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AGRISCIENCE AND TECHNOLOGY

ARMENIAN NATIONAL AGRARIAN UNIVERSITY

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АГРОНАУКА И ТЕХНОЛОГИЯ

НАЦИОНАЛЬНЫЙ АГРАРНЫЙ УНИВЕРСИТЕТ АРМЕНИИ

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Հայաստանի ազգային ագրարային համալսարան

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Национальный аграрный униветситет Армении

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Determination of Normalized Difference Vegetation Index (NDVI) by Applying Disco-Pro AG Drones in Vineyards

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ABSTRACT

Reliable and up-to-date data on every soil segment of the land areas cultivated for the contemporary land utilization is of vital significance.

Currently, the efficient planning and control over the agricultural activities is hardly possible without any reliable and updated information on the yield and agricultural soil types, whereas implementation of drones in the field of land management and in agriculture, on the whole, is one of the most perspective directions, since unlike the artificial sattelites, they provide more precise and guided images for the given location.

The aim of the research is to produce the digital field model and NDVI map for the crops by applying Parrot Disco-Pro AG drone kit.

Introduction

Land is the most vital natural resource for any country; it is also the material base of production sector, spatial background of economic allocation and development, as well as the main source for agricultural production. Soil is the natural base on which people live and work. In this regard, the efficient use of land resources is one of the most paramount issues faced by any country; thus, retrieving land information is very important to handle the mentioned problem. The availability of comprehensive soil data enables to make the land resource management system more effective. Particularly, in recent years, related to the global climate changes, the rational land utilization has become the main problem for many countries. In case of Armenia, the mentioned issue is getting more exacerbated due to the scarcity of land resources (Efendyan, 2017). There are multiple cases related to irrational use of agricultural lands, such as large-scale deforestation, increase of the urban and mining land areas at the expense of agricultural lands, etc. Therefore, detailed information on the land resources is viewed as a high priority. Receiving such type of qualitative and quantitative information is possible only by applying the latest equipment and technologies (GIS systems, satellite positioning systems, pilotless vehicles/ drones) in the agricultural sector; besides, the mentioned technologies can be used for solving multiple agricultural problems, including those related to precision agriculture (satellite farming), soil monitoring, yield forecasting and ecological control (Efendyan, 2010).

Materials and methods

Parrot Disco-Pro AG drone (Figure 1) has been used for conducting monitoring in the vineyards of Van Ardi winery.

The Parrot Disco-Pro AG drone captures photo of about 80 ha land area during a single flight at 120 m altitude. The flight distance is 2 km and the average duration - 25-30 minutes. Parrot Sequoia multispectral sensor is installed on the mentioned drone, which is a system consisting of 5 cameras. One of them is a RGB camera and the other 4 are multispectral cameras, which capture the plant reflected light in 4 different specters: green, red and two infrared bands, which are invisible to the naked eye. The Sequoia has got its own GPS within the multispectral sensor, which considerably increases the survey accuracy (d'Oleiere Oltmanns, 2012).

The technical descriptors of light reflectance of Sequoia multispectral sensors are introduced in Table 1.

Sequoia is a powerful instrument for conducting research and introducing precision agriculture. After producing field maps based on the drone, satellite and laboratory data and by marking the descriptive data for every centimeter, the farmer gets an opportunity to allocate resources more efficiently.

Figure 1. Parrot Disco-Pro AG drone and Parrot Sequoia multispectral sensor.

Table 1. Technical descriptors of four bands in Sequoia multispectral sensors*

Band	Reflectance Wavelength, nm
Green	530-570
Red	640-680
Near infrared	730-740
Infrared	770-810

*Composed by the authors.

As a result, it becomes possible to avoid the resource overrun in the areas, where they were previously overused and to increase the productivity of the field plots where irrigation, cultivation and fertilization activities were formerly incomplete.

This approach can increase the yield amount per unit land area reducing the expenses and raising the yield capacity per square meter up to the maximum. Besides, this technology enables to increase the yield quality and reduce the environmental load. The precision agriculture is also based on the application of the maps with accurate field descriptions. There are surely cadastral maps for each field, where the land plot borders are marked, anyhow, they hardly contain any useful information for the organization of agricultural activities.

Along with the land borders also some precise data on the soil chemical composition, its humidity level (including the depth of underground waters), the amount of emitted solar radiation, the slope steepness against the horizon, as well as on the prevailing winds, forests, ponds and industrial objects are required. The more factors are considered and the more detailed maps are drawn, the more efficiently computer, drone and satellite technologies can be used (Efendyan and Hovhannisyan, 2018).

The application of such technologies will enable to optimize the consumption rates of raw products and materials (fuel, seeds, fertilizer, water, etc.) in the agricultural croplands, to increase the yield capacity of the cultivated land areas, as well as yield quality.

Conducting surveys over the agricultural croplands through drones has become widespread throughout the world for the last 5-6 years. The study and investigation of the received data by applying spectral sensors is becoming a commonplace day by day, while in Armenia there is still lack of practice for their application. Thus, the objective of the current work is to develop and introduce the mentioned technologies and their application ways in the Republic of Armenia considering the world practice, which is not possible without relevant experiments and scientific analyses. To this end it was planned to produce the digital field model and NDVI map for crops by applying Parrot Disco-Pro AG kit.

NDVI normalized difference vegetation index is a common indicator of the photosynthetically active biomass (usually called Vegetation Index) (Hovhannisyan, 2017).

This index is calculated through the following formula:

$$NDVI = \frac{NIR - RED}{NIR + RED},$$

where *NIR* is the reflection coefficient in the near-infrared band, *RED* is the reflection coefficient in the red spectrum/band.

The ratio of plant light absorption and reflection in the red (*RED*) and near-infrared (*NIR*) color bands is considered.

This index is actively used in agriculture for the solution of general-purpose tasks. The more exuberant the flora during the vegetation period is, the higher the mentioned index is. Thus, the value of *NDVI* index can identify the development level of the green mass throughout the vegetation period. The index of *NDVI* is a relative value and doesn't address the absolute value of leaves and green mass; anyhow based on this indicator it would be possible to provide robust assessments on how well or bad the plant is developing. *NDVI* index is changing throughout the whole plant growing period and its value is different in the growing, flowering and maturation phases of the plant (Mozgovoy and Kravets, 2009).

Results and discussions

The experiments were conducted twice a month in June and July, 2018. The area was video captured at 100 meter altitude.

Figure 2. Landing of Parrot Disco-Pro AG drone.

NDVI vegetation index enables to identify the problem/vulnerable land sites in quick and highly precise manners. With the map of vegetation index it would be possible to keep track of the vegetation process finding out whether it develops regularly or adversely through the identification of dried and diseased plants. When detecting the problem land segments it becomes possible to approach these sites with precise coordinates and to search out the disease cause. The reasons can be different starting from soil mechanical composition and its texture up to pests and diseases. Based on the retrieved data the field-related specialists take decisions and plan relevant measures.

After field activities, the data processing was implemented in the desk research through the corresponding software programs (Magnotta, 2015). In the result the digital field model was produced with 7 cm/px precision (Figure 3).

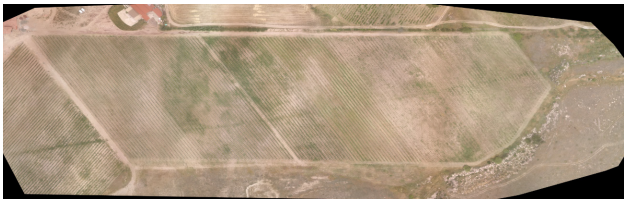

Figure 3. Digital field model.

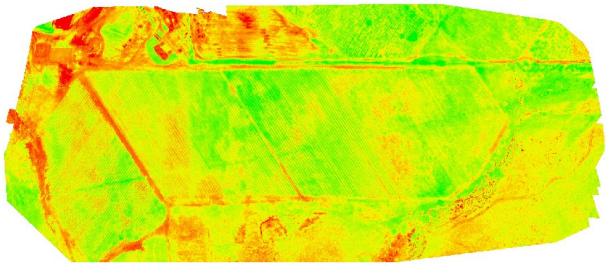

Figure 4. Digital NDVI model of the field for June.

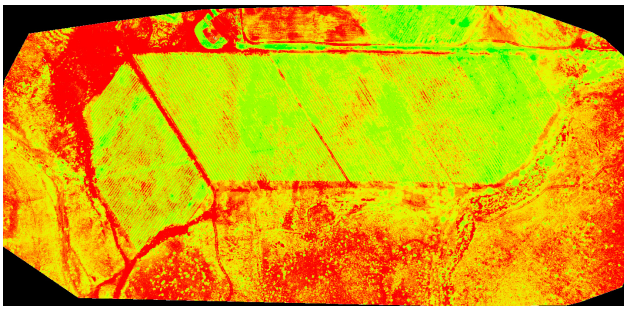

Figure 5. Digital NDVI model of the fields for July.

In the second stage NDVI digital model was produced (Figure 4, 5). Upon the color separation the field plots with dense vegetation and those where the vegetation growth has stopped or is completely missing, are clearly distinguished. The NDVI index of 0.85 has amounted to 0.9 within a month.

The vegetation maps composed through the spectral cameras enable to detect the pests or diseases at the early stage of their development, when the latter aren't visible with a naked eye and are not completely spread along the entire field, it is also possible to identify the focus of their

occurrence, if they are developed and penetrated from the neighboring lands.

It is possible to implement zoning in the produced maps by demarking the land sites, which need to be studied more comprehensively. Then these data with accurate and precise coordinates can be sent to farmers or agronomists.

Conclusion

The contemporary technologies, such as pilotless aerial vehicles (drones) can be of significant importance for the increase of agricultural productivity.

Since no agricultural crop monitoring with the spectral sensors installed in these drones has been implemented in Armenia yet, the studies and analyses conducted by our research group are somehow the starting steps for the implementation of the mentioned tools in the precision agriculture.

Application of drones in land management sector and in agriculture on the whole, is one of the most perspective directions for the use of these technologies. They enable to get up-to-date and effective data when required; besides the cached information for different time periods provides a wide opportunity to implement analyses on various procedures (Hovhannisyan, et al., 2018).

Due to the NDVI digital map it is possible to view the problem areas, where the vegetation is disturbed, as a result of which we can find quick and local solutions to the problems fixed in the mentioned areas.

So, the prospects of using drones in agriculture are diverse and they are continuously recording progress along with science development. Drone surveying is a new and developing technology in the agricultural sector, which can play a specific role in the development of the agriculture in Armenia.

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Theoretical Justification of Plant Stems Vibro-Cutting in Dense Environment

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ABSTRACT

The article considers the issue related to the disclosure of the reasons for the abrupt reduction of resistance force factors in case of plants stems vibro-cutting in dense medium through theory-based investigations.

The computation scheme of the liquid motion in the vicinity of vibro-blade has been recommended, which enabled to derive differential equation of the motion resulted under the impact of interaction forces between the vibro-blade and environment.

It has been proved, that the liquid in the vibro-blade vicinity is subjected to rapid damped oscillation, due to which the environmental resistance forces and the energy consumption rates are reduced in about 20 times against the same indices recorded in case of vibrationless cutting.

Introduction

In the previous three scientific reports (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020, Tarverdyan[3)], et al., 2020), the relevance and urgency of conducting comprehensive investigations on the plants stem cutting in the dense medium (water, soil) is thoroughly justified.

Particularly, the cleaning of reservoirs and canals from the cane-like and other water plants is an important issue. The practice of applying the current segmented-finger cutting apparatus has indicated that they aren't so much efficient for the use in aquatic environment.

In this regard rotary cutting apparatus are more preferable, anyhow, they haven't provided the desired results either (Tarverdyan, 1996, Tarverdyan, 2014, CSRIITE, 1978). The blade speed of the currently applied rotary cutting apparatus makes 30-50 m/s (Tarverdyan, 1996, Blinov, 1973); the mentioned speed generates such high resistance forces, which result in rapid reduction of rotation numbers in the rotors. In the result of investigations, it has been found out that the increase of the rotation numbers only in two times requires 5 times more power consumption (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020, Tarverdyan, 2014).

The attempts aimed at upgrading of cutting apparatus have been doomed to failure (CSRIITE, 1978); this means that the design of a completely new apparatus is the only way to handle the raised problem. Upon the results of long-term experiments on the plants stem (both thin- and stiff thick-stalked) cutting, it has been proved that it is possible to implement cutting in the dense environment with the minimum energy consumption using a vibro-blade which receives vibrational motion with low amplitude (2÷8 mm) and relatively higher frequency (30÷100 s^{-1}), while the rotation numbers transmitted to the rotor is relatively low making up to 1.0 s^{-1} (Tarverdyan, 1996, Tarverdyan, 2014, Altunyan, 2009).

The small rotation numbers in the rotor and, hence, the small circumferential velocities don't generate additional resistance forces in the dense environment, while the stem cutting resistance forces sharply drop down in the result of vibrational movements of the blades (Tarverdyan[1)], et al., 2020, Tarverdyan, 1996, Altunyan, 2009).

Materials and methods

Throughout the studies of field-related scientific literature no research work devoted to the theoretical research on the plant stems vibratory cutting in the dense medium has been ever found. To this end we have set a task to comprehensively study the vibro-cutting mechanisms in the dense environment and to try to reveal the causes for rapid reduction of vibro-blade resistance forces in the dense environment.

First, the plants stem vibrationless cutting in the water medium, and then cutting with vibratory blade movement in the same conditions have been considered. The solution to the first mentioned problem is thoroughly introduced in the first article of the current series (Tarverdyan[1)], et al., 2020), i.e., the cutting process of the cane stem in water environment with the blade of the rotary cutting apparatus without blade's vibration has been examined. A specific computational pattern has been selected and by using the well-known principles and laws of hydrodynamics (Milne-Thomson, 1964, Prandtl, 2000), all environmental resistance force factors affecting the blade have been determined. In the second stage of the problem solution, the vibratory cutting of the cane stems in water medium has been investigated (Tarverdyan[2)], et al., 2020).

Upon the experiments it has been asserted that it is relevant to implement the plants stem cutting in the dense medium along the mutually perpendicular directions of the blade cutting edge in conditions of balanced oscillations (Tarverdyan, 2014). So, to identify the specifics of vibro-cutting, the blade vibration mode should be chosen through the Elliptic law (Tarverdyan, 1996, Tarverdyan, 2014, Bolotin, 1978, Levendel, 1981). To disclose the effect of vibratory movement on the resistance forces of the water medium, a computation scheme has been selected (Tarverdyan[2)], at al., 2020) and an assumption has been made according to which the water mass within the range of elementary prism, shifts the movement direction during a single oscillation phase (the vibration frequency) resulted from the vibratory movement, and hence, the epure of the fluid motion velocities in the perpendicular directions of the blade sheet will look like the diagram introduced in Figure 1 a.

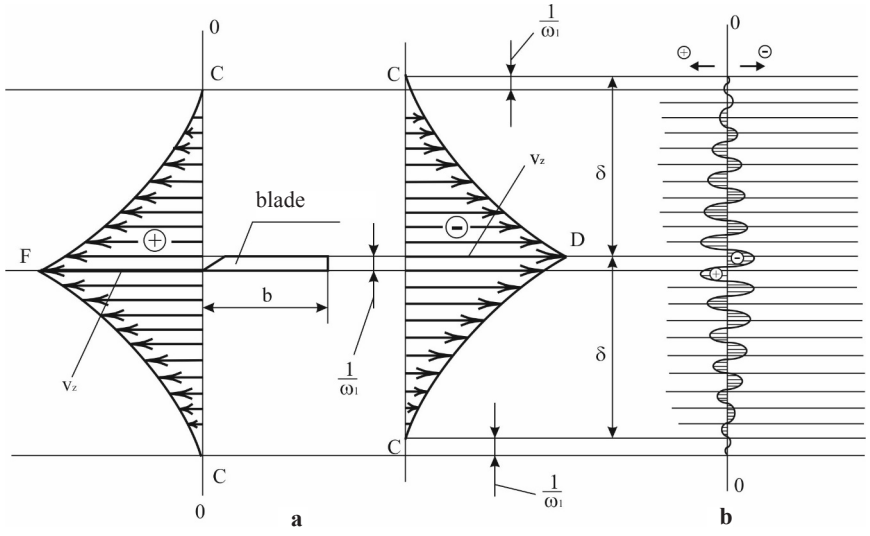

Figure 1. The epure of the fluid motion velocities in the vicinity of the vibro-blade moving in the liquid (*composed by the authors*).

The epure overview of the fluid particle velocities in the vicinity of vibro-blade is introduced in Figure 1b.

It is easily noticed that the total area of the summary epure can be practically assumed as zero, moreover, the higher vibration frequency is (ω_1,), the more reliable the abovementioned assumption becomes. So, if the volume of the vibration-driven moving liquid is practically equal to 0 (the area of the elementary prism base: $A \rightarrow 0$), then the moving liquid mass - $dm=0$ - and all the force factors (T_x and P_{in}), which are related to the mass flow of the moving liquid and generate resistance forces of the environment, are practically turned to 0 (Tarverdyan[2)], et al., 2020).

In case of vibration, from the resistance force factors in the blade movement, only resistance momentum is available, the value of which depends on forces (Tarverdyan[1)], et al., 2020), which is reduced in 10-35 times (Tarverdyan[2)], et al., 2020).

The recommended model and computation scheme for the problem solution have enabled to disclose the reasons for the abrupt decrease in the resistance forces of the water medium.

It is noteworthy that the received results are based on the abovementioned assumption and precise solution of the problem is of high priority, first, from the prospect of proving the assumption and then from that of revealing the specifics of vibro-cutting. Based on the afore stated and on the view of epure designed for the vertical water motion against the upper and lower vibro-blade sheets, it becomes logical to find the precise solution to the problem within the scope of the damped oscillation theory (Biderman, 1980).

As in previous cases (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020), here again, let's choose a design diagram which articulates the real state of the interactive forces in fluid motion, moving mass, vibro-blade and water environment and their regularities more accurately. When choosing the computation pattern (Figure 2), the well-known hydrodynamic provisions (Milne-Thomson, 1964, Prandtl, 2000) and the diagrams discussed in the previous works (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020) have been taken into account, the theoretical findings of which have been proved through scientific experiments with sufficient precision.

Since the rotational movement (shifting) of the blade hardly generates environmental resistance forces, which has been reasonably stated above, only vibration movement has been considered when designing the computation scheme.

The most significant difference against the previous schemes is that the fluid movement is performed only along the vibro-blade latitude b and longitude ℓ, since, as it has been already mentioned above, $\omega_0=0$. The letter designations of the values are the same as in the previous schemes (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020).

So, ω_0 is the rotor's rotation frequency, a_x is the oscillation amplitude along the length of the blade cutting edge, a_z is the oscillation amplitude perpendicular to the blade cutting edge, V_x is the vibration velocity towards the x axis ($V_x=a_x\omega_1 cos\omega_1 t$), V_z is the vibration velocity towards the z axis ($V_z=a_z\omega_1 sin\omega_1 t$), ω_1 is the vibration frequency in mutually perpendicular directions ($\omega_x=\omega_z=\omega_1$).

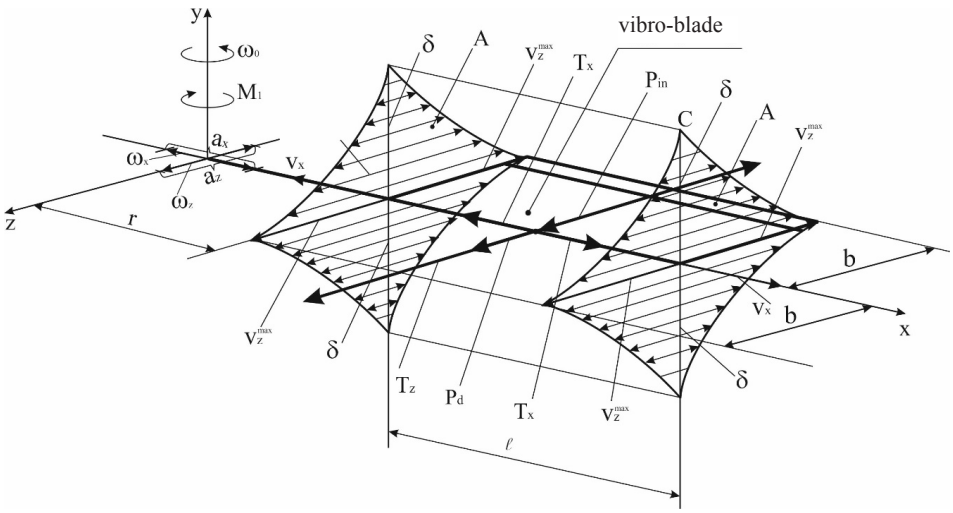

Figure 2. The computation scheme for the determination of the resistance forces in the vibro-blade movement of the cutting apparatus in water environment (*composed by the authors*).

In the considered case the liquid mass in movement will be:

$$M=A\cdot\ell\cdot\rho,$$

where A is the area of the prism built with four parabolic triangles $A=4\cdot\frac{1}{3}b\cdot\delta$, ρ is the liquid density.

By inserting we'll have:

$$M=\frac{4}{3}b\cdot\delta\cdot\ell\cdot\rho.$$

The interactive force factors of the moving fluid mass and vibro-blade are as follows (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020):

- Tangential resistance force towards the latitudinal direction of the vibro-blade sheet: T_z

$$T_z=6b\ell\sqrt{\mu\rho\omega_1}\frac{dz}{dt}.$$

- Tangential resistance force towards the longitudinal direction of the vibro-blade sheet: T_x

$$T_x=\frac{4}{3}\rho\omega_1\sqrt{\frac{vb\ell}{\omega_1}}\cdot\frac{2}{5}\ell\cdot\frac{dx}{d\ell}.$$

- Hydrodynamic resistance force, which is directed to the blade width vertical to the cutting edge: P_d.

$$P_d=c\cdot\lambda\cdot\rho\cdot\ell^2\cdot z.$$

- Inertia forces towards the Z and X axes: $P_{in(z)}$ and $P_{in(x)}$.

$$P_{in(z)}=\pm M\cdot\frac{d^2z}{dt^2},\qquad P_{in(x)}=\pm M\cdot\frac{d^2x}{dt^2}.$$

The letter designations and their numerical values in the above mentioned expressions are as follows for our problem: ρ is the environmental density (1000 kg/s^3, this and other values refer to water medium), μ is the viscosity coefficient (0.1 kg/m·s), v is the kinematic viscosity coefficient ($1\cdot10^{-6}$ m^2/s), c is the constant coefficient, it depend on the blade shape and sizes (in our case $c=1.45$ (Prandtl, 2000), b is the width of the blade sheet (0.03 m), ℓ is the length of the blade sheet (cutting edge) (0.3 m), λ is the thickness of the blade sheet (0.001 m).

Results and discussions

From the prospect of discussed problem the force factors, which are directed towards the Z axis and generate resistance moment against the rotor's shaft of applied cutting apparatus, whereupon the value of applied power is determined, are of primary interest. For the M mass of the liquid the Newton second law will look as follows:

$$M\frac{d^2z}{dt^2}=-M\frac{d^2z}{dt^2}-6b\ell\sqrt{\mu p\omega_1}\cdot\frac{dz}{dt}-c\cdot\lambda\cdot\omega_1^2\cdot p\cdot\ell^2\cdot z, \quad (1)$$

or by placing the M value we'll have:

$$\frac{8p\delta b\ell}{3}\cdot\frac{d^2z}{dt^2}+6b\ell\sqrt{\mu p\omega_1}\frac{dz}{dt}+c\cdot\lambda\cdot\omega_1^2\cdot p\cdot\ell^2\cdot z=0. \quad (2)$$

Here is the differential equation of the moving liquid mass, which enables to describe the damping oscillations in case of some parametric values.

It is worth mentioning that the expression of $6b\ell\sqrt{\mu\rho\omega_1}$ is the damping coefficient $\left[\frac{kg}{s}\right]$, and $c\cdot\lambda\cdot\omega_1^2\cdot\rho\cdot\ell^2$ is the coefficient of elastic resistance $\left[\frac{kg}{s^2}\right]$.

The expression (2) will look as follows:

$$\frac{d^2z}{dt^2}+\frac{9\sqrt{\mu\rho\omega_1}}{4\rho\delta}\cdot\frac{dz}{dt}+\frac{3c\cdot\lambda\cdot\omega_1^2\cdot\ell}{8\delta b}\cdot z=0. \quad (3)$$

In this expression μ, ρ, c, λ, ℓ, b are constant values, ω_1 and δ are also constant values in each considered case, anyhow, since one of the research objectives is the study of convergence just related to ω_1, then by assigning it with arbitrary values, we'll get the damping character and parameters within the identified range of the vibro-blade action (30÷100 s^{-1}).

