-fruited varieties is the same, 95,1%. The average stone mass is higher for Redhaven peaches and lighter for the stone separated from the O'Henry variety by 3,16 g, respectively. Consequently, the proportion of stone and stem in the fruit of the O'Henry variety is higher than that of the Redhaven variety.

The summarized results are evidence that the fruits of the studied peach varieties, the pits and stalks separated from them have a typical shape and size characteristic of the respective variety. The fruits of the Redhaven peaches are the largest with a larger mass, the separated stone is larger, and the stalk mass is higher compared to the other peach variety studied (fig. 4.).

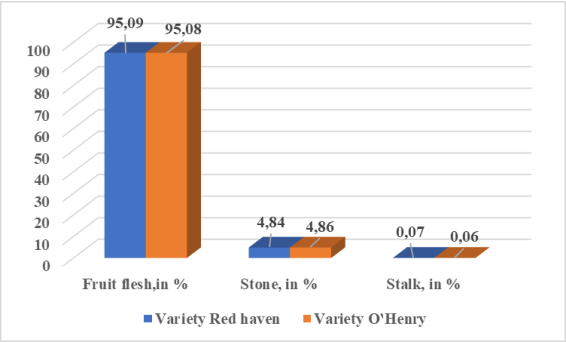

Figure 4. Mechanical composition of some varieties of peaches
Source: Own research

The results obtained (fig. 4) prove that in the case of Redhaven fruits: the percentage of fruit flesh is higher; the proportion of stone and stem is highest in the fruits of the O'Henry variety – 4,92%.

Based on the analysis and summaries of the results obtained, the following generalizations were made: the highest yield was for peaches of the Redhaven variety and the lowest was for peaches of the O'Henry variety. This is explained by the established high percentage of fruit meat (95,09%) and low percentage of stones and stalks – 4,91%. The mass and percentage of stones and petioles does not depend on the size of the fruit, but is a specific varietal feature of the studied fruits. We found that there were small differences in the studied peach varieties. This ratio of the individual parts of the mechanical composition of the fruit is controlled and taken into account when evaluating the fruits, determining the production yield and is an important element of the cost of the finished product (dried fruits, fruit, fruit and sugar preserves, etc.). Such studies are necessary in determining the effect of cultivation and in evaluating different varieties of peaches as raw materials for the processing industry.

The morphological characteristics of the studied peach varieties make it possible to determine the diameter of the cross-section of the fruit, which is set out in the regulatory documents. The results obtained were compared with the requirements and it was found that the *peaches of the Redhaven variety and of the O'Henry variety are of class Extra quality* (Regulation 543/2011).

Nectarines of the Sungrand variety are oval fruits, evenly covered with a dark red color. The fruit flesh is yellow, separating from the stone. The skin is medium thick, and the stone of the fruit is medium-sized. The fruits are large, measuring 73,6 mm long, 73,3 mm wide, 68,8 mm thick and weighing 216,728 g. The stone is medium-sized, well separated from the fruit flesh and has dimensions: length 41,1 mm, width 24,8 mm, thickness 29,6 mm and weight 11,376 g. It is 5,25% of the mass of the fruit variety under study (fig. 5 and fig. 6). It was found that the *diameter of the fruits was 71,1 mm*, therefore *the nectarines of the Sungrand variety are of class Extra quality* (Regulation 543/2011).

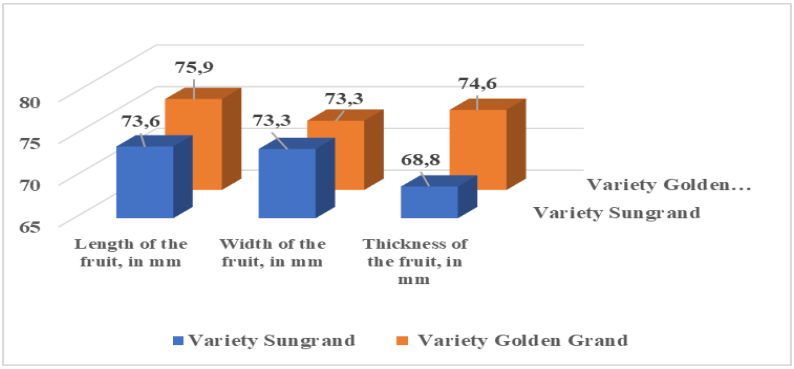

Figure 5. Fruit sizes of nectarines of variety Sungrand and variety Golden Grand
Source: Own research

The studied ***nectarines of the Golden Grand*** variety are large, oval fruits. The skin of the fruit is colored lemon yellow; the fruit flesh is well separated from the stone. The stone is medium-sized. The stalk of the fruit is short, firmly attached to the fruit.