The selected value for ω_1 determines the value of δ (the height of liquid strata in motion) (Tarverdyan[1)], et al., 2020, Tarverdyan[2)], et al., 2020):

$$\delta=\sqrt{\frac{\mu b}{V_z^{\max}}},$$

where $V_z^{\max}$ is the maximum value of vibration speed towards the latitudinal blade direction: $V_z^{\max}=a_z\cdot\omega_1$.

By inserting the numerical values of the constants in (3), we'll have:

$$\frac{d^2z}{dt^2}+7.5+10^{-3}\frac{\sqrt{\omega_1}}{\delta}\cdot\frac{dz}{dt}+1.813\cdot10^{-3}\cdot\frac{\omega_1^2}{\delta}\cdot z=0. \quad (4)$$

Let's assign:

$$m=7.5\cdot10^{-3}\frac{\sqrt{\omega_1}}{\delta}\text{ and }n=1.813\cdot10^{-3}\frac{\omega_1^2}{\delta}. \quad (5)$$

In each considered case, when ω_1 and consequently δ have certain values, m and n are constant and positive.

Let's find the solution of the differential equation (4) in the following form: $z(t)=e^{kt}$.

The descriptive equation will be:

$$k^2+mk+n=0. \quad (6)$$

For the oscillations to be convergent, the following term should be satisfied: $m^2-4n<0$.

In that case the equation (6) will have complex roots:

$$k_1=-\alpha+i\beta \text{ and } k_2=-\alpha-i\beta,$$

$$\frac{d^2z}{dt^2}+m\frac{dz}{dt}+n\cdot z=0.$$

The general solution of the equation will look as follows:

$$z(t)=e^{-\alpha t}(C_1\cos\beta t+C_2\sin\beta t),$$

where C_1 and C_2 constants are determined upon the following initial conditions: $z(0)=\alpha_1$ and $z'(0)=\beta_1$.

It is evident that for any C_1 and C_2 cases such A and φ values can be chosen so as to have the following:

$$C_1=A\sin\varphi,\quad C_2=A\cos\varphi,$$
$$A=\sqrt{C_1^2+C_2^2},\quad \varphi=arctg\frac{C_1}{C_2}. \quad (8)$$

The (7) expression can be presented in the following way:

$$z(t)=A\cdot e^{-\alpha t}(\sin\varphi\cos\beta t+\cos\varphi\sin\beta t)=Ae^{-\alpha t}\cdot\sin(\beta t+\varphi). \quad (9)$$

The (9) expression is the oscillation equation, the initial amplitude of which is A, and φ is the initial phase, which are determined through the (8) expression.

Let's determine the C_1 and C_2 constants.

From the term of $t=0$ it follows that $C_1=a_1$.

$$z'(t)=-\alpha\cdot e^{-\alpha t}(C_1\cos\beta t+C_2\sin\beta t)+$$
$$+e^{-\alpha t}\cdot(-\beta C_1\sin\beta t+\beta C_2\cos\beta t).$$
$$z'(0)=-\alpha C_1+\beta C_2=\beta_1,$$

wherefrom $C_2=\frac{\beta_1+a\cdot a_1}{\beta}$.

By placing in the (8) expression, we'll have:

$$A=\sqrt{a_1^2+\left(\frac{\beta_1+a\cdot a_1}{\beta}\right)^2},\quad \varphi=arctg\frac{a_1\cdot\beta}{\beta_1+a\cdot a_1}.$$

From the practical viewpoint the state of damped oscillation depending on fluctuation ω_1 frequency and the blade geometric parameters is of great significance.

Let's determine the C_1 and C_2 constants based on the initial terms relevant to our problem. At the beginning of the vibro-blade movement we have $(t=0)$, $z(0)=0$, from which it follows, that $C_1=\alpha_1=0$. The maximum oscillation velocity is in the point of $z=0$ therefore $z'(0)=V_z^{\max}\equiv(\beta_1)=c_2\cdot\beta$

wherefrom $C_2=\frac{V_z^{\max}}{\beta}$.

In case of initial parameters of our problem the equation of damped oscillation will take the following form:

$z(t)=C_2e^{-\alpha t}\cdot\sin\beta t$ or $z(t)=\frac{a_z\cdot\omega_1}{\beta}\cdot e^{-at}\cdot\sin\beta t$.

For each considered case it is necessary to determine α and β.

Let's consider the following options:

1. $\omega_1=30\ s^{-1}$: in this case

$$\delta_i=5.8\cdot10^{-3}\text{ m},\ V_z^{\max}=0.09\ \text{m/s},$$
$$m=7.5\cdot10^{-3}\frac{\sqrt{30}}{5.8\cdot10^{-3}}=7.08\ s^{-1},$$
$$n=1.813\cdot10^{-3}\cdot\frac{900}{5.8\cdot10^{-3}}=281\ s^{-2}.$$

The descriptive equation will be: $k_2+7.08k+281=0$.

$$k_{1,2}=-3.54\pm16.385i,\ \alpha=-3.54,\ \beta=16.385.$$

$$A=\frac{0.09}{16.385}=0.00549\quad m=0.549\text{ cm}.$$

The diagram of the damped oscillation function $z(t)=0.549e^{-3,54t}\cdot\sin(16.385t)$ is introduced in Figure 3.

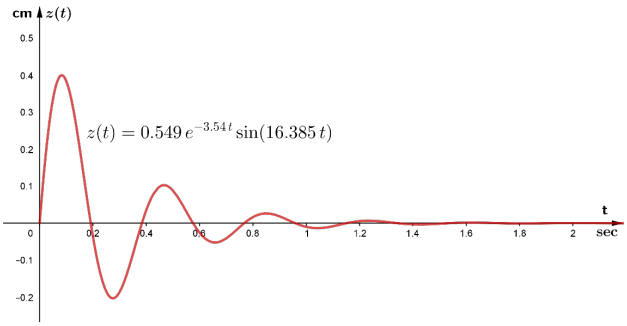

Figure 3. Diagram of $z(t)=0.549e^{-3,54t}\cdot\sin(16.385t)$ function. (*composed by the authors*).

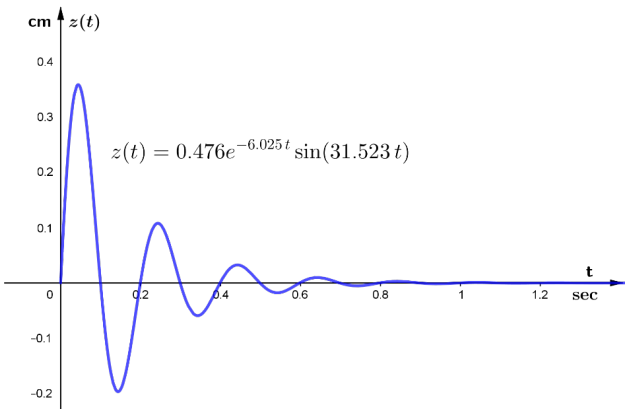

Figure 4. Diagram of $z(t)=0.476e^{-6.025t}\cdot sin(31.523t)$ function (*composed by the authors*).

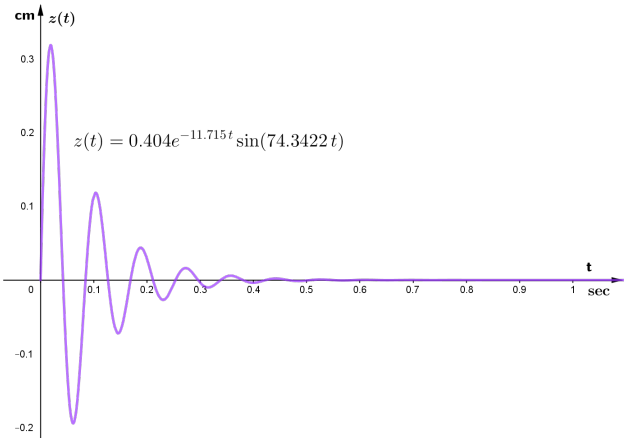

Figure 5. Diagram of $z(t)=0.404e^{-11.715t}\cdot sin(74.342t)$ function (*composed by the authors*).

2. ω_1=50 s^{-1}: in this case

$$\delta_i=4.4\cdot10^{-3}\text{ m},\quad V_z^{max}=0.15\text{ m/s},$$

$$m=12.05\ s^{-1},\quad n=1030\ s^{-2},\quad k_{1,2}=-6.025\pm3.523i,$$

$$\alpha=-6.025,\ \beta=31.523,\ A=0.476\text{ cm}.$$

The diagram of $z(t)=0.476e^{-6.025t}\cdot sin(31.523t)$ function is introduced in Figure 4.

3. ***ω_1=100 s^{-1}: in this case***

$$\delta_i=0.0032\text{ m},\quad V_z^{max}=0.3\text{ m/s}$$

$$m=23.43\ s^{-1},\quad n=5664\ s^{-2},$$

$$k_{1,2}=-11.71\pm74.342i,\quad \alpha=-11.715,$$

$$\beta=74.342,\ A=0.404\text{ cm}.$$

The diagram of $z(t)=0.404e^{-11.715t}\cdot sin(74.342t)$ function is introduced in Figure 5.

4. Let's also consider the effect of vibro-blade geometrical parameters on the convergence of oscillations. For the second variant ($\omega_1=50\ s^{-1}$) let's assume that $b=0.05$ m and $\lambda=0.002$ m. We'll have:

$$m=12.05\ s^{-1},\ n=1235\ s^{-2},$$

$$k_{1,2}=-6.025\pm34.622i,\ \alpha=-6.025,$$

$$\beta=34.622,\ A=0.433\ \ cm.$$

The diagram of $z(t)=0.433e^{-6.025t}\cdot sin(34.622t)$ function is introduced in Figure 6.

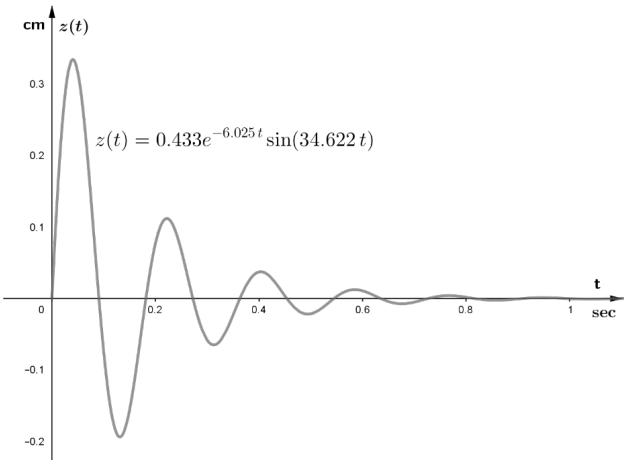

Figure 6. Diagram of $z(t)=0.433e^{-6.025t}\cdot sin(34.622t)$ function (*composed by the authors*).

Thus, based on the results of software solution of the equations and the oscillogram analyses, it can be stated that the water mass around the vibro-blade vicinity is subjected to fast damping oscillation in the water medium, which entails to the abrupt decrease in the environmental resistance forces.

Conclusion

Upon the precise problem solution the hypothesis that the fluid of the vibro-blade vicinity is subjected to the damped oscillation has been proved and justified; so the blade resistance forces in the dense medium are sharply reduced (10 ÷30 times).

The damping time of the oscillations (t) is inversely proportional to the vibro-blade oscillation frequency (ω_1). For example, if $\omega_1=30\ s^{-1}$, then $t=1.5\ s$ (Figure 3), if $\omega_1=50\ s^{-1}$, then $t=0.9\ s$, (Figure 4), if $\omega_1=100\ s^{-1}$, then $t=0.45\ s$ (Figure 5), which is quite logical and affirms the compatibility of background assumptions for the problem solution and the computation scheme with the real character of vibro-blade and water medium interactions.

The geometrical dimensions of the vibro-blade have no significant effect on the specifics and parameters of oscillation damping.

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Distribution of Static Deformations along the Friction Lining of the Brake Mechanism in the Cars of GAZelle Series

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ABSTRACT

The study of the shoe lining in the drum brake mechanism is of paramount importance to evaluate its wear regularity. Thereto, the computational scheme of the drum brake-shoe mechanism has been designed, the calculation formulae of tangential and radial components of the external points displacement in the lining have been analyzed, by means of which their numerical values have been determined, the diagram of the radial displacements has been designed and compared with descriptors of the wear change along the friction lining, according to which they alter with similar regularities.

Introduction

To determine the pressure distribution pattern along the shoe lining and to evaluate its effect on the wear of the brake mechanism elements, it is necessary to study the stress-strain state of the shoe lining. As a rule, the brake shoes have a high bending rigidity and relatively rigid supports, the deformation of which can be ignored. It is evident that the main deformable element of the drum brake-shoe mechanism is the friction lining which has a thickness of 10 mm - 16 mm and an elasticity modulus smaller in several ranges as compared to that of the shoe substance. Let's examine the work of the brake mechanism to determine its stress-strain state (Vardanyan, et al., 2019).

Since the inner radius of the brake drum and the outer radius of the shoe are not equal, their contact throughout the whole friction plane is not simultaneous and a friction pair contact with small area appears at the start of braking, which grows up along with the increase of the shoe pressing P power encompassing the full friction area of the lining and drum. To compress the drum, the shoe lining completely rotates round the O_1 point and all external points of the lining rotate round the radius ρ_i (Figure 1) (Bazikyan, Djinyan, 2005).

Materials and methods

Let's analyze the triangle O_1AO introduced in figure 1 to determine the external points A_i of the lining, where O_1O is the radius R_l of the lining circle, AO_i is the radius of the drum R_d respectively, $R_d-(R_l+h)=\Delta$ is the clearance between the drum and lining, and h is the thickness of lining.

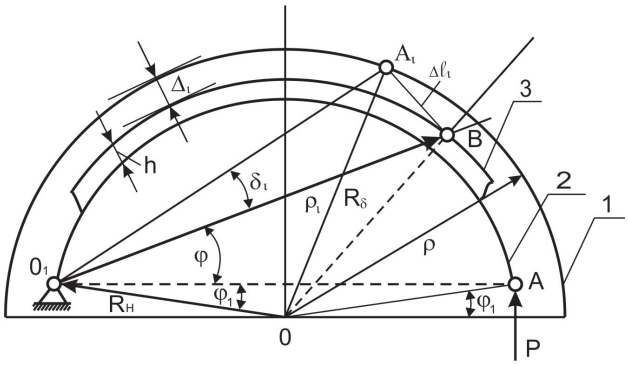

Figure 1. Drum brake-shoe mechanism. *1- drum, 2- shoe, 3- lining* (*composed by the authors*).

Let's determine the current value of the ρ_i radius vector depending on the rotation angle φ_i of the A_i point through the O_1A_i0 isosceles triangle considering that $\sphericalangle \varphi_i = \sphericalangle 0_1AB$ is a variable value for different A_i:

$$\rho_i = 2R_i \cdot \cos(\varphi + \varphi_i), \quad (1)$$

it is accepted that $O_1O \approx OB = R_1$,

we'll get from triangle O_1A_iO:

$$R_d = R_d^2 + \rho_i^2 - 2R_i \cdot \rho_i^2 \cdot \cos(\varphi + \varphi_i + \delta_i). \quad (2)$$

Placing the equation (1) in the (2) one and making some modification we'll have the following:

$$\frac{R_d^2 - R_l}{4R_l^2} = \cos^2\beta(1 - \cos\delta_i) + \frac{1}{2}\cos 2\delta_i \cdot \sin\delta_i, \quad (3)$$

where $\beta = \varphi + \varphi_i$.

From the derived (3) equation the rotation angle δ_i of the radius vector for A_i point in the brake mechanism can be determined.

The clearance Δ between the brake lining and drum is expressed through a rather small value due to which the rotation angle δ_i of the radius vector will be small as well, thus it can be accepted that $sin\ \delta_i = tg\ \delta_i = \delta_i$ and after some modifications the (3) equation will look like the following:

$$\delta_i^2 \cos^2\beta + \frac{1}{2}\delta_i \cdot \sin^2\beta - a_i = 0,$$

where. $a_i = \frac{R_d^2 - R_l}{4R_l^2}$.

The solution of the derived equation will be as follows:

$$\delta_{i1.2} = \frac{\sin\beta \pm \sqrt{\sin^2\beta + a_i}}{\cos\beta}. \quad (4)$$

From the derived solution it follows that the rotation angle δ_i of the ρ_i radius vector will be at minimum if the first derivative of the (4) expression is equal to 0:

$$\sin\beta = \frac{1}{\sqrt{2 + a_i}} \quad \text{or} \quad \sin(\varphi + \varphi_i) = \frac{1}{\sqrt{2 + a_i}}. \quad (5)$$

Therefore, the minimum rotation angle of radius vector will be:

$$\delta_i = \frac{a_i}{\sqrt{a_i + 1}}. \quad (6)$$

Let's determine the value of a_i depending on the clearance between the drum and lining, taking into account that $\Delta_i = R_d - R_1$, since while rotating round the point the O_1 distance of the A_i points in the lining from the R_1 grows up with the size of Δ_i. For that purpose after some modification of the expression we'll have:

$$a_i = \frac{R_d^2 - R_l^2}{4R_l^2},$$

$$a_i \cong \frac{\Delta_i}{2R_l}.$$

To contact the drum, the displacement value of A_i any point in the lining will be:

$$l_i = \rho_i \cdot \delta_i. \quad (7)$$

The first point to press the drum will be the one, the radius vector ρ_i of which matches the rotation angle φ:

$$\varphi = arc\sin\frac{1}{\sqrt{2 + a_i}} - \varphi_1.$$

Therefore, all external points of the lining will be displaced with the size of Δl_i before pressing the drum:

$$\Delta l_i = \rho_i \cdot \delta_{(\varphi=0)} - \rho_i \cdot \delta_i, \quad (8)$$

where Δl_i is the displacement of A_i point in the lining in case of rotation angle $\varphi = \frac{\pi}{2} - \frac{\delta_i}{2}$ of ρ_i radius vector.

Let's divide the Δl_i displacement into tangential V_i and radial W_i components and we'll have:

$$\begin{cases} V_i = \Delta l_i \cos\left(\varphi_i + \varphi - \frac{\delta_i}{2}\right) \\ W_i = \Delta l_i \sin\left(\varphi_i + \varphi - \frac{\delta_i}{2}\right) \end{cases}. \quad (9)$$

Results and discussions

Taking into account that the stress-strain state of the lining, the regularity of the pressure distribution along the lining, as well as the wear of the brake mechanism parts are characterized through the components derived in the system of lining displacement (9), let's determine their numerical values and design the descriptor $W_i=f(\varphi_i)$ (Figure 2).

The numbered values identify a_i for the following changing ranges: $a_i=0.1\text{-}0.28$, according to which $\delta_{imin}=0.02$ rad. The rotation angle φ_i of the radius vector is determined through the (5) formula:

$$\varphi_i = arc \quad \sin\frac{1}{\sqrt{2+a_i}} - \varphi,$$

where $\varphi=10^0$.

The computation results are introduced in Table.

The derived descriptor (Figure 2) testifies that the radial displacements of the external points in the lining grow up along with the increase of rotation angle of the points and it amounts to the maximum in the frontal part of the lining. Such characteristic will cause to the same regularity in the pressure distribution along the lining and to the similar descriptors of the lining wear (Figure 3), (Vardanyan, 2020).

Table. The computation results of the displacement components*

a_i	φ_i, radius	φ_i, degree	ρ_i mm	δ_i, radius	l_i mm	Δl_i mm	W_i mm
1.7716	0.27911	16.0	240.02717	1.06414	255.423	15.1723	0.134122
1.56278	0.29656	17.0	237.47569	0.97621	231.825	14.4	1.010796
1.37283	0.314	18.0	234.85195	0.89122	209.304	13.6296	1.769448
1.19958	0.33144	19.0	232.15674	0.80883	187.776	12.8533	2.412668
1.04114	0.34889	20.0	229.39089	0.72874	167.166	12.0624	2.941236
0.8959	0.36633	21.0	226.55523	0.65066	147.41	11.2474	3.353951
0.76247	0.38378	22.0	223.65064	0.57433	128.449	10.3977	3.647379
0.63962	0.40122	23.0	220.67798	0.49952	110.233	9.50074	3.815496
0.52629	0.41867	24.0	217.63818	0.426	92.7135	8.54179	3.84916

*Composed by the authors.

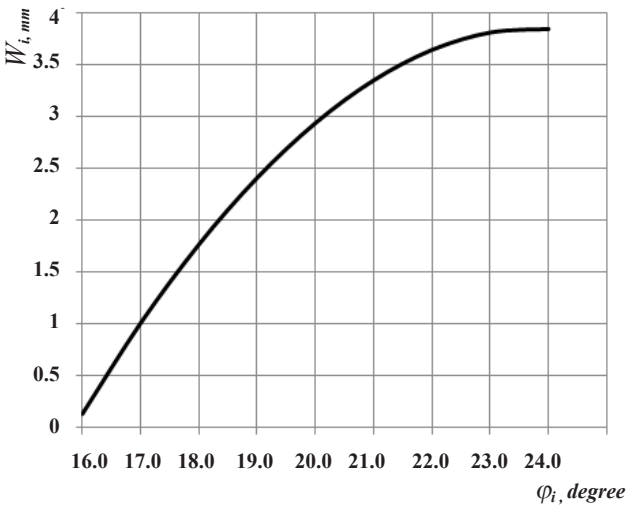

Figure 2. Radial displacement diagram of the external points in the friction lining (*composed by the authors*).

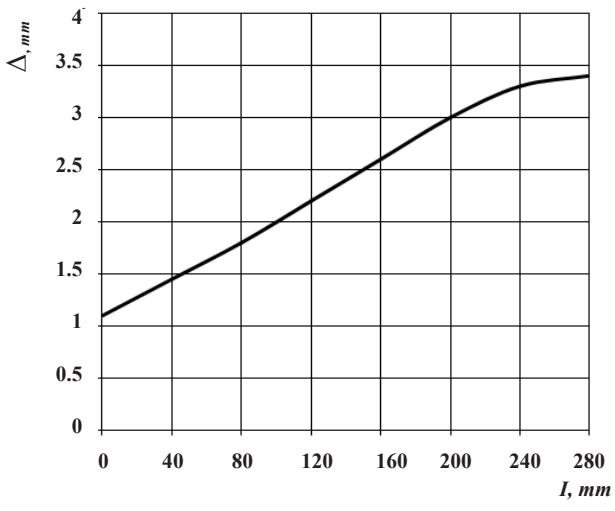

Figure 3. Description of wear change along the friction lining (*composed by the authors*).

Conclusion

Per the descriptor $W_i = f(\varphi_i)$ of the radial displacement changes in the external A_i points of the lining in the brake-shoe mechanism a conclusion can be drawn that along with the increase of the shoe rotation angle φ_i the radial displacements grow up with the sine theorem accepting the minimum value at the shoe base equal to 0.13 mm and the maximum one at the frontal part of the shoe amounting to 3.84 mm. Such characteristics will simultaneously bring forward similar descriptors in the wear changes and pressure distribution along the lining.

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Feasibility Study of Biogas Production from Miscanthus Biomass in the Tavoush Region

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ABSTRACT

This study aims to assess the economic feasibility of biogas production from the biomass of *Miscanthus Giganteus*. Three scenarios have been applied based on its productivity and stand's life. The breakeven prices per tonne for each scenario were calculated and sensitivity analysis was conducted with respect to various factors. Afterward, the cost per gigajoule was calculated and compared to Natural Gas. The cost per gigajoule of Miscanthus ranges from 920-3033 AMD based on the sensitivity results, hence it can be quite cheap alternative depending on the yield, discount rates and rhizome costs.

Introduction

Armenia is a developing country with limited natural and energetic resources. Its population is estimated at around 3 million. The country is not rich in natural resources and currently Agriculture remains the dominant sector in the economy contributing to 12 % of GDP as of 2019 (WB 2019). Armenia has 2.974 million ha of land area, out of which almost 69 percent is considered to be agricultural lands. Around 21.7 percent of the agricultural land is arable (FAO, 2019) which comprises almost 444.8 thousand ha of total land area (NSS 2020). Currently, 15.2 percent of the arable land is concentrated in Ararat Valley. Armenia is not rich in energetic resources; it doesn't have any confirmed oil and natural gas reserves and is not yet active in producing renewable energy, hence, the country is quite dependent on the imported energy resources (UNDP 2017). Along with those energy resources that we currently have, Armenia has a great potential for the sustainable energy because of the presence of hydroelectric and other renewable energy sources.

According to experts, reducing the cost of renewable energy production can help us reduce the import volumes of conventional energy resources (Pasoyan and Sakanyan, 2019).

Renewable energy resources are beneficial and important from different perspectives. First, renewable energy resources help reduce environmental damages, such as the air pollution arising from the usage of conventional energy sources. If the country maintains energy generation from local renewable energy sources, it ensures more price stability with affordable tariffs and avoids being controlled by other countries and regions. This way

the country ensures its energy and national security. Renewable energy generation would have mainly positive, long-term environmental effects as it reduces the need for power generation based on fossil fuels, thereby reducing Greenhouse Gas (GHG) emissions. One of the widely known energy crops, which are utilized as biomass for energy production is corn, which can be cultivated either solely for biomass generation (green mass) or for eating. Another energy crop, which is not yet famous in Armenia, but can be quite applicable is *Miscanthus Giganteus*. This study discusses the morphological characteristics of the plant in more detail and its economic feasibility for bioenergy production based on biological and economic research studies already made in Europe, USA, and some other countries, since Miscanthus has never been grown in Armenia.

The origin of Miscanthus is East-Asia, however, its species come from various climatic dimensions including subtropical and tropical, extra warm and cold locations. *Miscanthus Giganteus* has a great potential for carbon capturing and mitigating the climate change (Virani, 2011). According to the Climate Change Committee each year 23 000 hectares would provide 2 million tonnes of CO_2 emission savings in the agricultural sector and additionally 11 million tonnes CO_2 from the harvested biomass.

In order to understand how competitive Miscanthus is, the net present value method will be used calculating its breakeven price and then the cost per gigajoule will be estimated for comparing it with Natural Gas. If the cost per gigajoule of the energy is cheaper than for Natural Gas, then the opportunity to use the Miscanthus biogas can be attractive, otherwise, the biogas received from that will have no actual demand.

Finally, this study analyzes a twenty-year enterprise budget for Miscanthus to determine the gate breakeven price of the energy crop with three different scenarios depending on its productivity assumptions. The yield of this crop was calculated based on the biophysical characteristics of the crop. Unlike the other studies, the yield and input estimates of this study were based on environmental conditions in Tavush Region, Armenia, which is located in the north-eastern part of Armenia. The average hours of sunshine in Tavush Region is about 1900-2000 hours (Vardanyan, 2016). When getting to know Miscanthus growing locations through the literature, it can be noted that Miscanthus can be grown in this particular region.

Materials and methods

Miscanthus stands have very few requirements from the soil and that is what makes this grass valuable for the biomass production. Soil in Armenia is not rich in nutrients; that is why additional Nitrogen, Phosphorous and Potassium will be introduced into the soil in its establishment year and onward.

Miscanthus stand is productive for around 20 years. The harvesting starts in the 1st year after the establishment so that it ensures a complete procedure. Usually Miscanthus is harvested in spring and it is harvested only once (Virani, 2011). According to Lewandowski the moisture in Miscanthus drops from 70 % to 20 % in April. Harvesting in spring is also economically more beneficial, since the moisture in the grass increases the cost of harvesting and drying (Lewandowski, 2003). There are some distinct methods for harvesting, but according to European studies the harvesting can be done through a forage harvester, which is also used for harvesting silage maize or any kind of grass.

Miscanthus yield from one hectare can be different depending on the location and climatic conditions. In general, the life expectancy of the Miscanthus stand is around 20 years. This period can be further divided into an increasing yield quantity and flat yield phase. The progressive period is usually 3-5 years and the rest is characterized as flat until 20th year (Virani, 2011). The Miscanthus yield will be assumed as 18 t/ha in the Republic of Armenia.

The life expectancy of Miscanthus can fluctuate and based on the three scenarios the budget was calculated. The scenario analysis is conducted to understand the changes in breakeven price while changing the life span of the Miscanthus stand. Then a sensitivity analysis will be conducted to see how the changes of the three assumptions will be affecting the breakeven price: yield, rhizome cost and discount rate.

For growing the Miscanthus the basic economic conceptual framework will be applied to understand where the breakeven price stands. Armenia doesn't have a competitive market for the Miscanthus production, however for this study, the assumption would be a competitive market, where each of the producers is trying to maximize his profits. The standard microeconomic theory states, that in the competitive market the Marginal Revenue (MR) should be equal to price and on the other hand, the producer will carry on producing the Miscanthus only if price is equal to the Marginal Cost of producing it (MC).

Scenario A: Best Case Scenario

Miscanthus stands mature and become fully productive

in 3-5 years after establishing them and they can be productive up to 15-20 years (Figure 1).

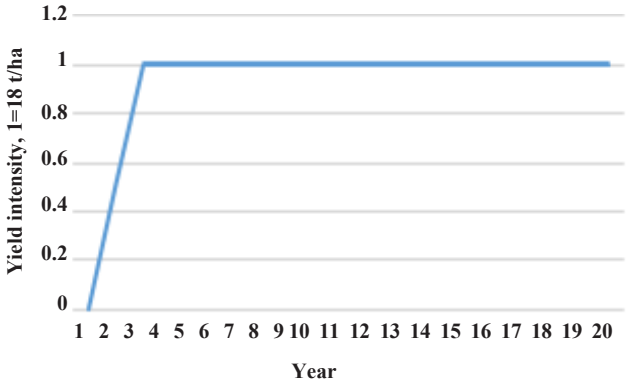

Figure 1. Scenario A - Best Case (*composed by the author*).

This depends on the climatic conditions, geography and quality of the rhizomes and the human factor of properly taking care of them. For the best case scenario, we assume that the rhizomes are of good quality (100 %), a full survival of the rhizomes during the winter is observed and all the rhizomes get mature at the end of the second year (50 %). The full productivity of the rhizomes starts from the 3rd year and lasts for 20 years.

Scenario B: Delayed Harvest Scenario

For this scenario (Figure 2), we assume that the stand becomes fully productive in 5 years, because of various reasons: resistance of cold weather, improper management, etc. It is worth mentioning that the duration of the stand productivity is still 20 year.

Scenario C: Early Termination

Since Miscanthus has never been grown in Armenia and there are many factors that can affect its yield capacity, the termination will occur at the 10th year of plant's growth (Figure 3).

Results and discussions

For this project the following formula has been applied to calculate the NPV for the 20-year Miscanthus:

$$NPV = \sum_{t=1} \frac{R_t}{(1+i)^t} - \frac{c_t}{(1+i)^t}.$$

NPV of this investment is dependent on the time period in years (t), revenue earned in AMD in the specified time (R_t) and the total costs in AMD in the time period of t (C_t) and the discount rate (i). The discount rate is the time value of money which in its turn is dependent on the risk involved in that specific investment. Since, Miscanthus has never been grown in Armenia, we do not have the market price of the crop for one tonne and since the revenue is a function of price and the yield, we will discount the yield. The breakeven price is determined dividing the sum of the discounted costs by the sum of the discounted yield. In the introduced table (Table 1) the breakeven price is presented for the best case scenario, when Miscanthus is fully productive from the 3rd year and the stand's life is 20 years. The breakeven price is 29 122.2 AMD.

The discount rate of the budget is 17.7 %, which has been derived using the formula approach applied by the Research Department of ICARE foundation.

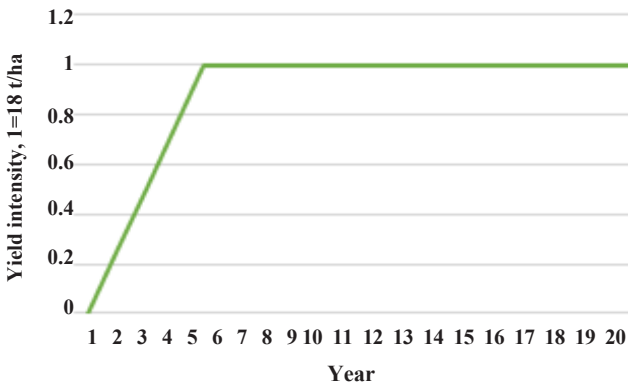

Figure 2. Delayed harvest (*composed by the author*).

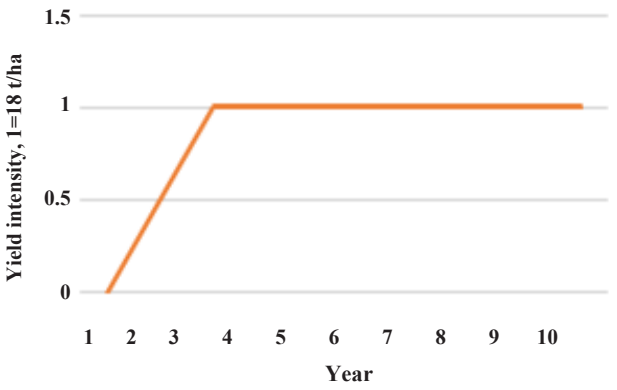

Figure 3. Early termination (*composed by the author*).

Table 1. Enterprise Budget for the Scenario A*

Items/ha	Year 1	Year 2	Year 3-20	Accumulated Costs
Land	30 000	30000	30000	600000
Rhizomes	410000			41000000
Transportation	1104000			110400000
Import Related Administrative Costs	20000			2000000
Establishing Activities and Materials				
Tillage	30000			3000000
Rental Potato Planter	30000			3000000
Fertilizers				
Nitrogen	72000	-	-	72000
Megaflor		3750	3750	71250
Herbicides				
2.4 -D	4500	4500	4500	90000
Harvesting				
Mowing		20000	20000	380000
Baling		33750	67500	124875000
Spreader		10000	10000	190000
Storage and Transportation		22500	40000	742500
Total Cost	1700500	124500	175750	4988500
Discounted Costs	1700500	105770.40	126865.17	2605002.91
Yield		9	18	330
Discounted Yield		7.83	13.61	89.45
Breakeven Price				29122.2 AMD

The following formula has been applied for the calculation of the discount rate, assuming that it is entirely equity financed:

$$r_E = r_{rf_{Armenia}} + b_{FishFarmCompany} \times (RP_{Mature\ market}) + ARP_{Country\ Armenia,}$$

Where $r_{rf\ \text{Armenia}}$ - Risk-free rate, $b_{FishFarmCompany}$ - Company's systematic Risk (Beta), $ARP_{\text{CountryArmenia}}$ - Additional country risk premium, $RP_{\text{Mature market}}$ - Market risk premium.

This approach has been suggested by Damodaran, who has calculated country risk and total risk premiums for over 100 countries utilizing the rating agencies' information. For this study the Small Country Risk Premium is considered 0, hence the discount rate is the following:

$$r_E = 7.92\ \% + 0.95 \times (5.3\ \%) + 0\ \% + 4,77\ \% = 17.7\ \%.$$

Table 2. Summary of Breakeven Prices*

	Scenario A	Scenario B	Scenario C
Breakeven price, (AMD)	29122.2	33134.65	32219.1

*Composed by the author.

The Miscanthus stand life for the Scenario B is 20 years, however, Miscanthus becomes fully productive from the 5th year. It is assumed that Miscanthus doesn't provide any biomass in the first year, however, starting from the second year it is starting to produce it with the following proportions: 25 %, 50 %, 75 %, 100 %, then it continues to be productive with the same 100 % rate till the 20th year (Virani, 2011). For the scenario B, all the input costs

are considered to be the same as for the scenario 1. With these assumptions, the breakeven price for the scenario was 33134.65 AMD. The breakeven price for this scenario is greater than for the first scenario with around 4000 AMD. For the third case scenario, the breakeven price is calculated as 32 219.1 AMD per tonne, which is less than in the case for the second scenario.

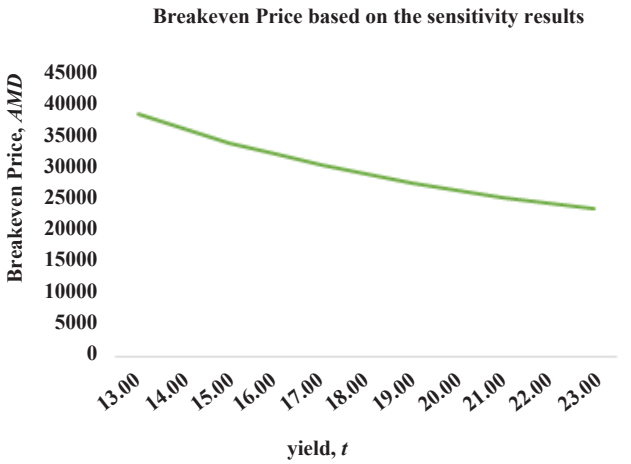

Figure 4. Yield sensitivity results for Scenario A (*composed by the author*).

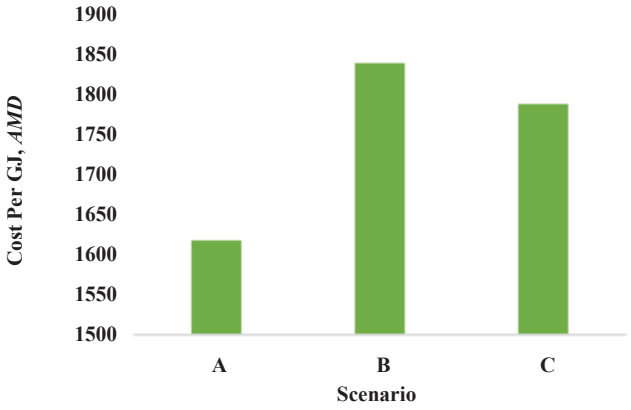

Figure 5. Cost per Gigajoule for Each Scenario (*composed by the author*).

It is noteworthy that the breakeven prices for three cases are different and the overall picture is presented in Table 2.

When calculating the breakeven farm-gate price of Miscanthus, the change of the yield should be considered. Everything else held constant, the higher Miscanthus yield will deliver lower breakeven prices as presented in Figure 4.

For the best case scenario, the breakeven price with respect to the change of the rhizome costs varies from 27 288.84 AMD to 52 039.93 AMD. These numbers are for the case of 24.6 AMD per rhizome and 205 AMD per rhizome respectively.

For the Scenario B, these numbers were 30987.24 AMD and 54.608.82 AMD, and for the Scenario C the prices were 30 092.95 AMD and 53 486.16 AMD respectively. It is noteworthy, that the change of the rhizome cost influences the breakeven price for the Scenario C the most. For the discount rate sensitivity analysis, each value differs from its previous one with ± 3.

The smallest value in the series is 2.7 % and the breakeven price is 16. 544.52 AMD for the Scenario A. The largest discount rate is 29.7 % and the breakeven price is 42238.33 AMD. For the Scenario B, when discount rate is 29.7 % the breakeven price is 51 628.19 AMD and for the Scenario C the breakeven price is less amounted as 44202.14 AMD. According to the calculations made, compared to the Scenario B, breakeven price in the Scenario C is smaller when the discount rate is increasing from the base rate.

Since breakeven prices are calculated, the cost per gigajoule and willingness to pay can be derived by the consumers including greenhouse owners. The cost per gigajoule is usually calculated dividing the total cost per tonne of Miscanthus by the energy content of per tonne of Miscanthus (Figure 5). According to the study the energy content of per tonne of Miscanthus is 18 GJ (Shepherd , et al., 2020). For example, in the Scenario A, the base case breakeven price is 29 122.22 AMD and whenever this number is divided by 18 GJ, we receive the cost per gigajoule as about 1617.9 AMD.

Since the breakeven price of the Scenario B is the largest, so is the cost per gigajoule (1840.81 AMD). As for scenario C, the cost per gigajoule was estimated as 1789.95 AMD.

Because the energy content of Miscanthus is constant, the cost per gigajoule is dependent on the yield of Miscanthus, the rhizome cost, discount rate, etc. The cost per gigajoule was calculated for the yield change from 13-23 t/ha, the rhizome cost from 24.06 – 205 AMD and the discount rate from 2.7 %-29.7 % for each 3rd member in the range. After having the calculations done for the cost per gigajoule, the comparison with the price per GJ of Natural Gas will be examined (Table 3).

For this study we will only consider the natural gas consumption by the greenhouses, processing companies and large enterprises that consume more than 10 000 cubic meters Natural Gas. Since the cost per gigajoule of the Miscanthus for different scenarios and sensitivity is different, the energy value per cubic meter of the Natural

gas should be calculated. The price per gigajoule for Natural Gas is around 2837 AMD for the greenhouses and other processing organizations. The companies that utilize more than 10 000 m^3 the cost per GJ is 3243 AMD.

Table 3. Energy Cost Comparison*

Fuel for Combustion	Miscanthus	Natural Gas
Energy Content	18 GJ/t	26. 392 m^3
Cost Range, AMD	919.14- 3033.82	2837
Average Cost, AMD	1976	2837

*Composed by the author.

As shown in the Table 3 the average cost of Miscanthus is cheaper than the Natural gas for the industries that have a ready boiling system in the enterprise.

However, Miscanthus can be either quite cheap alternative for the Natural Gas or very expensive mainly affected by higher discount rates and rhizome costs.

Conclusion

The objective of this study was to determine the feasibility of growing *Miscanthus Giganteus* for biogas production and to compare the energy cost with the Natural Gas.

Miscanthus is an ideal perennial energy crop, which is widespread in the European countries, US and in Asian countries. It has low moisture and nutrient content, which is good for the combustions. Miscanthus is famous for its carbon capturing abilities, which is another great advantage among other energy crops. Besides, it can also be grown in Marginal lands and not compete with other crops. The plant is not invasive and it is sterile.

Miscanthus Giganteus has never been grown in Armenia; hence the literature review was applied to derive its morphological characteristics and build an enterprise budget. Three main scenarios were developed depending on its productivity and the stand duration.

For all three scenarios the breakeven price per hectare was calculated. Later, based on the breakeven price, the cost per gigajoule was calculated and compared to the cost per gigajoule of the Natural Gas.

The base case breakeven prices for all of the three scenarios are 29 122.25 AMD, 33 134.65 AMD and 32 219.06 AMD. The lowest breakeven price among all the three scenarios is in the Scenario A. According to the sensitivity results, the bigger the yield of Miscanthus, the less the breakeven price for per tonne of Miscanthus is and vice versa.

In addition, the cost per gigajoule of Miscanthus ranges from 919.14 - 3033.82 AMD, price per gigajoule of the natural gas is 2837 AMD; hence as long as the price is lower than that, producing Miscanthus for biogas production is feasible.

In this research study it has been assumed that the industries which will buy Miscanthus for the biogas production have a boiler system. However, it is important to calculate the capital expenditures for the boiler construction. As long as the price difference of Miscanthus and Natural Gas is bigger enough to offset the cost of the boiler construction, the biogas production from Miscanthus biomass can be feasible solution. It is important to conduct research based on the real case studies through the pilot programs. This will enable to have a better understanding and precise details about the establishment process, caring activities, biomass yield, etc.

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Financial Feasibility of Sugar-Free Medium-Scale Dry Fruit Production: a Hypothetical Business Model

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ABSTRACT

This article studies the financial feasibility of a medium-scale business model operating in dry fruit processing sector, which can also provide an economic insight for those who want to transform the substantial fruit processing into a well-performing business enterprise. To evaluate how viable the business is, the main capital budgeting techniques have been applied. The financial model shows that the business is profitable with positive net present value, profitability index equal to 1.20, payback period of 4.3 years and internal rate of return (IRR) greater than the weighted average cost of capital.

Introduction

Fruit production sector in Armenia is extremely fragmented, and there are many large and small households, which are not registered as legal entities but they continue their business activities in the production (SMEDNC, 2018). However, recently there is a positive trend towards establishing larger enterprises to maximize efficiency and productivity.

According to the data provided by the Ministry of Agriculture (currently operating as a subdivision in the Ministry of Economy) there are about 35 fruit and vegetable processing companies in Armenia, out of which 8 are considered comparatively larger and provide around 250 tons of processed fruit and vegetables per year (Minagro, 2018). On the other hand, there are 350 physical and legal entities producing dried fruit and spices, only 6 out of which are medium-sized. Those only constitute 15 tons of the total annual capacity for the fruit and vegetable processing sector (Privacy Shield Framework, 2018).

During the recent years, the fruit production and processing sector is developing in the Armenian economy as shown in Figure 1, due to the fact, that the Government of the RA has also prioritized the sector and developed export-oriented strategies, which provide an incentive for the enterprises to be involved in the processing activities.

The export volumes of the Armenian processed fruit and vegetable products have also increased which is depicted in Figure 2 (NSC, 2020).

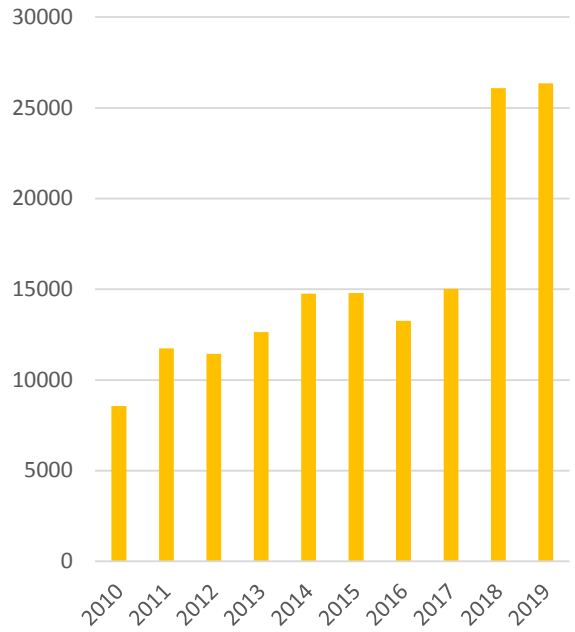

Figure 1. The volumes of the fruit and vegetables processing with current prices (*mln, AMD*) (*composed by the authors*).

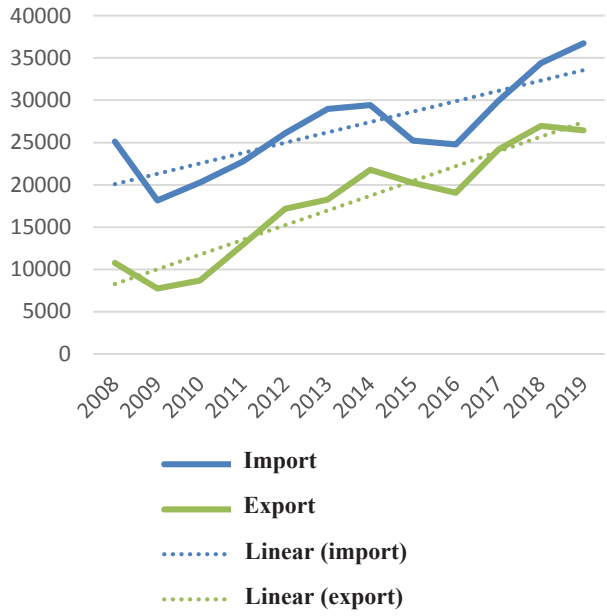

Figure 2. Foreign trade of the processed fruit, vegetable and plants products (*thousand, USD*) (*composed by the authors*).

Materials and methods

The viability of a business model is dependent on many factors. This paper will outline the economic and financial feasibility of a business model involved in the production of sugar-free dried fruits. The investment in this business opportunity will be attractive, if the financial indicators of the project correspond to the evaluation criteria, such as a positive net present value (NPV), internal rate of return (IRR) greater than the weighted average cost of capital (WACC), shorter payback period and higher profitability index.

This paper will apply the operational and assumption-based planning techniques to provide a reasonable insight for the investors.

Operational planning, as an important type of technique in business-modeling, aligns various functions of the business including marketing and sales with major objective of the business. Through this method, the overall resources of the organizations are rationally allocated within each department and the corresponding budget is composed for the specific time period (ACCIPIO).

In addition, desk research will be conducted which aims at acquiring more information on that specific business environment including competitor analysis.

To identify the major challenges and applicability of innovation in the processing sector a qualitative online survey has been conducted with selected agricultural experts.

For a thorough investment outlook, some marketing and sales tactics will be applied especially from the perspective of behavioral economics. A few visits have been made to the most famous supermarkets of Armenia, including Yerevan City and SAS Supermarket to explore the level of applicability for those behavioral tactics, which have been mentioned in the literature. According to the findings, the general recommendations have been made in the marketing section to boost the sales and visibility of the products.

Results and discussions

Industry analysis

Some studies have shown that the fruit production sector in Armenia has been flourishing within the last few years, as the government has adopted many support programs for the farmers through financial assistance, subsidized loans and other extension services. In addition, many international organizations have also started to support the agricultural sector, hence granting monetary assistance to small and medium business entities for enhanced capacity and productivity.

According to the SMEDNC, however, only 5-10 large companies provide proper packaging and labeling in the market. Their products are realized in the chain and non-chain stores. Most of the small producers, though, are involved in the wholesale, through getting profits from re-selling the products. The main dried fruits in Armenia are received from apricots, black and red plums, peach and even dried tomatoes in the recent years. The dried apricot, plum and peach products compose 75 % of the Armenian fruit processing sector. There are also dried apple, pineapple, pear and fig products, however, their volumes are comparatively smaller.

There is also a newly evolving trend of drying fruit from such vegetables and fruits as, watermelon, melon, eggplant and green beans.

Consumption

According to the experts' opinions, almost 70% of the Armenian population is considered dried fruit consumer (SMEDNC, 2018). Due to the lack of the fresh fruit during the winter time, the demand for the dried fruit is comparatively larger.