Nectarines of the Golden Grand variety have an average mass of 230,230 g. The average mass of the stone is 13,064 g and it is 5,67% of the mass of the fruit. The studied fruits are 75,9 mm long, 73,30 mm wide and 74,6 mm thick. The length of the stem is 9,7 mm. The stone separated from the fruit is 46,2 mm long, 25,1 mm wide and 31,7 mm thick (fig. 6). The diameter of the fruits is 74,0 mm. The established morphological characteristics of the *nectarines of the Golden Grand variety* correspond to the requirements reflected in Regulation 543/2011 for *quality class Extra*.

The studied nectarines of the Golden Grand variety have a larger diameter (by 2,90 mm) compared to the fruits of the Sungrand variety. A probable reason for the identified differences in size is the specifics of varietal characteristics, growing conditions and the ripening period of fruits.

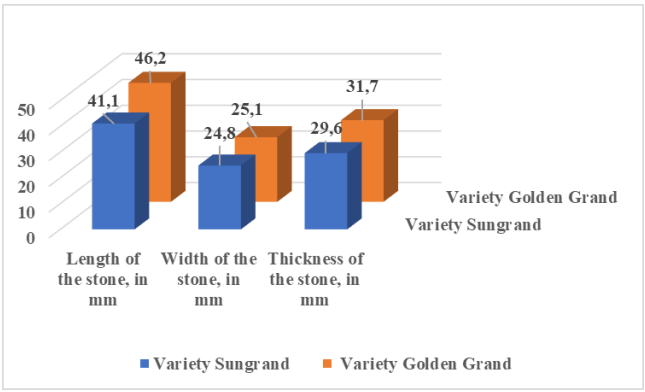

Figure 6. Stone dimensions of nectarines variety Sungrand and variety Golden Grand
Source: Own research

From the study of the two varieties of nectarines (fig. 5) we find that the fruits of the Golden Grand variety are larger. The average stone mass is higher in nectarines of the Golden Grand variety. The stone separated from the Sungrand variety is lighter by 1,688 g, respectively. From the data reflected in fig. 7, we find that the percentage of fruit meat in the fruits of the Sungrand variety is higher. In the fruits of the Golden Grand variety, the proportion of the stone and stalk is higher, compared to the nectarines of the Sungrand variety. After summarizing the results obtained, we found that the nectarines and the stone separated from them have a characteristic shape and size for the variety. The fruits of the nectarines of the Sungrand variety, the separated stone and the stalk have a lower mass compared to the other studied variety of nectarines.

The results of the study (fig. 7) prove that the percentage of fruit meat in Sungrand nectarines is higher. Therefore, the proportion of stone and stalk is higher in nectarines of the Golden Grand variety, being 5,73% of the fruit mass.

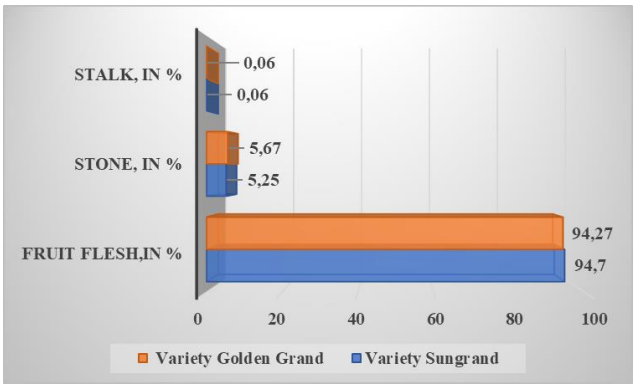

Figure 7. Mechanical composition of certain varieties of nectarines
Source: Own research

The nectarines of the Sungrand variety are lighter, and in the Golden Grand variety, the separated stone is larger and with a higher mass. After summarizing the results obtained, we came to the conclusion that the yield of Sungrand nectarines is higher. This is due to the higher percentage of fruit meat (fig. 7) and the low percentage of stone and stalk – 5,31%. In the case of nectarines of the Golden Grand variety, the yield is lower, due to the low percentage of fruit flesh and the higher percentage of stones and petioles separated from the fruit. The higher yield of nectarines of the Sungrand variety will determine the preferences of consumers and processors for this variety both for fresh consumption and for processing.