One of the obstacles to the expansion of apricot processing is the scarcity of raw materials. Because of the extreme weather conditions in late March and early April, apricot harvest can fluctuate significantly. The production of dried apricots in Armenia practically stops in unfavorable years. According to SMEDNC, the apricot harvest may exceed 100 000 tons per year under favorable weather conditions, however, only 3 % is directed for dried fruit production, experts say. In the case of peaches and plums growing, the trend is positive as there is a large raw materials availability. Due to this fact, the raw plum costs 175-200 AMD/kg during the harvest season, which is affordable for those who are ready to buy them for dried fruit production.

Production plan

It is assumed that the company will receive 30% of its raw fruit products from the own orchard, which is located right next to the production facility, the rest of the raw materials will be purchased from other providers. The following assumptions should be made while calculating the COGS (Cost of Goods Sold) of the dry fruit production.

It is assumed that the initial volume of the raw material will be 7 400 kg, which will have a 10% growth rate in each year. The raw material will be distributed according to the proportions provided in Table 1.

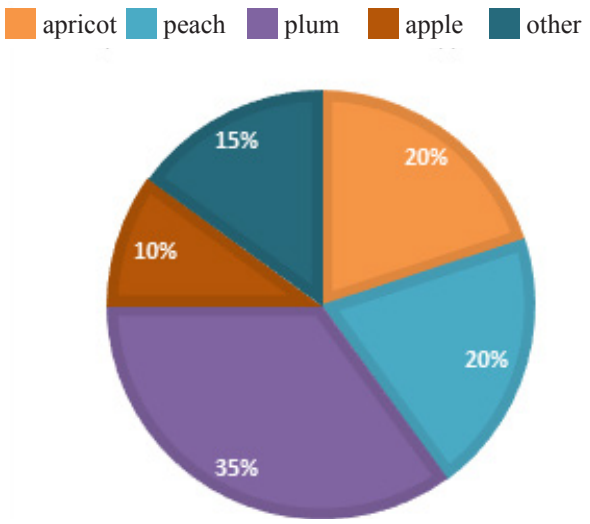

Figure 2. Dried fruit production from the raw fruit type, 2018 (*Source: SMEDNC, experts' opinion*).

Table 1. Raw materials and their proportion for processing*

Fruit type	Raw mass necessary for 1 kg dry fruit, *kg*	The proportion directed for processing, *%*
Apricot	3.5	30
Plum	5	30
Apples	7	30
Peach	8	10

*Composed by the authors.

Table 2 shows the raw material quantity needed in the 10-year lifetime for each fruit. As can be noted further, in the 10th year the total volume of the raw materials will reach 17 449 kg.

The main component of the COGS of dry fruit is the cost of the raw materials, which is approximately 40-45%, therefore, the fluctuations of the prices in raw materials can highly affect the price of the dry fruit.

The electricity costs compose the next biggest share in the COGS, especially if an artificial fruit dryer is purchased. It is assumed that there will be no need for extensive labor force, because the business will be small-scale.

Table 2. The volume of raw materials for the entire lifecycle of the business*

Raw materials quantity (fresh fruit mass)	Year									
	1	2	3	4	5	6	7	8	9	10
Apricot	2.220	2.442	2.686	2.955	3.250	3.575	3.933	4.326	4.759	5.235
Peach	740	814	895	985	1.083	1.192	1.311	1.442	1.586	1.745
Plum	2.220	2.442	2.686	2.955	3.250	3.575	3.933	4.326	4.759	5.235
Apple	2.220	2.442	2.686	2.955	3.250	3.575	3.933	4.326	4.759	5.235
Total	7.400	8.140	8.954	9.849	10.834	11.918	13.110	14.421	15.863	17.449

*Composed by the authors.

The number of the labor force will be increased for some seasonal works. During the production period, people will need to be involved in pest control and management and 2 other seasonal workers will be required for the following actions: harvesting, washing, sorting, packaging and other activities.

Based on the above-mentioned parameters, the cost of goods sold and the selling price (AMD) were determined (Table 3).

Table 3. COGS and the selling price of the products*

Processed fruit	Cost of goods sold (per 1 kg)	Selling price
Apricot	2.085	4.170.00
Peach	5.780	8.670.00
Plum	2.630	5.260.00
Apples	2.750	5.500.00

*Composed by the authors.

The company will pay income and turnover tax which will be 3.5%. In the table 4, the income statement of the enterprise is presented with 5 years of time period, though the overall business lifecycle is assumed to be 10 years.

According to the project evaluation criteria, if time span of the business model is less than 10 years, the project will not be financially viable.

As can be noted in the Table 4, the net income margin is increasing year by year and the following project evaluation indicators have been calculated:

- Net present value (NPV) = 3 038 315.08 AMD
- Payback period = 4.3 Years
- Internal rate of return (IRR) = 19 %, which is greater than the weighted average cost of capital (WACC=15%)
- Profitability index (PI) = 1.20

The financial indicators of the project show that the business with the assumptions made can be financially viable: the net present value is positive, IRR is greater than the WACC and profitability index is greater than 1.

Marketing and branding

There are many small and medium producers in the market and it is vital to have a strong competitive advantage over other products. Additionally, the enterprise needs to adopt good marketing practices in order to position itself in the local and international markets.

Marketing mix and SWOT analysis

For a comprehensive analysis, the marketing mix of the business was also applied with regard to product, price, place and promotion (Table 5).

A SWOT analysis (strengths, weaknesses, opportunities and threats) is a tool, that helps determine the internal and external factors that can affect the business activity. It can have a huge impact on the business success, as it helps identify all the challenges and opportunities for the business. In this paper the SWOT analysis has been applied for the hypothetical business model (Table 6).

Table 4. Income Statement of the enterprise for the first 5 years*

Income Statement	Year				
	1	2	3	4	5
Revenue	5.546.736	6.101.410	6.711.551	7.382.706	8.120.976
Revenue, USD	11.093	12.203	13.423	14.765	16.242
COGS	1.258.740	1.384.614	1.523.075	1.675.383	1.842.921
Gross Profit/EBITDA - Earnings before interest, taxes, depreciation and amortization/	4.287.996	4.716.796	5.188.475	5.707.323	6.278.055
EBITDA Margin, %	77	77	77	77	77
Total Administrative Expenses	(1.445.000)	(1.445.000)	(1.445.000)	(1.445.000)	(1.445.000)
Accountant	(204.000)	(204.000)	(204.000)	(204.000)	(204.000)
Administrative expenses (Enterpreneur salary)	(1.200.000)	(1.200.000)	(1.200.000)	(1.200.000)	(1.200.000)
Other	(41.000)	(41.000)	(41.000)	(41.000)	(41.000)
Storage and Marketing Expenses	(735.000)	(735.000)	(735.000)	(735.000)	(735.000)
Marketing costs	(600.000)	(600.000)	(600.000)	(600.000)	(600.000)
Product transportation costs	(90.000)	(90.000)	(90.000)	(90.000)	(90.000)
Raw materials transportation	(45.000)	(45.000)	(45.000)	(45.000)	(45.000)
Operational Profit (EBIT)	2.107.996	2.536.796	3.008.475	3.527.323	4.098.055
EBIT margin, %	38	42	45	48	50
Depreciation and amortization	(342.500)	(192.500)	(192.500)	(342.500)	(492.500)
Interest expense	-	-	-	-	-
Profit before tax	1.765.496	2.344.296	2.815.975	3.184.823	3.605.555
Turnover tax, 3.5 %	(194.136)	(213.549)	(234.904)	(258.395)	(284.234)
Income tax	(60.000)	(60.000)	(60.000)	(60.000)	(60.000)
Net Income	1.511.360	2.070.746	2.521.071	2.866.428	3.261.321
Net income margin, %	27	34	38	39	40

Table 5. The marketing mix of the business*

Product	Price
• Dried fruit products from local raw materials: apricots, plums, peach, apples • Juice and jams from the above mentioned products • Quality products which are sugar-free or with sugar substitutes • Packaging with Armenian Art works.	• Ordinary packaging: market price 3500-4500 AMD • Special package: market price 5000-8000 AMD • Discounts during the Christmas times • Sales with credits
Place	**Promotion**
• Sales to store chains and supermarkets, • Small stores and boutiques. • Wholesale • Restaurants • Healthy food cafes and restaurants	• Social media channels • Branding and positioning • Outbound advertising • Inbound advertising • Tasting • Tours • Collaboration with tour agencies

*Composed by the authors.

Table 6. SWOT analysis for the enterprise and the sector*

	Helpful	Harmful
Internal	*Strengths*	*Weaknesses*
	a) Armenia has favorable weather conditions, which allows to receive high quality fruit products to process b) Government and many international organizations provide financial assistance through subsidies, loans with lower interest rates, etc. c) Sugar-free dried products will promote healthy lifestyle due to its non-use of sugar. d) Business diversification: juice, jam, other processed products	a) Limited financial resources and cash flows b) Limited infrastructure: rural roads, transportation issues c) Uncertainty about the weather conditions d) Higher costs on innovative and modern technologies e) Higher costs of packaging f) Many unregistered and unlabeled processed food. g) lack of knowledge and skills in processing h) Lack of innovative technologies
External	*Opportunities*	*Threats*
	a) Vertical integration through buying additional land resources b) Expansion and transformation to an intensive orchard c) Agritourism development d) Increasing demand towards healthy and local products e) Support programs for agriculture development	a) Worsening political situation in Armenia b) Increasing number of COVID-19 infections c) Climate change and global warming d) Market saturation e) Limited market access f) Increasing price of inputs

*Composed by the authors.

According to the interviewed experts, the processing sector has major gaps, that needs to be addressed. Based on their assessment, the private sector may take some steps for improving its productivity. The two main factors affecting the productivity in fruit processing sector are the quality of raw materials and technical knowledge and skills. According to their assessment, dry fruit processors intensively apply the solar dryers and artificial dryers, however, they are using mainly energy intense technologies, hence having a financial burden in terms of operational costs. Experts also mention that product diversification is widely applicable in Armenia. According to the survey results, the main challenges in the fruit processing sector are: lack of knowledge and skills, limited access to market, small-scale and substantial processing, lack of marketing and sales skills.

Behavioral selling

While making decisions, people are not always rational, because of some external factors that affect the buying process. For example, when people are short of time, they are influenced by the time factor and the decisions can be absolutely different from the one they would make without that limitation. Here are some actions and tactics, which will help to boost the sales through the application of behavioral selling.

a. Decoy effect

The decoy effect is a cognitive bias by which consumers will tend to have a specific change in preference between two options when they are also presented with a third option that includes the mix of the positive benefits of the two other options (Intelligent Economics, 2018). Examples of decoy effect is the bundle pricing, when we include a few products within the set price. Additionally, packaging the products in small, medium and large boxes, will boost the sales of the medium size because people tend to choose the best combination of the price and quantity.

b. Anchoring

Anchoring bias occurs when people rely too much on pre-existing information or the first information they find when making decisions (Investopedia , 2021). While buying something people are highly influenced by the numbers that come to our eyesight first. Therefore, putting a bigger number on the packages than the price itself, can stimulate the buyer subconsciously think that the offer is indeed reasonable.

Table 7. Risk Management Matrix*

Risks	Level	Response activities
Lack of expertise and practical skills of fruit processing without sugar or sugar substitutes.	Medium	To train employees, finance their studies in agricultural education
Insufficient amount of raw materials	Medium/High	Vertical integration can be a solution: additional lands and raw materials
Lack of innovative and energy-efficient technologies	Medium	To find external sources to finance
Biological hazards: • Untimely contamination • Chemicals usage affecting people's health	Low/Medium	More actions should be taken for ensuring the food safety measures
Packaging damage	Medium/High	To choose high quality packaging materials
Demand risk	Low	To organize aggressive marketing and advertising, promotion, brand awareness, visibility
Higher competition	High	To urgently add more features, state the competitive advantage, diversify the food, think of an out of the box solutions to the quality, packaging and delivery
(Natural) Extreme weather coditions: • Floods, storms, hails, • Land desertification • Overall climate change • Earthquake	Medium/high	To apply anti-hail nets, agricultural insurance
Price increase in raw materials	Medium	To implement vertical integration, buy more lands

*Composed by the authors.

c. Endowment effect (Free trials)

It is very important people to taste your product and see how it tastes, that is why there are many occasions, such as fairs and festivals, where the company can offer some free products for our potential customers, who can taste and buy further.

Personalization

It is very important to use the personalization technique, because your product gives more value to your customer and they will eventually come back to you again. This includes customization of the product based on the holidays, celebrations, etc.

Risk management and mitigation plan

Risk management is a process, which helps the companies to identify the potential threats to the organization and implement response actions to mitigate or eliminate the risk. The risk can stem from various sources including but not limited to the external environment such as the financial instability of the country and legal environment, decreased quantity demanded, weather conditions, etc. Table 7 identified the most relevant risks related to the sectors and the corresponding actions have been proposed.

Conclusion

This paper outlined the investment opportunities in the fruit processing sector particularly focusing on the dry fruit production on a small-scale basis. In this hypothetical model four fruit types were considered for processing: apple, peach, plum and apricot. Those were selected taking the availability of raw materials into account.

For the first year 7 400 kg raw materials will be processed from the raw sources proportionately and the volume will be increasing by 10 % for each 10 following years. The processing will be without the usage of sugar considering the latest trend of healthy lifestyle which is appreciated by the consumers. The business also targets those who are suffering from the diabetes, obesity and other diseases,

which are highly dependent on the diet we undertake.

For the model, the 10-year enterprise budget was estimated to evaluate the business viability. Based on the results of capital budgeting techniques (positive NPV, IRR>WACC and PI>1), it can be stated that the project is profitable and can be implemented with the assumptions made.

Apart from testing the financial feasibility, a comprehensive industry analysis was made and a marketing strategy was developed based on the result of the current business environment. In addition, a SWOT analysis and a few behavioral techniques were proposed, which can be applicable for making the products more sellable in the market. This business model shows, that proper application of the agricultural potential in Armenia can turn into a profitable business, rather than small and substantial farming practices.

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Development Peculiarities of Bean Anthracnose and Protective Measures

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ABSTRACT

The life cycle of *Colletotrichum lindemuthianum fungus*, susceptibility of Armenian bean varieties to anthracnose disease, as well as its development dynamics have been investigated in conditions of Lor community in Aremenia.

Preventive measures have reduced the winter stock of pathogen infection and intensity of the disease development, while double application of Quadris and Revus Top fungicides during the vegetation period suppressed the development of anthracnose by 86.3-88.6 % and 91.6-92.4 %, respectively, as compared to the recorded indices in the control variant.

Thus, the recommended fungicides can be used alternately to combat bean anthracnose.

Introduction

The common dry bean or *Phaseolus vulgaris L.*, is the most important legume crop for direct consumption in the world. Among major food crops, it has one of the highest levels of variation in growth habit, seed characteristics (size, shape, colour), maturity and adaptation. Beans are nearly "perfect" food. Being nutritionally rich, they are also a good source of protein, folic acid, dietary fibre and complex carbohydrates (http://www.fao.org).

Diseases are the main reason of bean yield decline. Anthracnose is one of the most dangerous bean diseases in the world and can result in up to 100 % crop loss (Silva, et al., 2007). Anthracnose mostly infects common beans (P. vulgaris), however, other legume varieties can also be infected (http://vegetablemdonline.ppath.cornell.edu/).

Materials and methods

Field surveys on bean anthracnose were conducted in conditions of Lor community, at the RA Sisian province, during 2017-2019. Bean infectivity with anthracnose (P), as well as the degree of disease development (R) was assessed according to the common methods accepted in plant pathology (Dementyeva, 1985, Chumakov, et al., 1974).

The intensity of the anthracnose infection of plant leaves and pods was assessed with a 5-point scale:

0 point - no infection,

1 point - up to 10% of the leaf and beans/pods surface is infected,

2 points - 10.1%-25% of the leaf and beans/pods surface is infected,

3 points - 25.1%-50% of the leaf and beans/pods surface is infected,

4 points - more than 50.1% of the leaf and beans/pods surface is infected.

The disease rate (P), as well as the biological efficacy of the fungicides applied during the experiments were calculated through the respective formulae (Dementyeva, 1985).

Results and discussions

The causative agent of bean anthracnose is the fungus *Colletotrichum lindemuthianum* (Sacc. & Magnus) Briosi & Cavara (https://www.mycobank.org/). Bean seedlings grown from seeds infected with anthracnose often have dark brown to black sunken lesions on the cotyledons and stems. Diseased areas may girdle the stem and kill the seedling (http://vegetablemdonline.ppath.cornell.edu/). Under moist conditions, small, pink masses of spores are produced in the lesions. Spores produced on cotyledon and stem lesions may spread to the leaves. Symptoms generally occur on the underside of the leaves as linear, dark brick-red to black lesions on the leaf veins (Figure). As the disease progresses, the discoloration appears on the upper leaf surface.

The most striking symptoms develop on the pods. Small, reddish brown to black blemishes and distinct circular, reddish brown lesions are typical symptoms of bean anthracnose (Figure). Mature lesions are surrounded by a circular, reddish brown to black border with a grayish black interior (http://vegetablemdonline.ppath.cornell.edu/).

During moist periods, the interior of the lesion may exude pink masses of asexual sporulation – acervuli with spores. Severely infected pods may shrivel, and the seeds they carry are usually infected (Avagyan, 2006).

C. lindemuthianum fungus can survive for up to 5 years in infected bean pods and seeds that are air-dried and stored at 4^0 C. Survival is drastically reduced, however, when infected materials are buried in the field and come in contact with water (http://vegetablemdonline.ppath.cornell.edu/). Overwintering of the fungus on plant residues or in the soil greatly depends on climatic conditions. Humid weather conditions with mild temperatures (13-26º C and relative humidity greater than 92 %, or free moisture) during vegetation period contribute to the development of anthracnose on young leaves and beans (https://ag.umass.edu/).

Moisture is required for development, spread and germination of the spores, as well as for infection of the plant. A prolonged wet period is necessary for the fungus to establish its infection. The time from infection to visible symptoms ranges from 4 to 9 days, depending on the temperature, bean variety and age of the infected tissues (http://vegetablemdonline.ppath.cornell.edu/). The fungal spores are easily carried to healthy plants in wind-blown rain and by people and machinery moving through contaminated fields when the plants are wet, as well as by insects.

The damage caused by anthracnose to bean plants is manifested by a decrease in seed germination (up to 70 %), a change in the stems, leaves and pods, yield decrease, quality and taste of grains (Kotova and Kungurtseva, 2014).

Figure. The symptoms of bean anthracnose on the pods and leaves.

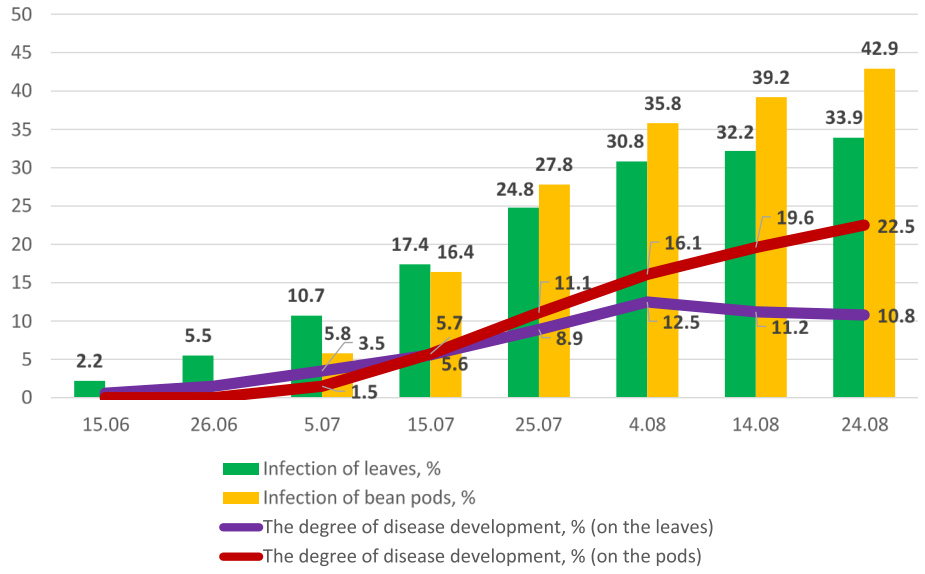

Diagram 1. Dynamics of bean anthracnose development, 2017 (*composed by the author*).

The pathogen of bean anthracnose may form also a sexual teleomorphic stage during life cycle (*Glomerella cingulata (Stonem.) Spauld. and Schrenk. f. sp. phaseoli*), however, in conditions of the Republic of Armenia, it successfully overwinters in an asexual anamorph stage - on plant residues, in the soil, as well as in infected grains - in the form of mycelium. The source of the plant primary, secondary and the following infections is the asexual sporulation.

During the vegetation season of 2017 in Lor community of Sisian province, we studied the dynamics of the development for bean anthracnose on "Armenian red" variety. Calculations were conducted after the first signs of the disease appeared, with a 10-day interval (Diagram 1). First symptoms of bean anthracnose were registered in the first decade of June. During June, bean anthracnose developed slowly (Infectivity of leaves was 5.5 %, disease intensity 1-2 points with the average of 1.1 points, and the degree of disease development - 1.5 %), but during July a rapid development of the disease was registered due to favorable weather conditions. According to the calculations made on August 4, the degree of leaf infestation with anthracnose was 30.8 %, the pods infestation was 35.8 % (P), the disease intensity - 1.6-1.8 points, and the degree of anthracnose development was 8.9-11.1 % (R) for leaves and pods respectively.

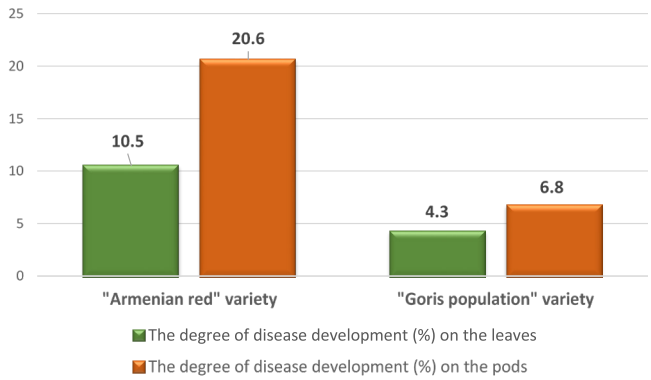

Diagram 2. Infection of local bean varieties with anthracnose (average data for 2018-2019) (*composed by the author*).

A depressive development of anthracnose disease on bean leaves was recorded during August - due to "leaves aging", while the infection of bean pods continued to grow - reaching 42.9 % (P for pods). In September, due to "aging of leaves and pods", a complete depression of anthracnose was recorded.

Above presented data coincide with research results of R.B. Martirosyan, according to which in Stepanavan province, Armenia, the development of bean anthracnose begins in late May - early June, the development of the disease reaches its maximum in the first decade of July and stops at the end of August, due to the full maturity of bean plant (Martirosyan, 1967).

While examining the infestation rate of local bean varieties "Armenian red" and "Goris population" with anthracnose (during 2018-2019), we found out (Diagram 2), that in case of bean cultivation without fungicide applications, the two most widely cultivated Armenian varieties have shown high to moderate sensitivity to anthracnose.

During 2018-2019, we studied also the effectiveness of fungicides applications against bean anthracnose. Experiments were carried out on the basis of the following preventive measures:

- healthy pods were harvested in the previous fall to obtain healthy seeds,
- after the harvest, all plant residues were destroyed (it is desirable to change the crop and return to the same field at least in the 3rd or 4th year, when the "self-cleaning" of the soil from pathogenic fungi took place),
- seeds were sorted before sowing: shriveled, discolored, diseased seeds were selected and removed,
- seeds were sown in a well-ventilated and well-drained area, optimal sowing density was observed,
- no plant care measures were implemented in the mornings and after precipitations, as bean anthracnose spreads more intensively in wet conditions.

During the growing seasons "Armenian red" bean plants were sprayed twice: the first application was administered at the stage of 5-6 true leaves, the second - at the beginning of the budding stage (according to the BBCH scale of phenological stages developed for beans, (https://en.wikipedia.org). The experiment was conducted with the following scheme:

1. Control - without spraying,
2. Two applications were conducted with Copper oxychloride WP (active ingredient: Copper Chloride - 900 g/kg, application rate - 4 kg/ha),
3. Two applications were administered with Antracol WP (active ingredient: Propineb - 700 g/kg, application rate - 2.5 kg/ha),
4. Two applications were realized with Quadris SC (active ingredient: Azoxystrobin - 250 g/l, application rate - 0.6 l/ha),
5. Two applications were conducted with Revus Top SC (active ingredients: Difenoconazole - 250 g/l and Mandipropamid - 250 g/l, application rate - 0.5 l/ha).

Fungicides weren't applied after flowering due to the risk of pesticide residues in the pods.