The morphological characteristics of the studied varieties of nectarines make it possible to determine the average diameter of the cross-section of the fruit. Based on the results obtained and the comparisons made with the requirements reflected in the regulatory documents, it was determined that the nectarines *variety Sungrand and variety Golden Grand* are *quality class Extra* (Regulation 543/2011).

In the studied literature, no similar studies have been found in which the relationship of the results of the morphological characteristics of the fruits with the requirements reflected in the regulatory framework for the varieties of peaches and nectarines studied by us has been presented, with which to compare the results obtained. We believe that such research is useful and necessary in the modern conditions of a market economy, because the quality of fresh fruits is a major requisite of the labeling and is the basis for the motivated choice of consumers. The morphological characteristics of the fruits provide a complete and complex assessment of the specific varieties of peaches and nectarines studied, and based on the mechanical composition of the fruits, an assessment is made of the purpose of the fruits and the effect of their use as a raw material for the processing industry.

3.2. Examination of the quality of apricots

The Hungarian Apricot variety is well distributed in Europe, it was imported to our country after the Liberation, the fruits are well known and preferred. Specific to them is that they are flat-spherical in shape, the skin of the fruits is medium thick, yellow-orange colored. The stalk of the fruit is fresh, firmly attached to the fruit. The stone is large and is 7,3% of the mass of the fruit, oval, with a rough surface. The nut separated from the stone is sweet with an average mass of 1 g.

The summarized results are presented sequentially for the fruit, stalk, drupe, and cross-sectional diameter of the examined fruits (fig. 8, fig. 9). The fruits of the studied apricot variety have an average weight of 54,56 g, medium-sized, with an average length, width and thickness of 47,7 mm, 44,7 mm, 48,6 mm, respectively. respectively 28,1 mm, 14,1 mm, 2,9 mm. The mass of the stone is 3,98 g and is 7,29% of the mass of the studied fruits. *The cross-sectional diameter of the fruit is 46,6 mm*, therefore, according to this indicator, the apricots of the Hungarian variety comply with the regulated *quality requirements of the Extra class* (Ordinance 16, 2010).

The studied variety Roxana is a Bulgarian variety, specific for the fruits is that they are large, with a rounded shape, and the stone is well separated from the fruit flesh and is 5,1% of the mass of the fruit. The fruit has an average weight of 67,26 g, with an average length, width and thickness of 58,7 mm, 50,5 mm, 51,2 mm, respectively. The stem is fresh, green in color and an average length of 6,0 mm. The stone is large, well separated from the fruit flesh, with an average length, width, thickness, respectively 32,8 mm, 13,5 mm, 25,8 mm. The average mass of the separated stones is 3,42 g and is 5,07% of the mass of the fruit. *The cross-sectional diameter* of the fruit is 50,9 mm (fig. 8, fig. 9), according to this size, *the apricots of the Roxana variety correspond to the quality requirements of the Extra class* (Ordinance 16, 2010).

Figure 8. Apricot fruit sizes from variety Hungarian, variety Roxana, variety Delmast and variety Silistra compotna
Source: Own research

Apricot Delmast is a French variety, the fruits are large, and the stalk is short, firmly attached to the fruit. The skin of the fruit is dark orange colored, the stone is oval, with a rough surface, medium-large, easily separated from the fruit flesh and is 6,4% of the mass of the fruit. The average mass of the fruit is 39,51 g, and the dimensions of length, width and thickness are 43,7 mm, 41,3 mm, 41,4 mm respectively (fig. 8). The stalk is fresh, 3,7 mm long, and is 2,30 mm and 1,19 mm shorter than that of the Roxana and Hungarian apricots. The stone is medium-sized, well separated from the fruit flesh with an average mass of 2,38 g and is 6,02% of the mass of the fruit (fig. 9). The cross-sectional diameter of the fruits of the studied variety is 41,3 mm. Based on the established results, the apricots of the Delmast variety are of *Extra quality* (Ordinance 16, 2010).