The selection of pesticides was based on the preparations against bean anthracnose recommended in various literature sources (Kotova and Kungurtseva, 2014; Booklet, Revus Top Fungicide. Washington, D.C. 20460; Bayer Crop Science. Official Website of Iraq; Quadris - Anthracnose Protection for Dry Beans; Characterization of Anthracnose Resistance in Common Bean, 2015). The

Table. Biological efficiency of fungicides against bean anthracnose (Lor community, 2018-2019)*

Experimental versions	Degree of disease development (R), %		Biological efficiency, %	
	on the leaves	on the pods	on the leaves	on the pods
Control	10.5	22.6	-	-
Copper Oxychloride 4 kg/ha x 2	3.2	7.2	69.5	68.1
Antracol 2.5 kg/ha x 2	1.5	3.4	85.7	84.9
Quadris 0.6 l/ha x 2	1.2	3.1	88.6	86.3
Revus Top 0.5 l/ha x 2	0.8	1.9	92.4	91.6

*Composed by the author.

Pesticide Handbook published by the the Food Safety Inspectorate of the Republic of Armenia does not include fungicides or seed disinfectants against bean anthracnose (https://snund.am).

The summary results of pre-harvest calculations for 2018-2019 are presented in Table. Double applications of fungicides Copper Oxychloride and Antracol during vegetation period have reduced the development of bean anthracnose by 69.5-68.1 % (for leaves and pods) and 84.9-85.7 % (for leaves and pods), respectively. The two sprayings with fungicides Quadris and Revus Top during vegetation period have significantly suppressed the development of anthracnose, providing 86.3-88.6 % (for leaves and pods) and 91.6-92.4 % (for leaves and pods) biological efficiency, respectively. Fungicides with higher biological efficiency - Quadris (0.6 l/ha) and Revus Top (0.5 l/ha), are recommended to be used alternately in the fight against bean anthracnose.

Conclusion

Based on the above stated reserch results the following conclusions can be drawn:

1. The pathogenic fungi of bean anthracnose overwinters in the asexual anamorph stage - on plant residues, in the soil, as well as in infected grains - in a form of mycelium. The source of the plant primary, secondary and the following infections is the asexual sporulation.

2. In Lor community of the Sisian province, the development of bean anthracnose mainly starts at the beginning of June; at first it develops slowly, then, in July, there is a rapid and intense development of the disease. A depressive development of anthracnose disease was recorded on bean leaves during August and on pods - in September, due to “aging of leaves and pods”.

3. Out of the two studied local bean varieties, the higher susceptibility to anthracnose was recorded in the variety “Armenian red”, comparatively lower - in the variety “Goris population”. Thus, in case of bean cultivation without fungicides, the two most widely cultivated Armenian varieties have shown high to moderate sensitivity to anthracnose.

4. Preventive measures can play an important role in the fight against bean anthracnose: selection of seeds from healthy pods, removal of plant residues, seed sorting, observance of the optimal sowing density, plant care only in dry weather. These measures reduce both the overwintering stock of anthracnose infection and the intensity of disease development during the vegetation period.

5. Two-time spraying (the first application was done at the stage of 5-6 true leaves, the second - at the beginning of the budding stage) of bean plants against anthracnose with different fungicides (Copper Oxychloride - 4 kg/ha, Antracol- 2.5 kg/ha, Quadris- 0.6 l/ha, Revus Top - 0.5 l/ha) provided high biological efficiency on the background of preventive measures. Fungicides with higher biological effeciency - Quadris (0.6 l/ha) and Revus Top (0.5 l/ha), are recommended to be used alternately in the fight against bean anthracnose to avoid resistance development.

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Evaluation and Improvement Ways of Ecological State in Agroecosystems of Voghjaberd Community

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ABSTRACT

The disturbance of equilibrium in agroecological systems of Voghjaberd community and their productivity decrease are mainly due to the strong landslides occurred in that area and to the erodibility of land resources. In the mentioned community 500 ha land area is highly prone to landslides, while 200 and 380 ha land areas are averagely and slightly susceptible to landslides respectively. About 69 % of the agricultural lands are strongly and averagely eroded.

Thus, in the landslide areas it is necessary to establish anti-landslide forest strips, while to mitigate erosion in the steep slopes it is necessary to implement perennial plant sowing and fertilization with organic fertilizers in the arable lands and rangelands.

Introduction

The imminent hazards to almost all natural and social systems of the globe are directly and indirectly related to the natural and anthropogenic factors. Biodiversity loss and negative environmental phenomena (soil erosion, landslides, chemical pulltion, etc.) sometimes irreversibly affect the productivity of natural and agricultural systems. The productivity of agroecosystems mainly depends on the soil fertility – the main resource of the mentioned system - which is considerably affected by various natural and anthropogenic factors the latter becoming the determinants of the soil productivity level (Biodiversity of Armenia, 2008, Statistical Yearbook of Armenia, 2017). In this regard the community of Voghjaberd in the Kotayk region is in an extremely unfavorable condition, where landslide and erosion processes are continuously taking place, which have rather adverse effects on the agricultural productivity: the yield capacity of the cultivated crops and fruit trees are decreasing year by year, the areas of natural pastures are subjected to degradation and the animals' productivity drops down.

The results of the latest (2015) reserach works conducted by the Geological Institute of National Academy of Sciences of Armenia have proved that the community of Voghjaberd is a landslide territory occupying 500 ha land area very much prone to landslides, also 200 and 380 ha lands, which are respectively mid and less prone to landslides; besides, these areas are developed into the clayish ground and

without any anti-lanslide measures, the consequences can be catastrophic (Galstyan and Mkrtchyan, 2013, Economic Research in the Kotayk Region, 2005, The Nature of Armenia, 2006, Environment and Natural Resources in the RA, 2016, Analysis of Socio-Economic State of the RA Kotayk Region, 2011).

Hence, any study aimed at the productivity increase of the community agroecosystems and sustainability provision, is quite actual and stems from the requirements of the developed strategy on the agricultural and environmental productivity increase of the mentioned community.

Materials and methods

The agricultural systems of Voghjaberd community in the province of Abovyan, have been significantly affected by the natural and anthropogenic factors. To this end, we have set a task to investigate the structure of the community agroecosystems, the current state of their productivity, as well as the landslide and erosion processes peculiar to the community, at the same time developing a system of agricultural measures to be taken for the improvement of the ecological state in the mentioned environment and for the increase of agrocenosis productivity.

The studies have been conducted based on the analyses of field, visual, cartographic and production indices as well as upon the results of laboratory, pedological and agrochemical analyses. To determine the degree of soil degradation, soil samples from the degraded and nondegraded land segments have been taken, in which the content of micronutrients (NPK) and humus has been determined through universal methods, which are introduced in the methodical manual on Agro-Chemical Analyses under the editorship of B.A. Yagodin (Yagodin, et al., 1989). The degree of vegetation cover in the rangelands has been determined through accounting the quantitative and qualitative indices of plants species composition per 1 m^2 (Tovmasyan, 2015). The three-year indices of livestock, plant and fruit growing activities have been provided by the community municipality (http://findarmenia.org/, RA Kotayk region in numbers, 2017), while the qualitative and quantitative descriptive indices of soils were found in the Atlas of Soils of the Republic of Armenia (Atlas of Soils of the Republic of Armenia, 1990).

Results and discussions

The results of the investigations have disclosed that the community lands continuously suffer from landslides and erosion processes, which strongly affect the agricultural activities resulting in the deterioration of soil fertility, yearly decrease in the yield capacity of the crops and orchards cultivated in small areas, degradation of the rangeland areas and in the abrupt reduction of animal productivity. According to the data registered in the Voghjaberd municipality and the surveys conducted among the population, the average annual cow milk productivity in recent years hasn't exceeded 1900 L (totally 72 cows are kept in the community), the sheep wool production has made 1.8 kg/year, while the poultry egg production capacity – 187 items per year, which is mainly related to the lack of sustainable forage base and insufficient interest of the farmers towards the mentioned branch.

The stated circumstances have fundamentally deteriorated the social and economic state of the community population paving way for emigration. Only within 2010-2017 years, 28 families emigrated from the community (105 residents totally); 21 families left to settle down in other residences of the Abovyan province with more favorable conditions, while 7 families resided in the provinces of Masis (2 families), Artashat (3 families) and Ararat (2 families).

The community land areas (totally 2360 ha lands, including ploughlands, grasslands and pastures) currently have low productivity level and when comparing them with the indices recorded upon the land surveys conducted in the 90s of the 20th century (Hayrapetyan, 2000), it can be stated that there were brown soil types with 3-4.5 % humus content, the soil reaction was from weakly alkaline to average alkaline (*pH*-7.4-8.5), where the content of easily hydrolyzed nitrogen made 3.2-4.2 mg in100 g soil, the affordable phosphorus and potassium content in 100 g soil was 5.9-6.9 mg and 32-42 mg respectively, that is, the soils were poorly provided with nitrogen, averagely and poorly provided with phosphorus, while they were rather rich in potassium (Table 1).

Upon the data of Table 1 the study results conducted in 2019 are introduced which indicate that the content of humus and mobile nutrients got reduced. The humus content decreased in 0.5 %, while out of the mobile nutrients, the nitrogen content in 100 g ploughland decreased in 0.6 mg, phosphorus content – by 1.1 mg, and the potassium content – by 4.0 mg. This is mainly due to the degradation degree of the agricultural lands in the community, which, as it has been already mentioned, is the consequence of landslides, particularly erosion of arable lands, improper soil cultivation and the overcrowded exploitation of pastures (especially near-village ones) without any rotational grazing.

Table 1. The agrochemical indicators of the brown soils in Voghjaberd community*

Land areas	The data of the RA Atlas, 1990					The data for 2019				
	Humus, %	pH	Mobile nutrients			Humus, %	pH	Mobile nutrients		
			N	P_2O_5	K_2O			N	P_2O_5	K_2O
Ploughlands	3.95	7.9	4.2	6.0	37.0	3.45	8.4	3.6	4.9	33.0
Grasslands	-	-	-	-	-	3.80	8.2	4.0	5.0	34.0
Pastures	-	-	-	-	-	3.90	8.0	3.7	5.1	34.0

*Composed by the authors

The community ploughlands and homestead lands are located in the slopes, where the upper fertile land strata are swept and moved away under the impact of atmospheric precipitations, particularly under that of heavy rainfall, which significantly affect the content of humus and affordable nutrients in the soil (Table 2).

The community lands are mainly of light brown type, while in the Abovyan province the soils, most subjected to mid and high erosion (49,8 %), occupy the overwhelming land territory along with other soil types.

The data of Table 2 show that 97.2 % lands of Voghjaberd community are brown soils, 68.7 % of which are averagely and strongly eroded, while the pasture areas near the community occupy 2.8 % or 66 hectare land area among the overall community lands and only about 39.6 % is strongly degraded.

The relatively lower content of humus and nutrients in the soil (as compared to the same indices recorded in 90s of the 20th century) is related to the afore stated circumstances. The decrease in the content of nutrients and particularly in that of humus, has surely affected the yield capacity of the agricultural crops cultivated in the community when comparing it with the similar average indices in the region and with those estimated in the community for the previous years (Table 3).

Table 2. Erosion rate of soils in the Abovyan province and Voghjaberd community, %*

Soil types	Area, thousand ha	Averagely and strongly eroded	
		Abovyan province	Voghjaberd community
Mountain-Meadow	19.3	10.0	-
Meadow-Steppe	5.5	9.1	-
Black soils	18.0	13.1	-
Brown soils	31.1	49.8	68.7
Semi-Desert gray soils	1.0	35.7	39.6 (pastures)

*Composed by the authors.

Table 3. The yield capacity indices of the crops and orchards cultivated in Voghjaberd community (2017-2019)*

Name of the crops	Average yield, c/ha					
	2017	2018	2019	The average for 3 years	The average for 2009-2015	The average of Abovyan province for 2018
Cereal crops	18.2	17.8	17.0	17.7	19.8	26.4
Tomato	195.0	200.0	176.0	190.3	245.0	394.0
Cucumber	178.0	170.0	165.0	171.0	187.0	318.0
Pomaceous tree	68.2	65.0	70.4	67.9	75.0	97.2
Drupaceous tree	36.0	34.0	35.0	35.0	40.0	63.2
Nut tree	90.0	85.0	91.0	88.7	98.0	102.0

So, if we compare the average data retrieved throughout the last three years on the yield capacity of agricultural crops and orchards (pomaceous, drupaceous and nut trees) of Voghjaberd community with the similar indices of the same community recorded in the previous years (2009-2015) and with those of the Abovyan province on the whole, it becomes vivid, that the yield capacity of the crops cultivated in the community is yearly decreasing, recording 15.2-24.0 % less indices than those observed for 2009-2015 in the same community; moreover, they were much lower than the average analogous indices throughout the whole region (Agriculture in the Republic of Armenia in 2011-2015, 2016, Socio-Economic Development Program of the RA Kotayk Region for 2011-2014, 2010). If the yield capacity of the community cereal crops per hectare made about 20.0 centner, that of tomato – 245.0 centner and cucumber – 187.0 centner, then in Abovyan province their average yield capacity made 26.4 c/ha, 394.0 c/ha and 318.0 c/ha respectively.

Low yield capacity indicators have been registered in the orchards as well, where according to the overyear average data, the pomaceous trees have provided 75 c/ha yield, drupaceous ones – 40.0 c/ha and the nut trees – 98.0 c/ha yield, which is less than the average of the region by 22.2 c/ha, 23.2 c/ha and 4.0 c/ha respectively. Such a low level of yield capacity in Voghjaberd community is related not only to low soil fertility, lack of scientifically justified fertilization norms and incomplete agricultural measures on the whole, but also to the adverse effects of natural hazards (landslides, erosion). Hence, if no preventive measures are taken in this respect, this catastrophic situation which reigns over the community for already 35 years can exacerbate even more and more.

As it has been already mentioned, 2.0 % of the overall land fund of the community or 66 ha land areas are semi-desert gray soils. These soil types are distinguished by natural low fertility, contain very little amount of organic matters and affordable nutrients (NPK) required by the plants.

These soils are mainly located in the pasture areas of the cummunity, particularly in near-village territories, where the soils are very much prone to erosion and have been almost defoliated due to the natural sparse vegetation, as well as to the overgrazing by animals. There are only 112-180 plants per $1m^2$ in these lands, which don't have any significant role in the prevention and mitigation of soil erosion. Grass growing in these land areas, especially with the seeds of perennial plants (sainfoin, fescue grass, cocksfoot, ryegrass, etc.) with 25-30 kg/ha seeding rate, as well as fertilization with at least 2 t/ha dosage of biohumus or organomix organic fertilizers is a vital need, which will reclaim the agro-meliorative state of those soils and serve as a most efficient means for the further prevention or mitigation of soil erosion.

Taking into account the low level of yield capacity of crops and fruit trees grown in the lands of Voghjaberd community, which is mainly due to natural (landslide and erosion) and somewhat to anthropogenic factors, we have tried to conduct an economic calculations on the losses the community residents suffer when cultivating this or that crop or fruit tree variety in the landslide-prone and eroded land areas.

In this respect, the calculations have been carried out for one hectare land area by comparing the yield amount harvested from the landslide and eroded lands with that of harvested from landslide-free and non-eroded land area. Besides, as to the information provided by the farm owners, in both places the crop sowing, cultivation and fertilization activities were implemented upon the same agricultural rules. The calculations have been conducted for cereal crops (winter wheat), tomato and cucumber. The sell price per 1 kg of cereal has been assumed at 150 AMD, while that of tomato and cucumber - 100 drams/kg each. Through the difference of harvested yield amount and its cost price the attributable profits and losses have been estimated, where the cost of expenses is also included.

The yield capacity indices and the yield prices (including the labor and fertilization expenses) for winter wheat, tomato and cucumber cultivated in the landslide and eroded land areas have indicated that everywhere in the mentioned areas lower yield, and therefore, lower-price product has been received as compared to the same indices of the crops cultivated in the landslide-free and non-eroded areas.

The calculations have shown that the winter wheat cultivated in favorable soil conditions has provided 9.5 c/ha yield surplus or 142.5 thousand AMD extra income against the same indices of winter wheat cultivated in unfavorable conditions (landslide and eroded areas). The same is true for tomato and cucumber, i.e., in case of favorable conditions, tomato has provided 185 c/ha yield surplus and 1 mln 850 thousand AMD more income (against the same indices recorded in unfavorable conditions) and in case of cucumber cultivation these indices have made 85.0 c/ha and 850.0 thousand AMD respectively (Table 4).

Table 4. The indices of economic estimation for the yield received from the crops of Voghjaberd community*

Crops Landslide hazard and eroded area		Yield, c/ha		Yield price, thousand AMD		Yield cost difference, thousand, AMD
		Landslide hazard and eroded area	Landslide-free and non-eroded area	Landslide hazard and eroded area	Landslide-free and non-eroded area	
1	Winter wheat	17.5	27.0	262.5	405.0	142.5
2	Tomato	205.0	390.0	2050.0	3900.0	1850.0
3	Cucumber	190.0	275.0	1900.0	2750.0	850.0

*Composed by the authors.

The economic estimations have testified that the landslide and erosion processes adversely affect the ecological state of Voghjaberd community, reduce the productivity of agroecosystems resulting in deterioration of the socio-economic conditions of the population living and working in the mentioned community, hence, promoting emigration.

Conclusion

Based on the conducted studies and economic assessments the following conclusions can be inferred:

The balance violation and productivity decrease of agroecosystems in Voghjaberd community are mainly due to the strong landslides and erodibility of the land resources, as a result of which there are 500 ha land areas highly susceptible to landslides, 200 and 380 ha land areas averagely and low susceptible to landslides respectively. About 69 % of the community lands are strongly and averagely eroded, exceeding the same index of the brown soils spread in Abovyan province in more than 10 %.

The economic estimations have disclosed that the winter wheat, tomato and cucumber cultivated in favorable conditions (landslide-free and non-eroded) have provided 40.2-68.5 yield surplus and much higher profitability as compared to the same indices of the mentioned crops cultivated in landslide and eroded land areas.

For combating the landslides occurring in the community it is recommended to establish anti-landslide forests both in the very landslide and in even farther territories.

To prevent erosion processes in the steep slopes of the community it is necessary to implement perennial plant seeding (sainfoin, fescue grass, cocksfoot) and fertilization activities in the arable lands and pasture areas.

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Introducing Seed Material Selection Method for the Increase of Tomato Seed Yield and Quality

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ABSTRACT

The aim of the research was to identify the most efficient cluster level and crop harvesting period (day) for tomato seed production, as well as to find out which seed breeding options will ensure higher quality indicators. The study objects were mid-early ripening tomato variety "Anahit 351" and mid-ripening varieties "Lia" and "Eraz".

Experimental results showed that tomato seeds taken from the fruit of second cluster after 10 days of ripening have provided highest seed weight, high germinability and germination energy meanwhile ensuring high productivity.

Introduction

Proper organization of theoretically justified seed production is almost missing in some agricultural areas of the Republic of Armenia. Today, seed breeding often refers to physical, chemical, and biological stimulants that improve seed sowing quality and efficiency (Ryabchikova, 2018).

Taking into account the rapidly changing production-economic and market conditions in our Republic, the scientific investigations on consistent seed breeding management methods and on a number of other issues related to various agricultural crops, including tomatoes, are of utmost importance.

The share of vegetable croplands, particularly tomatoes, in the agrarian system of the Republic of Armenia has significantly increased in recent years. Tomato occupies 21 % of the total sown areas of vegetable crops (20 616 ha) (www.armstat.am).

Tomato is the most popular vegetable crop. It is endowed with high taste properties and is rich in vitamins (*A, B, C, PP*), organic acids (citric acid and malic acid) and mineral salts (*Ca, Na, Mg, Fe* and etc.). It is used fresh and processed (Zuev, et al., 2016).

We have set up a task to research and identify the most effective cluster number and the period (day) for harvesting tomato seed crops, as well as to reveal the options where the seed yield would demonstrate high quality indicators.

Materials and methods

The current research was carried out on the experimental farm of "Scientific Centre of Vegetable and Industrial Crops" within 2019-2020. The research objects were mid-early ripening tomato variety "Anahit 351" and mid-ripening varieties "Lia" and "Eraz".

Phenological observations and biometric measurements were conducted during the vegetation period. The weight of 1 tomato seed crop, seed number and weight per 1 fruit, as well as the weight of 1000 seeds and number of locales were determined according to the cluster level and harvesting time after tomato fruit maturation (Sichev, et al., 1991). Biochemical analysis of the plants was carried out. Dry matter content was determined through IGF-454B2M refractometer, while total sugars were determined through Bertrand's method and ascorbic acid – through the Moore method (Peterburgskiy, 1968, Yermakov, 1972).

The content of proteins, fats, starch and phosphorus in the seeds of studied tomato varieties were determined (Yermakov, 1972). Seed germination capacity and germination energy were determined according to GOST standards. The period corresponding to 75 % of germinated seeds was recorded as an indicator characterizing the germination process (Sichev, et al., 1991).

Per the determined seed crop harvesting time and identified cluster level, from each hundred plants of the studied varieties ten kilograms of seed fruit were taken, which were deseeded and dried out in the open air. The yield of obtained seeds was determined through weighing method in grams. The yield calculation was implemented by weighing the yield of each experimental bed. The total yield per each cluster level and per hectare was also calculated and the average weight of the fruit was determined (Methodology for State Variety Testing of Agricultural Crops, 2015).

The data retrieved as a result of the study were subjected to statistical analysis (Dospekhov, 1985).

Results and discussions

Investigations showed that the examined varieties differed in biomorphological indicators. Thus, average height of the tomato plant variety "Anahit 351" was 55.6 cm, and "Lia" variety exceeded "Anahit 351" by 4.4 cm, while "Eraz" variety, on the contrary, conceded by 9.9 cm. The varieties also differed in cluster and fruit number both on the main stem and throughout the whole plant. The best indicators were registered in "Anahit 351" (Table 1). As the data of the Table 1 indicate, the fruits of "Lia" variety are roundish, while those of "Anahit 351" are slightly flattened and in "Eraz" variety they are ellipsoid. The variety of "Anahit 351" was distinguished by the number of locales and seeds in the fruits.

Qualitative analyses of the fruits and seeds in the studied tomato varieties were performed on the 5th, 10th and 15th days after fruit maturation to find out the option with highest quality. The content of dry matter, total sugars, ascorbic acid and seed nutrients (proteins, fats, starch and total phosphorus) of the mentioned varieties was determined in the laboratory.

The results of biochemical analysis showed that in all studied varieties, both dry matter and ascorbic acid were higher in the second cluster of 10-day ripened fruits, and total sugars were higher in the third cluster of 15-day ripened fruits. The seeds taken from the second and third clusters of 10-day ripened fruits (Table 2) were the most prominent regarding the high content of nutrients.

Studies show that the quality of seeds obtained from different clusters of "Anahit 351", "Lia" and "Eraz" tomato varieties and harvested in different periods is also different.

Table 1. Biometric indicators of tomato varieties*

Varieties	Plant height, cm	The number of clusters, n		The number of fruits, n		Fruit index	Fruit weight, g	Number of locales in 1 fruit, n	Number of seeds in 1 fruit, n
		On the main stem	On the whole plant	On the main stem	On the whole plant				
Anahit 351	55.6	5.5	10.5	7.4	15.2	0.7	162	4-5	420
Lia	60.0	4.8	7.5	9.9	15.0	0.9	212	2-3	285
Eraz	45.7	5.3	9.9	8.2	17.3	2.1	72	2	150

*Composed by the authors.

Table 2. Biochemical indicators of fruits and seeds per options, 2019*

Varieties	Options, clusters/day	In fruits			Seed chemical composition per dry matter, %			
		Dry matter, %	Sugars, %	Vitamin C, mg/%	Protein	Fats	Starch	Total phosphorus
Anahit 351	2/5	6.0	3.0	18.4	26.25	26.30	2.95	0.880
	2/10	6.9	3.3	18.8	28.66	26.72	3.15	0.892
	2/15	6.8	3.3	18.6	26.35	26.01	2.75	0.867
	3/5	6.7	3.1	17.9	26.65	24.95	2.68	0.872
	3/10	6.8	3.2	18.2	27.86	26.90	3.25	0.884
	3/15	6.2	3.6	18.0	26.31	25.82	2.85	0.868
Lia	2/5	6.5	3.1	19.0	28.21	25.20	2.44	0.925
	2/10	7.0	3.3	19.5	29.75	26.78	2.78	0.975
	2/15	6.8	3.4	19.4	29.25	25.71	2.46	0.922
	3/5	6.2	2.8	18.9	28.24	25.35	2.11	0.927
	3/10	6.3	3.4	19.2	29.48	26.72	2.56	0.953
	3/15	6.0	3.7	18.7	29.05	26.01	2.12	0.950
Eraz	2/5	7.2	3.5	17.3	28.55	24.87	2.78	0.735
	2/10	7.5	3.8	18.1	30.14	25.65	3.37	0.828
	2/15	7.3	3.6	17.7	28.65	25.16	3.17	0.805
	3/5	7.1	3.4	17.5	29.02	25.11	3.13	0.749
	3/10	7.3	3.5	17.3	29.87	25.80	3.20	0.799
	3/15	6.8	3.9	17.0	28.11	25.00	3.09	0.740

*Composed by the authors.

As it can be seen from the data of introduced Figure, the seed weight per 1 fruit of "Anahit 351" variety is higher than that of "Lia" and "Eraz" varieties in 1.5 and 2.8 times respectively. At the same time, it should be noted that in all studied varieties, the highest seed weight was recorded in the second cluster of 10-day ripened fruits.

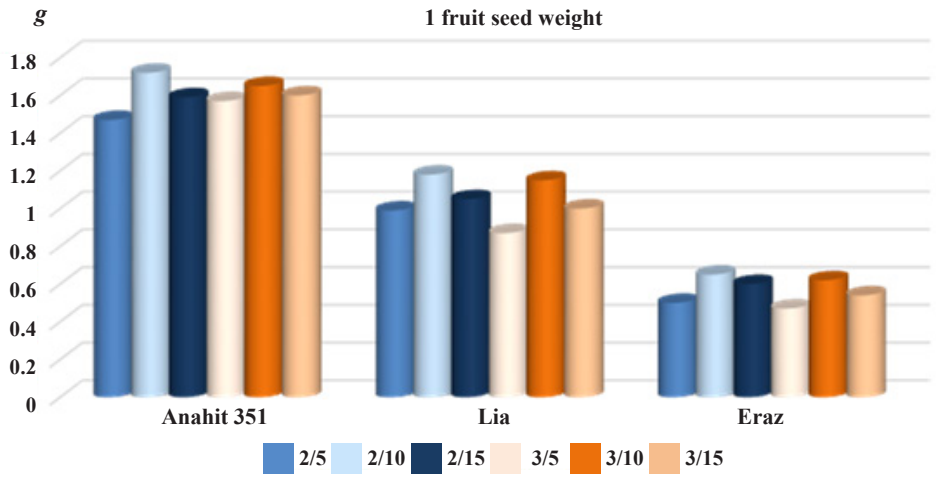

Figure. Weight of seeds in one fruit depending on cluster level and harvest period (*composed by the authors*).

Table 3. Seed germinability and germination energy of tomato varieties according to options in laboratory and field conditions*

Varieties	Options, clusters/days	In laboratory conditions		In field conditions	
		Germinability, %	Germination energy, %	Germinability, %	Germination energy, %
Anahit 351	2/5	94± 1.4	87± 3.2	92± 2.5	85± 2.4
	2/10	97± 1.1	90± 1.7	96± 1.8	89± 1.3
	2/15	95± 1.2	88± 1.3	94± 1.4	87± 2.5
	3/5	91± 2.4	85± 1.5	87± 3.5	82± 3.6
	3/10	93± 1.2	87± 2.4	94± 1.3	86± 1.2
	3/15	93± 1.4	85± 3.1	91± 3.2	83± 1.4
Lia	2/5	95± 1.5	90± 2.4	92± 4.2	85± 3.8
	2/10	97± 1.3	92± 1.1	95± 1.7	90± 1.7
	2/15	94± 1.4	86± 1.7	94± 2.6	83± 2.6
	3/5	93± 0.9	86± 2.1	92± 3.3	85± 2.1
	3/10	97± 3.1	88± 3.0	96± 1.5	88± 3.4
	3/15	97± 2.2	90± 2.8	95± 3.4	83± 3.8
Eraz	2/5	95± 1.5	89± 3.4	92± 1.7	85± 5.4
	2/10	98± 1.0	91± 1.5	95± 1.3	89± 1.8
	2/15	96± 2.4	90± 2.0	94± 1.4	87± 3.1
	3/5	96± 1.7	87± 1.8	93± 2.4	85± 2.7
	3/10	97± 2.5	92± 1.6	92± 1.3	84± 2.0
	3/15	94± 3.4	90± 2.5	92± 3.0	83± 2.5

*Composed by the authors.

To thoroughly assess the quality of tomato seeds, the seeds taken in 2019 (cluster/day) were sown in the following year per the same options. Seed germination capacity and germination energy were determined in laboratory and field conditions. Studies indicated that in contrast to open field conditions, seed germination capacity and energy were higher in laboratory conditions due to more favorable medium for seed germination. However, the field germination rate was also quite high in all 3 studied varieties (Table 3).

The results of phenological observations showed that the germinability and germination energy of the seeds taken from the second and third clusters of the the same options 10 days after ripening, were relatively higher than those in the seeds of 5 - and 15 – day ripened options in all mentioned varieties.

Sowing of the tomato seed varieties harvested in different time periods and from various clusters was implemented in 2020 per the mentioned options to disclose their efficiency.

Yield amount was calculated according to varieties and options per hundred plants, and seed yield rate was determined per 10 kg of seed material. It was found out that the seed materials harvested from the second cluster after 10 days of fruit ripening showed relatively higher productivity in all varieties. Thus, the yield capacity of "Anahit 351" variety made 851.7 c/ha; anyhow, high yield (846.3 c/ha) was also provided in the seeds harvested from the third cluster after 10 days of fruit maturation. The same pattern is observed for "Lia" and "Eraz" varieties. The yield capacity for "Lia" variety made 928.7 c/ha and 916.0 c/ha in respective options and for "Eraz" variety it was 796.6 c/ha and 785.0 c/ha respectively. This regularity is also true for seed yield indicators (Table 4).

Table 4. Tomato yield capacity and seed yield rate depending on fruit cluster level and harvest time, 2020*

Varieties	Options, cluster/day	Yield, c/ha	Seed yield from 10 kg seed crop
Anahit 351	2/5	835.3	30.5
	2/10	851.7	35.2
	2/15	843.7	32.0
	3/5	835.0	29.4
	3/10	846.3	31.9
	3/15	840.7	30.0
	$LSD_{0.95}$ -1.1 Ex% - 0.7		
Lia	2/5	905.0	19.9
	2/10	928.7	21.5
	2/15	896.0	20.4
	3/5	902.7	20.1
	3/10	916.0	21.2
	3/15	896.7	20.0
	$LSD_{0.95}$ - 3.1; Ex% - 1.1		
Eraz	2/5	740.3	8.1
	2/10	796.6	11.6
	2/15	764.0	10.4
	3/5	757.0	10.0
	3/10	785.0	11.0
	3/15	753.0	9.5
	$LSD_{0.95}$ - 3.9; Ex% - 0.9		

*Composed by the authors.

Conclusion

So, taking into account the aforementioned circumstances and the conducted analyses, it is worthwhile stating that when selecting seed materials, those from the second clusters after 10 days of fruit maturation are highly recommended. The mentioned option ensures highly productive seed material from the qualitative and quantitative aspects, the seeds of which provide higher yield capacity when sowing in the following year.

The seed material of the third cluster harvested after 10 days of fruit maturation can be also used as the second recommended option, since their seeds also provided higher yield capacity as compared to the other discussed options.

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The Use of Complexon for the Increase of Regeneration Capacity in Some Fruit Trees after Hailstorm

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ABSTRACT

Hailstorm causes huge damages to the orchards and vineyards in the Republic of Armenia. Particularly the yield, annual and perennial shoots, as well as the fruiting organs are badly damaged.

A fertilizer has been synthesized and applied by our research group, by means of which the artificially simulated injuries on the shoots or those caused by the hailstorm are recovered with noticeable intensity.

According to the experimental data the artificially simulated wounds on the shoots of "Victoria" plum tree have been well recovered, the index of which makes 35-45 % in the control variant, while in the variant where Complexon-3 has been twice administered it has amounted to 95-99 % with slight differences.

Introduction

Hail is a type of atmospheric precipitation which is formed out of the frozen water drops with various shapes and sizes. Hail mainly falls during the daytime (Soviet Armenian Encyclopedia, 1979, Gayvoronskiy, 1976, Margaryan and Simonyan, 2014).

Hailstorm damages or destroys the plants (crops). The hailstorm in Armenia often occurs with such intensity, that it damages the yield of orchards and vineyards, annual and perennial shoots, as well as fruiting organs (Margaryan and Simonyan, 2014). The growth and fruiting of such plants slow down and the possibility of getting infected with diseases and pests grows up. According to the studies conducted by different researchers, regeneration of the plants often lasts several years depending on the hailstorm intensity (Grigoryan, et al., 2014, Dinevich, 1990, Jackson, 2013, Mazin, 1972, www.asprus.ru).

In order to facilitate the process of viability recovery in the hail-damaged plants, different agro-technical events and materials are developed and implemented, such as pruning, growth stimulants, fertilizers, toxins, etc. (Startsev, 2018, Taov, 2000). There are different ways for hail fighting, such as hail cloud dissipation, dispersion of silver containing compounds through shells and planes, or shooting at the hail clouds through the device named "Zenit" (Agricultural Encyclopedia, 2015). The latter, however, is not efficient. Application of anti-hail nets is a more efficient method, but they are rather expensive and hence, not available for most farmers yet.

Considering the circumstance that almost every year hailstorm causes huge damages to horticulture and viticulture in the Republic of Armenia, we have recommended a water-soluble complex fertilizer, the application of which recovers the hail-stricken trees and vines and enhances their viability with remarkable intensity (within the same vegetation period). Thus, it was also planned to search for scientific evidences on the positive effects observed in the mentioned fertilizer.

Materials and methods

The aim of the research is to disclose the effect of applying the combined water-soluble fertilizer (Complexon-3) synthesized by our research group on the recovery process of the damage (hailstorm) simulated on the biennial shoots of the fruit trees.

The field experiments have been conducted in the orchards of the Zovashen community in the Ararat region (3 farm households) on the "Victoria" and "Italian Vengerka" plum tree (7-year-old), "Lodz" peach tree (6-year-old) and "Shaqarkeni" apple tree (30-year-old) varieties.

In the plum orchards the experiments have been conducted on the background of $N_{90}P_{60}K_{45}$ fertilization (April 5, 2020). The experiments in peach orchards have been set up on the background of $N_{90}P_{90}K_{60}$ fertilization, while the apple trees haven't been fertilized at all.

The damage to the trees was simulated artificially on the biennial shoots with a priori assumption that the area of hail damage on the trees makes averagely 1 cm^2. Based on the fact that depending on the hailstorm intensity the injuries (slight wounds) can be of different degrees, 3 mimicked injuries of different degrees on the same biennial shoot have been simulated: a - only the bark has been damaged, b – the bark and phloem, c – the bark, phloem and xylem or the upper layer of cambium have been damaged.

So, 3 different wounds have been simulated on the same biennial shoot. For the experiments 5 trees have been selected, i.e., the trials have been conducted with 15 repetitions. One tree has been taken as a control option.

Immediately after wound simulation (16.05.2020), the first foliar nutrition with water solution (40g per 10L water) of Complexon-3 was implemented. The second foliar nutrition was applied on May 19, 2020 only in plum tree experiments.

The impact of Complexon-3 on the healing process of the mimicked wounds of the biennial shoots was tracked on May 31, June 28 and October 18, 2020. It should be noted that the time of inducing artificial damages in the trees is adjusted to the time period of natural hailstorms occurred in the terrain.

The first two observation periods coincide with the trees intensive growing period, while the third observation period coincides with the eve of winter dormancy.

To examine the experimental plots, soil samples from the orchard sites have been taken and their chemical analyses have been conducted through the accepted methods in the Republic of Armenia (Yagodin, 1987).

The reliability of the study results have been justified through the dispersion analysis. The experimental error (Ex%) and the least significant difference (LSD) between the discussed options has been estimated (Dospekhov, 1979).

Results and discussions

The experiments have been carried out on the light brown carbonate soils, the description of which is presented in Table 1. According to the table data the humus content at the depth of 0-30 cm in the experimental plots of plum trees makes 3.48-3.96 %, the soil mechanical composition is clay and sandy of medium texture, the reaction (pH) is 7.5-7.6, the content of carbonates makes 4.96-5.1 %, the dissolved salts content in water is 0.046-0.051 %, the ratio of Ca-Mg fluctuates within the range of 0.68-0.083.

According to the data of Table 1, the soil mechanical composition, the content of water dissolved salts and carbonates are quite favorable for the growth of fruit tree varieties. The ratio of Ca-Mg in the soil solution is distorted at the price of calcium, which was regulated through the application of double superphosphate.

The experimental plots are poorly provided with affordable nitrogen and phosphorus and averagely provided with potassium.

Table 1. The chemical and mechanical properties of the experimental plots*

Soil type, crop	Light brown, Plum tree	Light brown, Peach tree
Depth, cm	0-30 30-60	0-30 30-60
Mechanical composition	Clay and sandy, medium	Clay and sandy, medium
Humus, %	3.48/1.56	3.96/1.44
pH	7.6/7.8	7.5/7.8
Content of carbonates, %	5.17/6.84	4.96/6.76
Content of dissolved salts, %	0.046/0.038	0.051/0.048
In water solution mg/eq in100g soil, Ca^{2+}	1.3/1.8	1.5/1.6
In water solution mg/eq in100 g soil, Mg^{2+}	1.9/2.5	1.8/2.0
Plants affordable nutrients, mg in 100 g soil, N	4.14/3.01	5.12/3.38
Plants affordable nutrients, mg in 100 g soil, P_2O_5	2.28/1.84	2.81/2.06
Plants affordable nutrients, mg in 100 g soil, K_2O	31.61/28.74	25.45/21.36

Table 2. The effect of Complexon-3 on the regeneration property of the plum tree after simulated hailstorm*

Options	Plum tree varieties					
	Victoria (Jane Prune)			Italian Vengerka (Chernosliv)		
	The study periods for 2020					
	First 31.05	Second 28.06	Third 18.10	First 31.05	Second 28.06	Third 18.10
Control (without spraying)						
shoot 1	37	40	45	44	50	65
shoot 2	30	35	40	45	50	65
shoot 3	25	30	35	42	55	60
The 1st sprayed tree						
shoot1	70	95	97	70	80	80
shoot2	50	90	95	80	90	95
shoot3	40	85	95	70	90	95
The 2nd tree						
shoot 1	45	55	98	35	40	40
shoot 2	45	50	99	30	35	40
shoot 3	35	40	97	25	30	40
The 3rd tree						
shoot 1	45	50	55	67	80	82
shoot 2	35	40	45	65	80	83
shoot 3	25	35	65	55	70	75
The 4th tree						
shoot 1	40	85	98	70	90	95
shoot 2	45	80	99	55	70	97
shoot 3	46	75	95	40	65	99
The 5th tree						
shoot 1	60	90	98	35	40	45
shoot 2	55	85	99	30	35	50
shoot 3	40	80	99	25	30	45

Note: *the data of the Table 2 and 3 are retrieved by averaging results on the repair process of wounds of different degrees simulated on the same shoot.*

*Composed by the authors.

Table 3. The effect of Complexon-3 on the regeneration properties of peach and apple trees after simulated hailstorm*

Options	"Lodz sliced" peach variety			"Shaqarkeni" apple variety		
	The study periods for 2020					
	First 31.05	Second 28.06	Third 18.10	First 31.05	Second 28.06	Third 18.10
Control (without spraying)						
shoot 1	25	50	50	40	40	50
shoot 2	20	45	65	45	45	50
shoot 3	15	40	65	35	35	70
The 1st sprayed tree						
shoot1	35	90	92	40	40	95
shoot2	33	80	91	33	35	97
shoot3	25	70	90	20	30	97
The 2nd sprayed tree						
shoot 1	72	90	90	40	80	99
shoot 2	50	80	95	33	60	85
shoot 3	32	70	95	20	55	95
The 3rd sprayed tree						
shoot 1	25	50	55	27	50	85
shoot 2	33	40	45	20	45	90
shoot 3	40	40	60	15	35	95
The 4th sprayed tree						
shoot 1	60	70	70	10	70	95
shoot 2	50	65	70	15	95	96
shoot 3	30	50	85	17	65	96
The 5th sprayed tree						
shoot 1	33	50	60	15	50	60
shoot 2	27	50	60	17	45	65
shoot 3	20	40	55	18	40	70

*Composed by the authors.

The data of Tables 2 and 3 indicate the effect of Complexon-3 on the recovery process of artificial damages simulated on the biennial shoots of the experimented trees. It is noteworthy that per our observations wound healing process (barking) takes place through the following phases:

1. Discoloration of the damaged surface from milky to the brown color,
2. Formation of cuticular hillocks out of the stomatal pores from the both sides of the damaged surface,
3. Hillocks growth, their approximation and gradual recovery of the phloem wound,
4. Wound repair with the resin layer coating,
5. Wound repair with the bark layer coating.

The data introduced in the Tables 2 and 3 testify that the application of Complexon-3 exerts a significant impact on the wound repair process (barking). Moreover, this process is more intensive after the second nutrition with the solution of Complexon-3, particularly in case of "Victoria" plum trees.

The data of Table 3 show that the barking process (bark regeneration) on the shoots of peach tree occurred much slower, yet going on throughout the whole vegetation period, while the wound repair process in apple trees went on up to June 19, 2020 and then was almost interrupted.

We believe that the abovementioned is related to the fact that the crops foliar nutrition with Complexon-3

was implemented only once (May 16, 2020), where the biological peculiarities of the plants also played a key role.

The course of such process in the apple trees is also related to the age of tree (30-year-old), due to which the biological processes considerably slow down, while in peach trees the damage recovery is related both to the age and peculiarities of the plant species.

Conclusion

According to the results of the experiments, Complexon-3 can be used to recover the crop injury caused by the hailstorm within the same vegetation period.

Wound repair process, upon the use of Complexon-3, takes more intensive course in the actively growing period of the trees.

The course of wound repair is also related to the tree variety (species) and the frequency of Complexon-3 application. In case of only single foliar nutrition the wound healing process in the plants is much slower and less complete as compared to that of recorded in case of double or triple foliar nutrition.

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Selection of Endemic Lactic Acid Bacteria for Lactose-Free Milk Production

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ABSTRACT

The *β-galactosidase* activity of lactic acid bacteria isolated from traditional lactic acid product matzoon was studied. It has been shown that some endemic lactic acid bacteria isolated from the matzoon samples produced from cow milk have *β-galactosidase* activity. Three Strains have been selected out of 370 studied lactic acid bacteria.

β-galactosidase is of great practical importance and is also used for the production of glucose-galactose syrups, sweeteners, as well as for obtaining lactose-free milk and whey processing during waste disposal.

Introduction

As a traditional and national Caucasian dairy product, matzoon is a symbiotic consortium of lactic acid bacteria and various types of saccharomyces.

Depending on the milk type, its composition and geographical origin, matzoon differs in taste, smell, content of nutrients and density. As a complete chemical food, it contains almost all the nutrients necessary for the human body. Various samples of matzoon differ in milk protein, fat, lactose, vitamins (*A, B, C, D, E*) and other features (Afrikian, 2009). Selected as a "probiotic" during natural evolution, matzoon cleanses the body from toxins, regulates metabolism, reduces the amount of cholesterol in the blood, increases the body's well-being, regulates colitis and intestinal dysfunction neutralizing the effects of drugs, especially antibiotic and hormonal ones (Hakobyan, et al., 2016).

It is well-known that milk contains about 4 % monosaccharide – lactose that some people are unable to digest.

In the absence of lactase which cleaves lactose, people become lactose intolerant, which does not depend on milk, but rather on the specificity of the human body or the lack of β-galactosidase (enzyme) activity (Bellmer, et al. 2005). A real salvation for such people is lactose-free milk, which containing all the useful substances does not have any undesirable effect on the gastrointestinal tract (Bury and Jelen, 2000). Lactase is widespread in nature. The plants

and microorganisms are the natural sources of the enzyme (Cebeci and Gürakan, 2003, Jurado, et al., 2002). Lactases obtained from lactic acid bacteria, which are absolutely safe for humans are of particular interest. Fungal strains are now widely used for the enzyme production, although the focus is on the lactic acid bacteria as they are safe and can be used as starting materials in dairy products (Kim and Rajagopal, 2000, Kreft and Jelen, 2000).

The aim of this research was to conduct a comparative study on the *β-galactosidase* activity of endemic lactic acid bacteria isolated from matzoon samples produced from cow milk.

Materials and methods

For the research 370 endemic lactic acid bacteria isolated from matzoon samples taken from different regions in Armenia and kept in the Culture Collection of the Microbial Depository Center (MDC) of the SPC "Armbiotechnology" NAS RA were used.

The identification of lactic acid bacteria was performed through API BioMerieux, inc, 50 CHL and 50 CH systems.

Bacteria were grown in MRS nutrient broth at 30-37 ^{0}C for 16-24 hours.

O-nitrophenyl-β-D-galactopyranoside (ONPG) was used to determine the activity of *β-galactosidase*. One of the final products of ONPG hydrolysis *O-nitrophenol* (ONP) stains the solution yellow, the concentration of which was measured by spectrophotometer (biochemical analyzer-photometer STAT FAX 1904+, USA) at a wavelength of 410 nm. The activity of *beta-galactosidase* was determined according to the well-known method (Le Minor and Ben Hamida, 1962).

The activity of strains was recorded for 20 min, with the intervals of 1, 2 and 24 hours. The amount of enzyme that catalyzed 1 μmol of *O-nitrophenol* per minute under the appropriate conditions has been selected as the unit of *β-galactosidase* activity. The calculation has been conducted according to the following formula (Baran, 1996):

$$U_{/ml} = \frac{\Delta A_{420/\min}}{\varepsilon},$$

where $\Delta A_{420/\min}$ is the rate of absorption change, ε is the absorption coefficient according to ONP 1.3546 ml $\mu mol^{-1}/cm^{-1}$.

The specific activity was calculated through the following formula:

$$U_{/mg\ protein} = \frac{\Delta A_{420/\min}}{\varepsilon \times mg\ protein / ml\ medium},$$

or

$$U_{/mg\ CDW} = \frac{\Delta A_{420/\min}}{\varepsilon \times mg\ CDW / ml\ medium},$$

where CDW is the dry cell weight.

The amount of lactose in milk and in dairy products was determined through the cyanide method (Bychkova, 2014). The amount of lactose in milk was calculated according to the following formula:

$$\omega = \frac{0.012 \times V_1 \times 100\ \%}{V_2 \times m},$$

where 0.012 is the amount of lactose required to restore 10 ml of 1 % solution of red blood salt $K_3[Fe(CN)_6]$, V_1 is the total volume of the test solution, V_2 is the volume of the test solution used to titrate 10 ml of $K_3[Fe(CN)_6]$ solution, m is the volume of milk (dairy products).

The statistical analysis of the obtained data was performed by the software of Microsoft Office Word 10 and Microsoft Office Excel 2010. The differences were considered reliable at $p<0.05$.

Results and discussions

For the determination of the *β-galactosidase* activity, 370 strains of lactic acid bacteria were studied; 25 Strains with probiotic properties, highly resistant to antibiotics and 4 % NaCl, as well as with thermostability at 45 ^{0}C and pH 8.0 were selected. 20 of the strains belong to lactobacilli, 5 to lactococci. As it can be seen from the data presented in Table 1, the selected bacteria belong to different species of the genus Lactobacillus; 8 Strains that become active within 20 minutes belong to *L. fermentum*, *L. delbrueckii* and *L. cremoris*, the remaining strains become active within one hour (Table 1).

In strains with *β-galactosidase* activity, the possibility of lactose cleavage was determined (lactose content in milk was 4.1 %).

Table 2 describes the lactose digestion by the selected LAB in 1 hour.

Table 1. *β-galactosidase* activity (IU) of lactic acid bacteria*

Species of lactic acid bacteria	*β-galactosidase* activity (IU)	
	20 min	1 hour
Lactobacillus fermentum G-4	0.09	0.09
L.fermentum G-12-1	0.35	0.26
L.fermentum G-12-2	0.29	0.29
L.fermentum G-12-3	0.13	0.27
L.fermentum 24-7	0.46	0.47
L.fermentum 27-1	0.57	0.57
L. mesenteroides ssp. cremoris G-6	0.07	0.05
L.delbrueckii ssp. lactis 17-13	0.31	0.48
Lactobacillus sp. 13-1	0	0.34
L. curvatus ssp. curvatus 17-7	0	0.47
L.fermentum 27-4	0	0.66
L.fermentum 27-6	0	1.28
L.salivarvarius 32-4-1	0	0.58
Lactobacillus sp. 40-1-4	0	0.66
Lactobacillus sp. 35-2-2	0	0.43
L.delbrueckii ssp. lactis 40-1-3	0	0.56
L.paracasei ssp. paracasei 41-15-1	0	0.52
L.delbrueckii ssp. lactis 42-1-1	0	0.53
L. plantarum 103-1-3	0	0.65
L.delbrueckii ssp. lactis 17-15	0	0.46
L.delbrueckii ssp. lactis 17-20	0	0.59
L.lindneri 18-2	0	0.73
L.delbrueckii ssp. lactis 27-2	0	0.60
Leuconostoc lactis 32-4-2	0	0.59
Leuconostoc lactis 21-1	0	0.48

Table 2. Lactose digestion by lactic acid bacteria*

Lactic acid bacteria	*β-galactosidase* activity (IU)	Residual amount of lactose in milk ω, %
L.fermentum 27-4	0.66	0.4
L.fermentum 12-3	0.27	0.5
L.fermentum 27-6	1.28	0.9
L.delbrueckii ssp. lactis 40-1-3	0.56	0.6
L.delbrueckii ssp. lactis 27-2	0.60	0.8
L.delbrueckii ssp. lactis 17-13	0.48	1.1
L. mesenteroides ssp. cremoris G-6	0.05	1.5

*Composed by the authors.