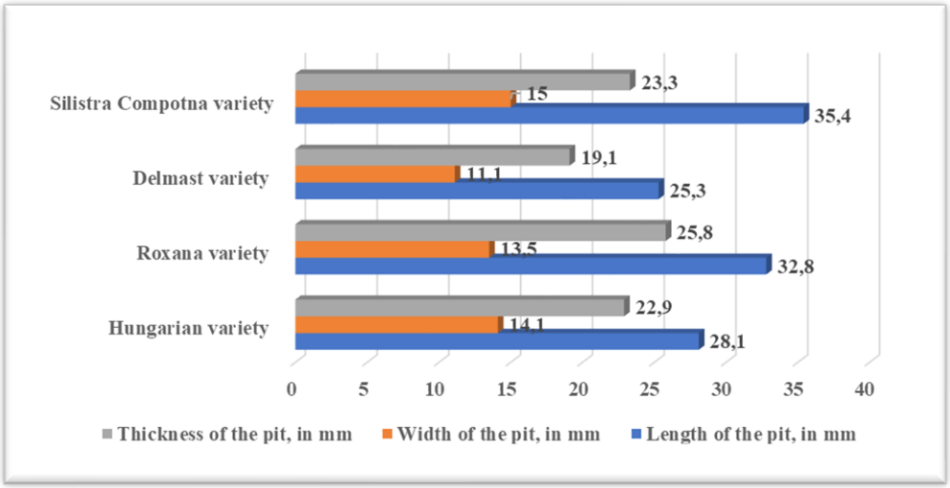

Figure 9. Apricot pit dimensions from the variety Hungarian, variety Roxana, variety Delmast and variety Silistra compotna
Source: Own research

The Apricot variety Silistra compotna is a Bulgarian variety. The fruits are large, globose, flattened on the sides, with symmetrical halves. The fruit flesh is orange, easily separated from the stone, and the nut is sweet. The fruits are medium-sized with an average weight of 65,12 g, flattened, of medium length, width and thickness, respectively 58,84 mm, 42,4 mm, 48,0 mm (fig. 8). The stalk is fresh, 5,9 mm long, shorter by 0,1 mm than in the Roxana variety and 1,0 mm and 2,2 mm longer than the fruit stalks in the Hungarian and Delmast varieties, respectively. The stone is large, well separated from the fruit flesh with an average weight of 4,08 g and makes up 5,68% of the mass of the fruit. The diameter of the fruits of the studied variety is 45,2 mm, therefore the apricots of the Silistra Compotna variety are of *Extra quality* (Ordinance 16, 2010).

The studied apricots of the Delmast variety have the smallest width and thickness compared to the apricots of the other varieties studied (fig. 8). This is probably due to the greater load of trees with fruits, and also influence the varietal characteristics and climatic conditions during fruit ripening (temperature, precipitation, etc.).

Figure 10 presents summarized results of the mechanical composition of the studied apricot varieties. From the conducted study, we found that the highest percentage of fruit flesh there is in apricots of the Delmast variety, and the percentage of stalks is lowest in apricots of the Silistra Compotna variety. The stone of the studied fruits has the highest percentage in the apricot's variety Hungarian, and the lowest in the variety Roxana. Therefore, the proportion of stone and stalk in the studied apricot varieties is highest in the fruits of the Hungarian variety (7,37%) and lowest in the Roxana variety (5,15%).