As it can be seen from the data presented in Table 2, the selected strains differ in *β-galactosidase* activity and the amount of residual lactose in milk. *L. fermentum 27-6* strain has high *β-galactosidase* activity and high residual amount of lactose, whereas *L. mesenteroides ssp. cremoris* G-6 strain with low *β-galactosidase* activity has high residual amount of lactose under the same conditions. It can be assumed that the lack of this symmetry may depend on external factors. As a basis for our future research and for the production of lactose-free milk a consortium of the following strains has been created: *L.fermentum 27-4, L.fermentum 27-6, L.delbrueckii ssp. lactis 27-2*. Preliminary data showed that the average lactose content in the formed consortium was 0.6 % (1 hour after processing milk at 37 ^{0}C). Thus, the selected endemic LAB can be the basis for the production of lactose-free milk, the technology of which is currently missing in Armenia.

Conclusion

The consortium of 3 selected strains (*L. fermentum 27-4, L. fermentum 27-6, L. delbrueckii ssp. lactis 27-2*) can be used for the fermentation of milk and the production of lactose-free milk.

The production of bacterial beta galactosidase is rather widespread. Active in a wide range of temperatures and pHs, lactic acid bacteria are also of particular interest as a potential source of *β-galactosidase*. Apart from using lactic acid bacteria as a probiotic, they are also of vital significance for many people who do not digest lactose, while via non-lactose foods they are able to return to a healthy lifestyle and diet. Therefore, the prospective strains studied by our research group are endowed with high *β-galactosidase* activity and could be possibly used in the production of lactose-free milk, which would be quite beneficial especially for lactose intolerant people using dairy products.

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Study of Opportunistic Pathogenic Microflora in Otodectosis of Small Domestic Animals

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ABSTRACT

According to statistical data, 10-20 % of dogs and cats get an appointment with a veterinarian because of otitis externa - inflammation of the skin of the external auditory canal. The large role in the development of the inflammatory process in the auditory canal belongs to the epidermal staphylococcus, which often complicates the course of otitis caused by the parasitic ear mite *Otodectes cynotis*. The high sensitivity of epidermal staphylococcus to ampicillin, cefazolin and levomycetin allows us to recommend these antibiotics as a means of local treatment along with acaricides and antihistamines in the complex therapy of otodectosis of small domestic animals.

Introduction

Inflammation of the skin of external, middle and internal auditory canal or otitis media is a fairly common disease of small domestic animals, the causes of which can be mechanical damage, ear mite *Otodectes cynotis,* pathogenic fungi Malassezia pachydermatis, allergic reactions and autoimmune diseases. Thus, otitis media can act as both independent and secondary diseases (Belov and Danilov, 1990). According to statistics, 10-20 % of dogs and cats get an appointment with a veterinarian because of otitis externa - inflammation of the skin of the external auditory canal. Despite the variety of causes, the clinical picture of otitis media is very specific, and hence, the treatment of animals based only on clinical diagnosis is ineffective. Animals with otitis media are characterized by a head tilted towards the affected ear, head shaking, scratching in the area of the external auditory canal due to itching, unpleasant smell, and sometimes a leakage from the auditory canal, as well as painful reaction and fluctuation during external palpation of the auricle root (https://www.svoydoctor.ru, 2018). Otitis media is dangerous with its complications, since the inflammatory process that spreads along the continuation of the tissues with otitis media can lead to the development of inflammation of the membranes of the brain and cause death or permanent disability of the animal. From the point of view of complications, the greatest danger is otitis media of the inner ear - labyrinthitis, in case of which not only hearing loss occurs due to damage to the eardrum, but also there is a direct risk of developing meningitis and encephalitis.

A large role in the development of the inflammatory process in the auditory canal belongs to opportunistic pathogenic bacteria, which can be both the main cause of otitis media, for example, with mechanical damage to the skin or the ingress of water and foreign bodies into the auditory canal, and a factor that complicates the inflammatory process caused by a parasitic ear mite, yeast fungi or an allergic reaction of the body. In the diagnosis of otitis media, it is necessary to identify not only the primary and secondary causes of the disease (mites, allergic reactions, yeast fungi and bacteria), but also predisposing and supporting factors that increase the risk of the disease (abundance of hair and maceration of the skin in the external auditory canal, hypersecretion of earwax and epithelial hyperkeratosis). Only a comprehensive approach to the diagnosis of otitis media, including clinical and instrumental, parasitological and bacteriological methods of research, can become the key to therapy and prevention.

In our research, we set out to determine the specific composition of the microflora in ear scabies (*Otodectosis*) of dogs and cats and its sensitivity to the most commonly used antibiotics in veterinary practice. The results of the research will help to identify the main culprit of bacterial complications in parasitic otitis media of small domestic animals and suggest the most effective drug for local therapy.

Materials and methods

The research was conducted in the laboratory of the Department of Epizootology and Parasitology of the Armenian National Agrarian University. Four cats and four dogs were under study, who were diagnosed with otodectosis (ear scabies); the age of the examined animals of different breeds ranged from 6 to 24 months. The animals belonged to different guardians and were in different housing and feeding conditions. The diagnosis of otodectosis was made on the basis of microscopic examination of the skin scraping of the external auditory canal, in which the tick Otodectes cynotis from the family Psoroptidae was found. From the contents of the external auditory canal of patients with otodectosis seeding on differential diagnostic nutrient media was made, such as Bismuth-Sulfite Agar and Endo Medium for the isolation of *Salmonella* and *Escherichia*, respectively, as well as on a selective nutrient medium – Mannitol Salt Agar for the isolation of *Staphylococci*. After seeding, the culture media were placed in a thermostat at 37 ^{0}C for 24 hours. The sensitivity of microbial colonies obtained in the culture medium to antibiotics was determined by the disc diffusion method (Kuzmin and Sefershaev, 1959). Bacterial smears were prepared by the conventional method on glass slides and after fixing over the flame of the burner, they were colored by Gram. Microscopic examination of the smears was performed under the immersion system of the microscope using the lens 90 and the eyepiece 15. The total number of bacteria in the studied samples (content of the external auditory canal) was determined by direct counting method in fixed and colored bacteriological preparations according to Burgwitz methodology (Afanaseva, 1976). The number of microorganisms in 1 g of the test sample was determined by the formula:

$$N = nPQ / pqg,$$

where n is the arithmetic mean number of cells in one field of view, P – area of the preparation (400 mm^2), p – area of the microscope field of view, mm^2, Q – the amount of water to dilute the sample (500 or 250 ml), q – volume of one drop of suspension (ml), g – the amount of pathological material taken.

Results and discussions

Clinical and instrumental examination of the experimental animals indicated that different degrees of pain and fluctuation is observed when palpating the root of the affected ear; almost all animals had itching and scratching on the outer surface of the auricle, and black – brown accumulations of purulent exudate mixed with earwax were found in the external auditory canal. The body temperature of the examined animals remained within the upper norm limits during the entire treatment period.

Bacteriological examination of the contents of the external auditory canal revealed the following results: on bismuth – sulfite agar and on the endo medium, single white colonies with a grayish tinge, smooth surface and even edges were observed, and on mannitol – salt agar, a continuous growth of colonies of white with a grayish tinge of mucosal plaque occupying the entire surface of the nutrient medium was found.

In smears prepared from colonies grown on the listed nutrient media, gram-positive cocci were found, located in the field of view of the microscope in clusters resembling bunches of grapes. The cultural, morphological and tinctorial features of the detected microorganisms allow us to identify them as white epidermal staphylococcus (*staphylococcus epidermidis*), which is often found on the skin and mucous membranes of humans and animals and can provoke purulent wound infections (Larry, et al., 2019). The average number of detected microorganisms per gram content of the external auditory canal in dogs

turned out to be more than in cats, which is explained by the highest species resistance of the cat body to oppoertunistic pathogenic microflora (Table 1).

Table 1. Results of bacteriological examination of the contents of the external auditory canal in animals with otodectosis*

Average number of staphylococci in the field of view of the microscope		Average number of staphylococci per gram content of the external auditory canal	
In dogs	In cats	In dogs	In cats
80	60	47059	35295

Table 2. Sensitivity of staphylococcal strains isolated from animals with otodectosis to antibiotics*

Name of the antibiotic	Growth retardation zone (mm)	
	In dogs	In cats
Ampicillin	2.9	2.8
Tetracycline	0.2	0.3
Streptomycin	1.0	1.2
Cefazolin	2.5	2.7
Levomycetin	2.3	2.4

*Composed by the authors.

At the same time, when determining the sensitivity of the isolated strains of *Staphylococcus* to antibiotics by the disc diffusion method, it was revealed that all of them, regardless of the species of the animal from which they were isolated, are most sensitive to ampicillin, cefazolin and levomycetin (Table 2). When determining the antibiotic resistance of the isolated strains, the choice fell on a limited number of antibiotics that are widely used in practical veterinary medicine, are easily available and relevant for use.

The results of the studies are consistent with the literature data indicating the leading role of epidermal *staphylococcus* in the exacerbation of various purulent – inflammatory processes and its high sensitivity to antibiotic therapy.

Conclusion

Based on the results of the conducted research, the following conclusions can be drawn:

1. The main factor complicating the inflammatory process in otodectosis of small domestic animals is epidermal *staphylococcus*;

2. The average number of *staphylococci* in the contents of the external auditory canal in dogs exceeds the same indicator in cats, which indicates a relative species difference in the general nonspecific resistance to conditionally pathogenic microflora in these animal species;

3. The sensitivity to antibiotics in different strains of epidermal *staphylococcus* isolated from otodectosis patients in dogs and cats does not correlate with the age and type of animals.

4. The high sensitivity of epidermal *staphylococcus* to ampicillin, cefazolin and levomycetin allows us to recommend these antibiotics along with acaricides and antihistamines in the form of drops and ointments in the complex therapy of otodectosis of small domestic animals.

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The Use of Topinambur (*Jerusalem artichoke*) Concentrate in the Curd Production

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ABSTRACT

Curd production technology upon the use of topinambur (Jerusalem artichoke) tuber has been developed. For the curd production, hydrolyzed concentrate obtained from the tuber of Jerusalem artichoke has been used in the form of herbal supplement. New food product exceeds the traditional one in its biological values due to enrichment with carbohydrates, vitamins, nonessential and essential amino acids. The optimal dose of introducing the hydrolyzed concentrate has been also determined.

The use of hydrolyzed concentrate of Jerusalem artichoke solution reduces the coagulation duration of milk mixture and increases the product yield; at the same time it saturates the product with inulin.

Introduction

Each civilized country seeks to ensure welfare of its population by making the food production sector viable and prosperous branch of economy with clear understanding that food product is the foremost need for humanity. The nation's health and mental capacity also depends on the quantity and quality of the food product consumed by the population. One of the most important prerequisites of a healthy nation is the use of high-quality and vitamin rich food, which very often stays behind the scope of the society being engaged in multiple social problems. For most people the food safety and wholesomeness is not so much important as its price availability. Taking into account the aforementioned issues the use of protein food becomes rather relevant.

Curds, curd mass, curd cheese and albumin curd belong to the range of high-protein dairy products. Curd is a rather useful milk concentrate with high content of calcium salts. Curd products are easily and almost completely digested by the human body. They are rich in essential amino acids (methionine), vitamins (particularly *A, E, P,* B_2, B_6 and B_{12}), folic acid, calcium salt, iron, sodium, magnesium, copper, zinc, fluorine and phosphorus. Just due to the mentioned compounds curd is digested rather easily. As a food product variety curd is necessary for the growth and regeneration of all body tissues. It is useful for nervous system, heart activity and blood system. It should be added that the high content of calcium makes curd product indispensable in case of tuberculoses, bone

fractures, diseases of hematopoietic system and rickets.

The main objective of the current work is to produce a curd product rich in vitamins, amino acids, protein and micro-macro-nutrients. To this end the following activities should be accomplished:

- to study the effect of topinambur on the bio-technological procedures,
- to study the role and impact of herbal supplement on the produced foodstuff,
- to test the optimal dose ratio of the topinambur concentrate used for the curd production
- to study the biochemical, physicochemical and microbiological processes taking place throughout the curd production process.

The use of specially processed topinambur in curd production process has been investigated for the first time. Due to this crop the product acquires easily digestible carbohydrates, vitamins (B_1, B_3, B_5, B_6), folic acid, calcium and minerals (*K, Ca, Mg, Na, Fe*). Topinambur contains inulin, which has an absolute sorbent capacity; it binds and expels a huge amount of toxins penetrated into the body intestine via food intake or during digestion. Besides, inulin stimulates the motility of gastrointestinal tract. Addition of topinambur concentrate affects the water absorption capacity and the protein content in the curd products.

Materials and methods

Curd belongs to the range of high-protein dairy products and is produced via milk coagulation with pure lactic acid cultures. Topinambur is endowed with soothing, immune-boosting, body-strengthening, anti-sclerotic, toxin-removing, cell-membrane protecting (in case of excessive glucose, water amount grows up and damages the cells) effects. According to some data, topinambur (mannose) can prevent the occurrence and development of autoimmune diseases and cancers. The energy value of 100 g topinambur tuber amounts to 73 kcal. The same mass contains 78 g water, 2.54 g ash, 2 g protein, slight amount of fats - 0.01 g unsaturated fatty acids, 0.067 g omega-3, 0.256 g omega-6 and saturated fatty acids 0.145g (https://www.dasaran.am).

Inulin is a compound sugar consisting of residual fructose molecules. It is not dissolved in cold water, while due to the inulosucrase enzyme it gets dissolved in the lukewarm acidic gastric juice, then swells up and expands into the colon without splitting. Thereafter it covers the intestinal mucosa, due to which the transfer of glucose and cholesterol into the blood is retarded. Up to 14 g and more inulin can be found in 100 g topinambur tuber. Plant sterols (9 mg, 16.4 %) also have anti-cholesterol effect. Inulin absorbs harmful and toxic matters, including glucose and fructose. In recent years it has been disclosed that inulin really reduces the burden of insulin producing organ, but it can't substitute insulin. It is important to know that topinambur contains chrome (3.5-18 mkg, 24 %) which increases tissue susceptibility towards the insulin, and vanadium (24 %) imitating the insulin effect. The general chemical composition of topinambur tubers (Table 1, 2) depends on the crop variety and harvest time.

Table 1. The general chemical composition of topinambur tubers*

Chemical composition	Quantity, %
Dry matters	20.2-25
Inulin	2.5-20
Membrane	0.6-1.25
Nitrogen containing matters	1.4-2
Proteins	up to 2
Ash	0.9-1.2

Table 2. Amino-acid composition of topinambur tubers*

Amino acids	Tubers	Green mass
Protein	8.33	0.50
Lysin	0.33	0.46
Histidine	0.21	1.10
Arginine	0.45	1.02
Threonine	0.29	0.53
Tyrosine	0.12	0.13
Valine	1.33	1.06
Phenylalanine	0.48	0.38
Leucine	0.89	2.11
Tryptophan	0,83	2,12

*Composed by the authors.

Figure 1. Technology of water-soluble extract production (*composed by the authors*).

Based on the use of the crop varieties and their samples a highly profitable, loss-free, resource-saving agri-food production technology encompassing all production phases for complex processing of topinambur tubers, has been developed (Polyanskiy, et al., 1999).

The technology of producing water-soluble extract out of the inulin-containing topinambur tubers is introduced in Figure 1.

Results and discussions

The experimental samples of the curd mass have been produced in the laboratory of the chair of "Animal-Based Foodstuff Processing Technology", ANAU. The experimental and control samples of the curd mass have been produced from the same batch of normalized milk through common technology. After determining the physicochemical indices of the used raw material (milk), the pasteurized milk is cooled to the coagulation temperature - 30-32 ^{0}C. Then 40 % $CaCl_2$ solution (40 g) per 100 kg milk and 2-3 % coagulant (ferment) is added to the heated milk (Dilanyan, 1962).

All ingredients have been added by stirring up the milk uninterruptedly. 1.5 % - 2.0 % topinambur concentrate and 3% - 5 % hydrolyzed topinambur juice is mixed in the experimented sample. The end of milk coagulation and the final coagulum is determined through its pH value, which should be equal to 5.1-5.2 (or according to the serum titratable acidity 75-85 ^{0}T) and by the serum form isolated from the coagulum. If during the coagulum cutting, equal cutting edges are formed with glossy smooth surfaces, it means that the coagulum is ready for further processing. The serum emerged in the cutting place should be transparent and of light greenish color (Beglaryan, R., Beglaryan, A., 2003, Zobkova, 2019).

The quantities of topinambur concentrate and hydrolyzed juice are introduced in Table 3, based on which the optimal dose with the account of organoleptic indicators (Table 5) has been identified.

Table 3. The optimal quantity of topinambur concentrate and hydrolyzed juice*

Sample	The quantity of topinambur concentrate, %	The quantity of hydro-lyzed juice, %	Duration of coagulation, *h*
Control	0	0	8
Experimental 1	2.0	7.0	6.5
Experimental 2	1.5	5.0	6
Experimental 3	1.0	3	7

*Composed by the authors.

Table 4. The technological indicators of the curd produced through the developed technology (Gharagulayan, 1980)

Technological indicators	Experimental	Control
Fat content of the concentrate, %	3.9	3.9
Titratable acidity, ^0T	19	19
Pasteurization temperature, ^0C	74	74
Holding minutes	2-3	2-3
Coagulation temperature, ^0C	30-32	30-32
The dose of added coagulant, %	3	3
The dose of added calcium chloride, *g*	40 g per 1 ton of milk	40 g per 1 ton of milk
The dose of topinambur concentrate, %	1.5	0
The dose of hydrolyzed topinambur juice, %	5	0
Coagulation duration, hour	6	8
Acidity at the end of coagulation, ^0T	80	88
Coagulum *PH*	5.1	5.2
Coagulum cutting and granulation, *minute*	25	30
Granule size, *mm*	18-20	18-20
Fat content of whey, %	0.2	0.3

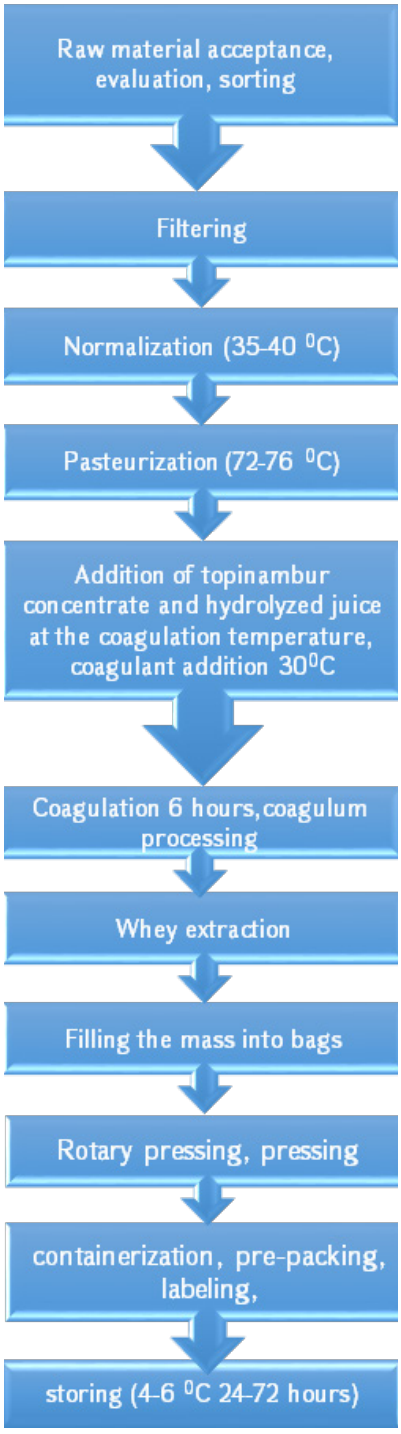

Figure 2. Diagram for the technological scheme of curd production (*composed by the authors*).

Table 5. The effect of topinambur quantity on the organoleptic indicators of curd product*

Indicators	The options of experiments			
	Experimental 1	Experimental 2	Experimental 3	Control
The added quantity of topinambur concentrate, %	2.0	1.5	1.0	-
The added quantity of hydrolyzed topinambur juice, %	7.0	5.0	3.0	-
Fat mass ratio, %	18	18	18	18
Water mass ratio, %	65	71.5	72.5	73.5
Titratable acidity, ^0T	197.5	195	193.5	192
Taste and flavor	Lactic acid, well distinguished topinambur taste and flavor	Lactic acid, without off-taste and off-flavor, slightly distinguished topinambur taste and flavor	Lactic acid, without off-taste and off-flavor, undistinguished topinambur taste and flavor	Lactic acid, without off-taste and off-flavor
Color	White with distinguished topinambur tinge	White with slightly distinguished topinambur tinge	White	White
Appearance	Dense homogeneous whole mass	Fine, slightly dense, homogeneous whole mass	Homogeneous whole mass	Fine, homogeneous whole mass

*Composed by the authors.

The new technological scheme of curd production is introduced in Figure 2, while the technological indicators of the produced curd are presented in Table 4.

Due to the topinambur concentrate the curd product content is supplemented with easily digested carbohydrates, vitamins and minerals. The mentioned products can serve as a

prophylactic and treating measures for the patients suffering from the diseases of gastrointestinal tract and diabetes. The extract which is subjected to hydrolysis is also very useful for diabetics.

Considering the aforementioned we can state that the use of plant concentrates enables to diversify food product varieties, improve the food quality and use it in the therapeutic and prophylactic diet.

The processing of topinambur tubers was conducted in the following way: after processing of 1 kg topinambur tuber its net mass made 988 g. After grinding the tubers, its pulp weight made 850 g and the extract – 570 g. The pulp was dried up at the temperature of 50 ^{0}C and 305 g concentrate was resulted. The amount of dry matters dissolved in the extract of topinambur tubers was examined by means of KERN ORA 32BA refractometer, according to which they made 22 %. Then 570 g extract was filtered with filter paper and it became 550 g. The filtered solution was hydrolyzed with 2 g citric acid salt (boiling for 20 minutes) resulting in 382 g hydrolyzed solution. The hydrolyzed solution was diluted with distilled water 3 times, as a result of which the amount of dry matters made 63 %. Relatively higher organoleptic indices were recorded in the curd mass with 1.5 % concentrate and 5 % hydrolyzed solution. The study results have indicated that the application of optimal dose of topinambur tubers increases the curd mass yield by 1.1 %. As a result, the curd mass obtains specific taste, flavor and homogeneous fine density.

The application of plant additives doesn't affect the microbiological indicators and promotes the production of food variety with new delicate flavor properties, high nutritional and biological value and with relatively longer shelf life.

Conclusion

Based on the results of scientific-research and theoretical-experimental investigations the following conclusions have been inferred:

The feasibility of using topinambur tubers in the curd production has been theoretically justified and empirically confirmed. It has been proved that the biological value of the curd product manufactured with the experimented topinambur tubers is more complete, than that of observed in traditional food product. This is related to the availability of topinambur tubers rich in carbohydrates, essential amino acids and vitamins, which make the food product easily digestible. It is recommended to use topinambur tubers' concentrate (upon drying method) and hydrolyzed juice, which contains a great amount of carbohydrates, (mainly inulin) as herbal supplements in dairy industry. In the initial stage it is transformed into fructose, glucose and other carbohydrate containing mediums via acidic hydrolization.

Thus it is also recommended to use the optimal dose of topinambur tubers' concentrate and hydrolyzed solution, which results in the reduction of curd mass coagulation period and in the increase of the product yield.

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Waste-Free Use of Quail Meat in Semi-Finished Food Production

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ABSTRACT

Semi-finished food production from the meat raw material has gained a broad application in the consumer market due to ease of its production organization, digestibility, fast consumption, long shelf life and safety.

The research considers the development trends in cutlet (semi-finished meat product) manufacturing technologies via quail meat and plant-based filler application.

The study aims to improve cutlet production technology through replacing the chicken meat with quail meat and supplementing buckwheat flour.

A new cutlet production technology and recipe has been developed and their relevance has been proved.

Introduction

Semi-finished meat products are the most widely consumed food products due to their flavor properties, long shelf life and high nutrition value. In Armenia, a wide range of semi-finished products are manufactured mainly from chicken meat, beef and pork. Nowadays, the issue of developing waste-free technologies is faced by all meat processing organizations of the Republic of Armenia. The new developed technology via using quail meat in cutlet production is related to the waste-free production, since it is also planned to prepare cutlet farce through chopping the bones of the quail meat carcass into pieces. The quail meat is endowed with rich and succulent flavor, as well as with high nutrition value. It is recommended for the application in the dietetic nutrition. The quail meat exceeds the chicken meat, pork and beef in its wholesomeness, flavor and dietary qualities. The systematic use of the quail meat in medicine promotes the treatment of diseases in gastrointestinal tract, liver, kidney, cardiovascular and respiratory system (Pryanishnikov and Miklyashevsky, 2001).