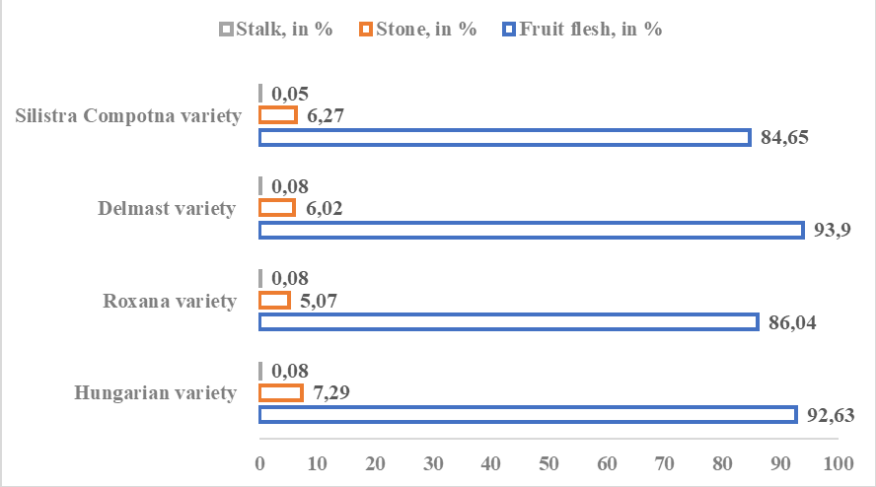

Figure 10. Mechanical composition of some varieties of apricots
Source: Own research

The results obtained from the study (fig. 10) prove that the percentage of fruit flesh is almost equal, with the fruit of the Delmast variety being 1,27% higher than that found in the Hungarian variety, and the lowest in the fruits of the Roxana variety. We found that the proportion of stone and stem is highest in the fruits of the Hungarian variety – 7,37%, and the lowest in the Roxana variety. After analyzing the results, we came to the conclusion that the highest yield of apricots of the Delmast variety and the lowest yield of the Silistra Compotna variety. The high yield of the Delmast variety is determined by the established high percentage of fruit meat (93,90%) and the low percentage of stones and stalks – 6,10%. The proportion of the individual parts of the mechanical composition of the fruit is controlled and taken into account when determining the market value of the fruit for fresh consumption and as a raw material for processing. The sweet nuts separated from the stone of the studied varieties of apricots are used in the production of confectionery, as substitutes for almond kernels.

The mass and percentage content of the stones and petioles does not depend on the size of the fruit, but is a specific species and varietal characteristic of the studied fruits. We found that there are differences in the studied varieties of apricots. This indicator determines the production yield and is an essential element of the cost of the products, such as dried fruits, fruit and fruit and sugar preserves. Such studies are necessary when determining the need and effect of growing a particular variety of apricots and when evaluating the fruits of different varieties of apricots as a raw material for the processing industry.

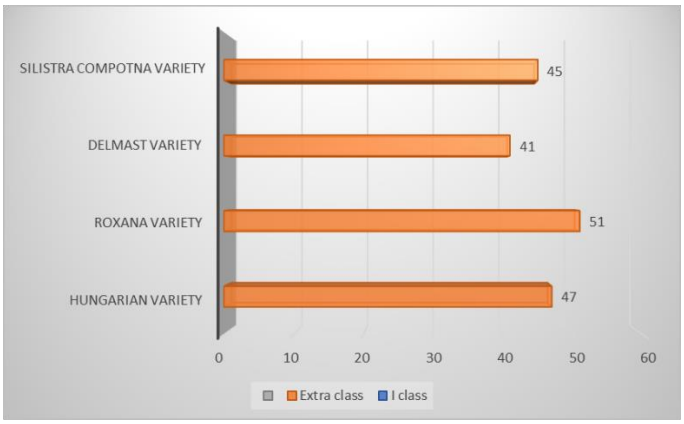

Figure 11. Cross-sectional diameter and quality of some variety's apricots
Source: Own research

From the morphological characteristics of the studied varieties of apricots, the diameter of the cross-section of the fruits is determined (fig. 11), laid down in the requirements laid down in the normative documents, and according to its values, the quality of the fruits is determined. After comparing the results obtained with the requirements reflected in the regulatory documents, we found that the apricots of the Hungarian variety, the Roxana variety, *the Delmast variety and the Silistra compotna variety are of Extra quality* (Ordinance 16, 2010).

In the studied literature, no studies have been found in which the relationship of the results of the morphological characteristics and mechanical composition of the fruits with the requirements reflected in the current regulatory framework for the varieties of apricots studied by us has been presented and analyzed, with which to compare the results obtained. Such studies are useful and necessary in the modern conditions of a market economy, because the quality of fresh fruits is extremely important, it is one of the mandatory requisites of the fruit labeling and last but not least it is the basis for the motivated choice of consumers when choosing and buying a specific variety of fresh fruits.

4. Conclusion

The study of the morphological characteristics of some varieties of peaches, nectarines and apricots gives us grounds to summarize that the high yield and high quality determine the advantages of the studied varieties of fruits. From the study we have found:

- The studied varieties of peaches, nectarines and apricots, the pit and stalks separated from them, have a typical shape and size. The diameter of the cross-section of fruits, set out in the normative documents, is determined and according to the values of this indicator, the quality of the examined varieties, peaches, nectarines and apricots, is *class Extra quality*.
- Based on the results of the morphological characteristics of the studied fruits, a complete, complex assessment (of fruits, stones and stalks) of the studied varieties of peaches, nectarines and apricots was made, and *on the basis of the mechanical composition of the fruits, an assessment was made of the purpose of the fruits and the effect of their use as a raw material for the processing industry*.

Based on the results obtained after the application of the proposed integrated approach for assessing the quality of certain varieties of stone fruits (peaches, nectarines and apricots), the following main conclusions can be drawn on the basis of morphological characteristics:

1. By means of the morphological characteristics of stone fruits, the mass, sizes of fruits, stones and petioles of individual varieties are determined. The results are extremely useful and serve to: classify the fruit (according to the size and mass of the fruit); determine quality of fruit; evaluation of the purpose of fruits for fresh consumption and as a raw material for the canning industry; determination of the yield of the respective stone fruit variety and based on the result, the economic effect of the use of the particular fruit variety as a raw material in the processing industry, for the production of fruit preserves, fruit and sugar preserves, nectars, dried fruits, etc., is calculated.

2. The quality of the examined stone fruits was determined by the diameter of the cross-section of the fruits, and after comparing the results with the requirements set out in the regulatory documents, it was established:
    - peaches variety Redhaven and variety O'Henry are *quality class Extra*;
    - nectarines variety Sungrand and variety Goldengrand are *quality class Extra*;
    - the apricots variety Hungarian, variety Roxana, variety Delmast and variety Silistra Compotna are *quality class Extra*.

In today's dynamically developing environment, the quality of fresh fruits (FFs) is extremely important for consumers, traders and processors of FFs. In recent years, the requirements for FFs and in particular for their freshness, composition, properties and quality have significantly increased. There are many and different factors (support for the production of FFs, length of supply chains, market organization, etc.) influencing the supply of quality raw materials to the market, retail chains and canneries and in particular quality fresh fruits.

With the conducted study, we prove the possibility of assessing the quality and the purpose of fresh fruits, by applying the complex approach to the morphological characteristics of fruits. The results of the morphological characteristics of the fruits should be compared with the requirements reflected in Ordinance 16, 2010 and Regulation 543/2011, and depending on the average diameter of the fruits, the quality of the fruits is determined. According to the requirements reflected in the regulatory documents, one of the requisites in the designations on the packaging of fresh fruits is quality class.

By carrying out a morphological characterization of fresh fruits, the aim is to determine the mass, size of the fruits, stones and petioles of individual varieties of fresh fruit. The results obtained are applicable in:

- writing the full description and characteristics of the studied variety of fresh fruits;
- the classification of fruits (according to the size and mass of fruits);
- determining the quality of the fruit;
- assessment of the purpose of the fruits, depending on their quality, for: the commercial network (fresh consumption), export, raw material for canning industry;
- calculation of the expected number of wastes from the specific fruit variety (skin, stone and stalk) that will be generated after their processing or culinary processing.
- determination of the yield of the respective stone fruit variety, and on the basis of the result, the effect of using the specific fruit variety as a raw material for the processing industry, for the production of fruit preserves, nectars, dried fruits, etc., is calculated. Through these calculations, financial losses can be reduced and a positive effect is realized from the use of a certain fruit variety in the processing industry.

The focus of future work may be directed at: calculation of the expected number of wastes from the certain fruit variety (by carrying out a morphological characterization of fresh fruits - skin, stone and stalk) that will be generated after their processing or culinary processing.; introduce the possibility to manage and use the separated wastes obtained after possessing of fresh fruits.

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