The origin of buckwheat is the Northern India, where it is also called black rice. Usually there are two types of buckwheat: Common and Tartary buckwheat. The hull of the Tartary buckwheat is thicker, while the grain is smaller. The Common buckwheat is usually winged and wingless. The Common buckwheat has a widespread

application in the food sector, while the Tartary buckwheat is used both in forage production and soil cultivation as a green manure. Buckwheat contains a great amount of iron, as well as calcium, potassium, phosphorus, iodine, zink, molybdenum, cobalt, vitamins B_1, B_2, B_9, *PP* and Vitamin *E*. Flour can be produced from buckwheat, which is not used in bread baking due to lack of gluten, and if so, it is mixed with wheat flour. Buckwheat, its flour and the food varieties produced from buckwheat are regarded as foodstuffs of rather high nutrition value. Buckwheat flour is easily digested and dietetic with high flavor properties.

Materials and methods

The aim of the current work is to develop and produce a new variety of semi-finished food product using the quail meat with its bone tissue supplemented with plant-based protein. Throughout the research the chemical composition (Table 1) and functional properties of the quail meat and its application in the semi-finished food production has been studied; besides, semi-finished food product manufacturing technology via the mixture of quail meat and buckwheat has been developed. By using the bone tissue of the quail meat in the farce of semi-finished product, the waste-free production technology has been ensured and the food product has been supplemented with micro-nutrients, such as phosphorus and calcium.

Table 1. The chemical composition of the quail meat*

n/n	Name of the component	Amount
1	Proteins, *g*	18.2
2	Fats, *g*	17.30
3	Carbohydrates, *g*	0.4
4	Vitamin A, *mg*	0.07
5	Vitamin B_1, *mg*	0.1
6	Vitamin B_2, *mg*	0.26
7	Vitamin PP, *mg*	8.3
8	Vitamin B_9, *mg*	0.07
9	Humidity, %	70.03
10	Na, *mg*	35
11	K, *mg*	257
12	Ca, *mg*	21
13	Mg, *mg*	25
14	F, *mg*	190
15	Fe, *mg*	3.20
16	Energy value	230 kcal

*Composed by the authors.

The cutlets are usually produced through the following technology:

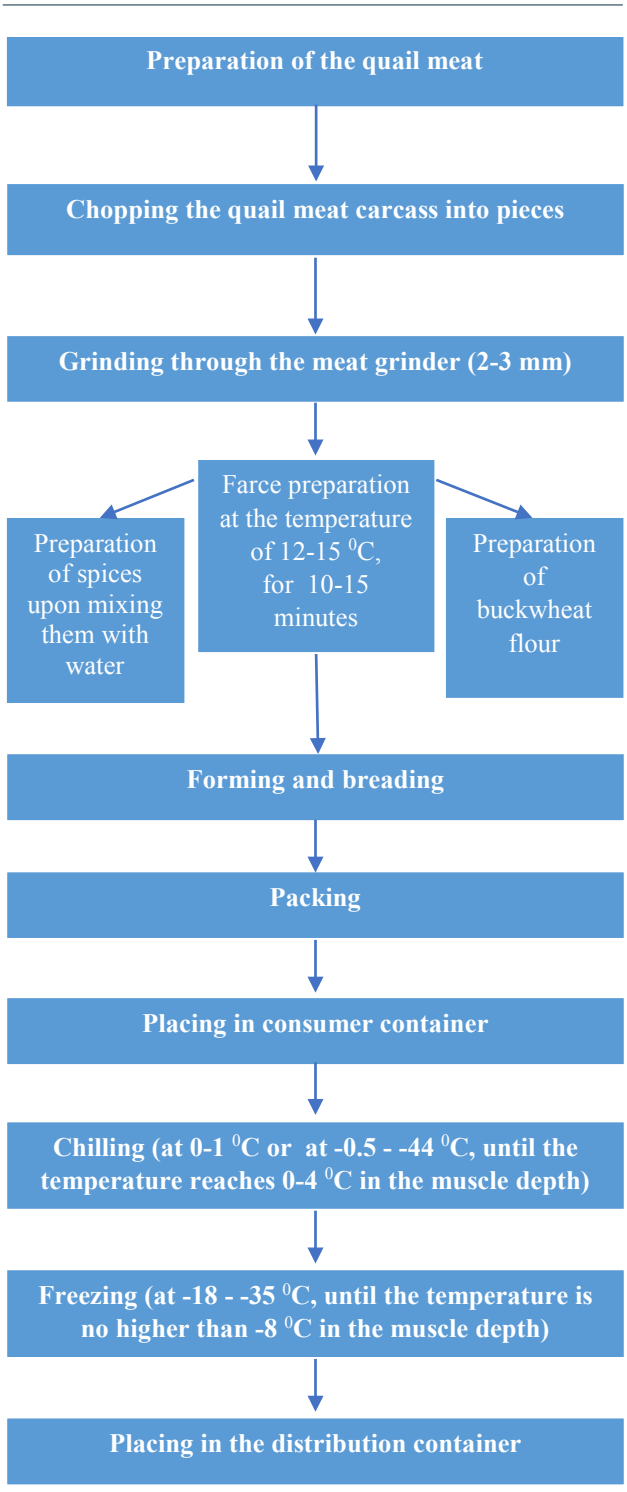

Diagram. The technological scheme of cutlet production with buckwheat flour and quail meat (*composed by the authors*)

A new cutlet recipe via the use of quail meat and buckwheat flour, as well as the technological scheme (Diagram) of its production has been developed by our research group and the experimental sample has been produced in the laboratory of the chair of "Animal-Based Foodstuff Processing Technology", ANAU.

The quail meat, its farce in different production phases and ready-to-eat cutlet have served as a study subject for this investigation. Since the studies are conducted for the first time in Armenia, we have used homemade cutlets as a control variant according to GOST P 52675–2006. First, the quail meat with the bone tissue was investigated considering that the quail meat carcass is the only meat variety among the poultry meat, the bone tissue of which is highly resistant to various pathogenic diseases. Thus, one of our research objectives is also to process such semi-finished meat product which can be recommended to the consumers irrespective of age and health group (Rogov, et al., 1989).

Based on some investigations new cutlet recipe has been developed, which is introduced in Table 2. According to the required standard the recipe is applied per 100 kg bland raw material.

Table 2. New cutlet recipe with quail meat and buckwheat flour*

n/n	Name of raw material	Quantity, kg
1	Quail meat with bones	72
2	Dry cow milk	20
3	Egg	3
4	Breadcrumb	4
5	Wheat flour	1
6	Edible salt	1.2
7	Black and white pepper	0.05

*Composed by the authors.

The finished product output makes 115 % , while the output of finished product per the bland raw material, particularly that of in the control variant makes 100 %.

The cutlet produced from the quail meat has been studied per its humidity, proteins, fat, mineral substances, plant-based fillers, edible salt contents. The energy value of the new semi-finished product has been estimated. The ready-to-eat cutlet has been subjected to degustation and the food product has been assessed through 30-point scale system scoring 27 points, which is considered an excellent index for the semi-finished food products (Table 3).

All experiments have been conducted with three replications and the arithmetic mean has been assumed as the final outcome which is introduced in the respective Tables 4, 5.

Table 3. Organoleptic indices of the cutlets made from the quail meat carcass and buckwheat flour*

Indicator	Description
Appearance	Round or oval, with evenly breaded surface, without breaks
Taste and flavor	Fit to high-quality raw material with weak flavorings

*Composed by the authors.

Results and discussions

As it is indicated in Table 4, the humidity amount in the experimented sample is lower than in the control sample. This is due to the fact that the buckwheat flour and crushed bony raw material included in the cutlet recipe, are endowed with high water absorption capacity and have bound (absorbed) the excess humidity, increasing the output of finished product and prolonging the shelf life of the experimented food product. The surplus of protein amount (by 9.1 %) in the experimented sample again comes to prove the efficiency of the quail meat carcass, plant-based protein and buckwheat flour application.

Table 4. The physicochemical indicators of the cutlets made from the quail meat carcass and buckwheat flour*

Name of the sample	Humidity %	Protein %	Fat %	Mineral substances (including edible salt) %
Control sample	68.2	10.3	18.1	3.4
Experimented sample	66.4	19.4	6.1	8.1

*Composed by the authors.

According to Table 5, the fat content in the control sample lags behind that of experimented sample by 12 %, which is accounted for the chemical composition and overall characteristics of the quail meat carcass and buckwheat flour. Due to the high protein content, the experimented sample is easily digested and can be recommended to the patients sick with cardiovascular and diabetic diseases (Skurikhin and Volgarev, 1987).

Table 5. Energy value estimation of the cutlets made from the quail meat carcass and buckwheat flour*

Name of the sample	Protein %	Fat %	Energy value, *kcal*
Control sample	10.3	18.1	204.1
Experimented sample	19.4	6.1	132.5

*Composed by the authors.

Apart from manufacturing high-quality food product our aim is also to reduce the production costs and, to some extent, the production duration based on the circumstance, that there is no deboning process as a separate stage in the cutlet production. So, the raw stuff is used with the bones, which increases the qualitative and organoleptic indicators of the manufactured food product.

Conclusion

New type of semi-finished product has been developed and produced by applying bone tissue of quail meat and saturating it with plant-based protein and buckwheat flour.

Based on the conducted analyses and estimations the following conclusions can be drawn:

For the first time the chemical composition of the quail meat, its functional properties and application in the semi-finished food production has been researched.

Upon the application of quail meat bone tissue in the farce of semi-finished product the waste-free production has been ensured and the food products have been supplemented with macronutrients, such as phosphorus and calcium.

The recipe of semi-finished product via the mixture of quail meat and buckwheat flour and the production technology has been developed for the first time, and it has been proved that their application promotes the increase of finished product yield by 15 %.

The new product has been investigated per its organoleptic and physicochemical properties. It has been proved that the humidity content in the new product is reduced; as a result its shelf life and protein content has increased due to quail meat and buckwheat flour application at the same time making the product easily digestible and nutritious.

The energy value of the mentioned product has been also estimated, which makes 132.5 kcal.

The aforementioned conclusions provide a ground to state that the manufactured food product is endowed with high functional and technological properties and that it can be introduced in the production and also be recommended to the patients suffering from cardiovascular and diabetic diseases as dietary and health-promoting meat product.

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Manufacture and Use of Semi-Finished Fig Products in Biscuit Production

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ABSTRACT

The use of natural ingredients is one of the ways to handle the problems related to the development of new technology for specialized domestic bakery production, whereas in case of their deficit the complete use of food nutrients becomes rather difficult.

So, we have set up a goal to develop a technology for functional biscuit production by using semi-finished fig products and at the same time replacing sugar with sugar substitutes of natural origin and low cost price.

Since the production of such food varieties is rather restricted in our country, the new product obtained through the recommended technology would provide an additional opportunity to develop the sector of dietary food production.

Introduction

Confectionery production technologies in food enterprises, as well as in many other confectionery production sectors have undergone significant changes in recent years. In contemporary conditions, confectionery production units produce a wide range of food products that are significantly different in their composition, production technologies and consumer properties. Despite the fact that they are not staple products, they are in high demand among the population due to their consumer attractiveness (especially for children) (Aksenova, 2005, Toshev and Chaika, 2004).

In the current production stage, it is relevant to identify such development trends for confectionery production, which are aimed at the introduction of innovation technologies and stem from the following premises: world trends in life patterns, identification of demands among the consumer target groups, expectations of consumer attractiveness for the product and competition increase in globalization conditions.

Flour products have a considerable share (about 50 %) in the confectionery market and are in permanent demand among all social strata with different incomes.

Currently the world's leading food trends include organic foods, functional food products, healthy and consistent diet.

Thus, new technologies can be developed with scientific production bases and upon the reference to the traditional technologies (Shenderov, 2003).

Materials and methods

The biscuit produced from high quality wheat flour has been used as a control sample, while fresh and dried fig fruits and the stevia syrup have been used as functional components.

Water constitutes about 79.1 % of fig fruit. Carbohydrate is the main macronutrient in the content of this fruit - 19.2 g per 100 g fruit; cellulose makes 3 g of carbohydrates and the remaining 16 g are sugars.

Fig contains only 0.7 % proteins, while fats are almost missing, which means that it contains very small amount of saturated fats and is absolutely free from cholesterol.

In the mentioned amount of proteins, the essential amino acids like, tryptophan, threonine, valine and histidine make up 2 % each. The content of other irreplaceable amino acids (leucine, lysine, methionine and phenylalanine) are also in equal amounts making 1 % of protein each. Calorific capacity in 100 grams makes 74 kcal (Arendt and Rzhevkin, 1950).

Stevia leaves have been used as a sweetening material in South America and Japan since 1970. It does not have any glycemic index and calories, and its use, as a sweetener, is already common in many countries.

Long-term scientific research on the stevia properties has shown that this plant can be used for a long time, even during the entire lifetime with no adverse effects on human health. In case of its systematic use in the food ration the amount of glucose in the blood of diabetics significantly decreases and the elasticity of vessel walls improve (https://stevia-steviosidejj-indeks-st-stevii/).

The aim of the current research is to manufacture new functional biscuit products, which will be fit for the target groups including people suffering from diabetes and those following consistent food ration. To this end the following objectives have been developed and implemented:

1. producing functional filler from fresh and dried fig fruits, which can be used in the biscuit production,
2. reducing sugar content in the food product as much as possible replacing it with sugar substitutes,
3. investigating the qualitative properties of the manufactured product, particularly the organoleptic and physicochemical indicators,
4. determining optimal doses of additional raw materials,
5. developing biscuit production technology.

The research methods regulated upon the GOST standards have been used during the investigations in line with the current technical conditions of GOST 24901-2014 (GOST 24901-2014 interstate standard). The biscuit recipe has been drawn up through multicomponent estimation methods.

The experimental sample was baked in 2 ways but with the same technological scheme of production. In the first version, the stevia syrup was added to the fresh fig fruits to prepare pulp filler, and in the second version, it was prepared by adding the syrup of stevia to the dried fig fruits.

Results and discussions

The trials have been conducted based on the research results related to the control variant of the biscuit product made from the sweet yeast dough and those related to experimental food varieties. The sweet dough biscuit made from the high quality wheat flour has served as a research object, since it contains considerable amount of sugar. Technological description is introduced in Figure 1.

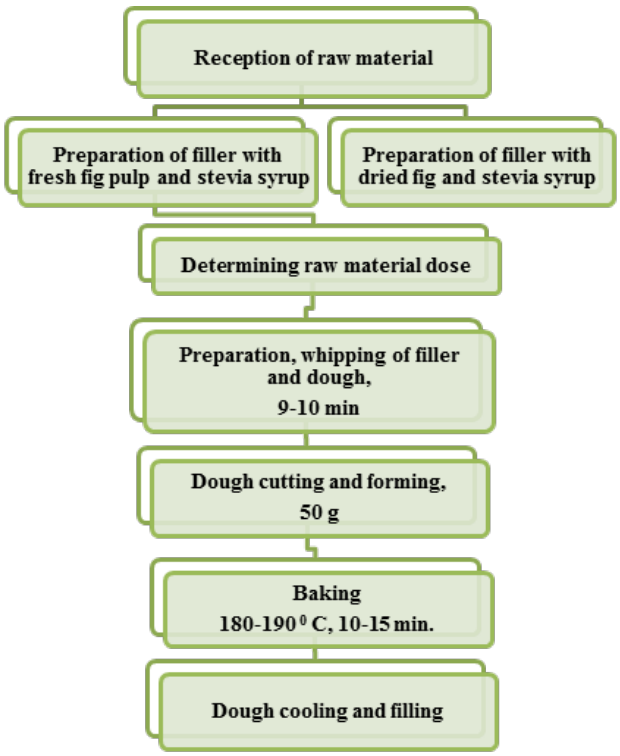

Figure 1. Technological scheme of biscuits (*composed by the authors*).

For the study, the stevia syrup was applied, which, unlike the stevioside, has a very delicate and well distinguished sweet flavor. The impact of different doses of stevia syrup added to the fig filler prepared for butter biscuits has been studied. Since fig is seasonal fruit, its filler was prepared with fresh and sugar-free dried fruits.

The finished product was evaluated 4 hours after baking according to its organoleptic and physicochemical properties.

Since one of the research objectives was to avoid using sugar as an ingredient in the butter biscuit, it was replaced with the stevia syrup, glycemic index of which is 0. The sweetness of the finished product was ensured via the functional filler.

In the first version, the filler mass was prepared from fresh fig by adding 6-7 drips of stevia syrup to 100 g fig pulp and in the second version 7-8 drips of syrup was added to 100 g sugar-free dried fig fruit.

During the investigations, first of all the effect of the filler on the humidity rate of finished product was examined. The results are presented in Figure 2.

According to Figure 2, the humidity index increased from 15.8 % to 16.6 % and 16.1 %, respectively. The increased humidity is due to biscuit fillers, since the semi-finished fig products are endowed with high humidity rate, and hence, affected the humidity index of the finished product as well. This will reduce the shelf life of the finished product to some extent; nevertheless, if we take into account that the food is of functional significance, then that deviation is not so much significant. In case of observing the established technological regulations, the developed technology enables to produce functional food product with efficient organoleptic and physicochemical properties characteristic to finished product (Table 1).

Table 1. Qualitative indicators of finished products*

Indicators	Product description		
	Control sample	Biscuit with fresh fig pulp and syrup filler	Biscuit with dried fig pulp and syrup filler
Dough physicochemical indicators			
Total sugar content, %	45	2.1	2.4
Water permeability, %, no less than	150	153	148
Alkalinity, no more than	2.0	1.8	1.9
Physicochemical indicators of the filler			
Filler mass content, %, no less than	15	15.3	15.5
Sugar mass content in the filler, %, no less than	65	5.8	5.1

*Composed by the authors.

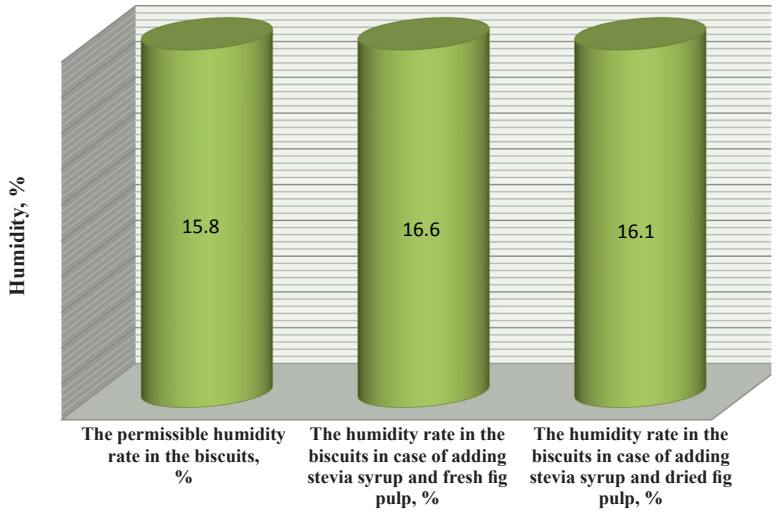

Figure 2. Determining Biscuit Humidity Rate, % (*composed by the authors*).

Since the new food product is intended first for the use of diabetic patients, the most important indicator in such food products is the amount of sugar content.

Table 2. Organoleptic indicators of finished products*

Indicators	Product description	
	Control samples of biscuit	Experimental samples of biscuit
Appearance Form Surface	Diverse, without pores, swellings or damaged edges	Without pores, swellings or damaged edges
Color	From light yellowish to dark brown, considering the raw material used	Light yellowish
Filler mode	Uniformly baked	Baked, non-sticky
Taste	Distinguished, typical to the taste of components included in the biscuit recipe, without off-taste	Well distinguished, delicate fig and stevia taste
Flavor	Distinguished, typical to the flavor of components included in the biscuit recipe, without off-flavor	Well distinguished, with delicate fig flavor and without off-flavors

Table 3. The recipe of the biscuit baked with stevia syrup*

Raw materials	Raw material consumption, g
Wheat flour	250.0
Edible salt	2.0
Butter	400.0
Stevia syrup	1.0
Sunflower oil	60.0
Dried/fresh fruits of fig	200/150
Lemon juice	50.0

*Composed by the authors.

The results of the research presented in Table 1 indicate that the sugar mass content in the dough of experimental variants make 2.1 % and 2.4 % respectively against that of the control variant (45). This is due to the fact that sugar was excluded from the dough preparing recipe altogether and the slight sugar content in the experimented samples is probably due to other products used in the recipe, which contain small sugar amounts. The abrupt decline in the sugar content of the filler is due to the syrup application. Here also some sugar content was observed; anyhow it doesn't have anything to do with glucose, but it is rather related with total sugar content in the fig fruit, since stevia syrup doesn't contain any glucose.

According to the organoleptic evaluation, the biscuit obtained pleasant taste but somewhat brown colorings. The taste and flavor of fresh biscuits became more pronounced (Table 2).

The data provided in Table 2 show that the use of syrup and figs enables to improve the organoleptic properties of the baked biscuit as well enhancing its taste (more distinguished) and flavor (more delicate).

Thus, based on the research, a recipe for the new product has been developed (Table 3).

Conclusion

Based on the experimental research we have come to the conclusion that fig is a rather useful foodstuff, and as a functional component it can be used in the production of functional confectionery. The two possible ways of fig application have been justified, namely its application in fresh and dry (dried fruit) forms, herewith ensuring the seasonality of the product.

The method and optimal doses of stevia syrup application have been developed and identified. In the result of laboratory trials the organoleptic and physicochemical properties of the finished product have been determined.

It has been proved that the sugar content in the new products manufactured through the developed technology and recipe has been minimized, while the application of sugar as such, has been rejected at all, whereupon the glucose content has been also removed.

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Development of Cupcake Production Technology Using Rye Flour

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ABSTRACT

Functional food production has become relevant, particularly in recent years, related to technical advancement, reduction of physiological energy consumption and imbalance in labor capacity. Healthy diet is one of the most important factors describing the health of country's population.

In this regard development of new technologies for manufacturing new range of flour confectionery products is considered to be quite actual, while functional food production technology is of significant importance from the prospect of food industry development on the whole.

The recommended technology can be easily introduced in the production with no need for additional technological equipment.

Introduction

Healthy, balanced and full diet is the guarantee for human growth and development, as well as for the prevention of various diseases and health protection. Functional food consumer properties include three components: nutritional value, flavor quality, physiological effect. Traditional foods, in contrast to the functional ones, are characterized only by the first two components (Matveeva and Koryachkina, 2012, Glenn and Christine, 2000).

One of the primary directions for the development of confectionery production sector is the development of new range of products using new raw materials. Flour confectionery has high nutritional value, quite attractive appearance and taste, but they contain large amount of fats, sugars and carbohydrates, while very small amount of other useful nutrients.

Confectionery specialists around the world are developing, improving and producing new confectionery products useful for children and older people. They mainly contain alternative raw materials that have significant amount of functional food components. However, on the other hand, there are many useful components and raw materials that are sometimes impossible to apply in processing technologies meanwhile ensuring food attractiveness for consumers (Matveeva, 2012).

Cupcakes are products made of sweet yeast dough, which contain large amount of eggs, sugar and fats, while for taste property improvement they are also supplemented

with raisins, fruits, succades, nuts, etc. Anyhow, they don't contain any functional component (Tikhomirova, 2002).

The bakery flour made from rye flour is the second to wheat flour in the production and consumption sector. It contains iron, one and half times more magnesium (32.0 mg) than wheat flour, 224.0 mg potassium, as well as vitamins B_2, B_3 (PP), B_3 (PP), B_4, B_5, B_6 and B_9 (Kuznetsova, 2014).

Another important factor is the high fiber content (8.0 mg), which has rather beneficial effect on human digestion. The rye fibers are somewhat unique, as they rapidly get mingled with water molecules, which means that they are able to bind and remove toxins and harmful substances accumulated in the body. Though the rye flour has other considerably useful properties, it hasn't found wide application in confectionery production yet, since up to now no high quality product has been manufactured due to shortcomings in technological processes. (Kuznetsova, 2014, Matveeva, 2012).

Materials and methods

The control sample of cupcake product, product types prepared via different ratios of rye flour, as well as those made with supplemental "HIT" improver have served as research materials.

Taking into account the urgency of developing new technologies for healthy food production and the relevance of expanding such products range, an objective was set up to produce a wide range of cupcake products with high nutritional value by applying high portion of rye flour, as well as to ensure the proper structural-mechanical properties and quality improvement indices of the mentioned products.

While paving paths for the accomplishment of the mentioned objective the following steps should be tracked out:

- developing a new technology and recipe for producing new cupcake product as a flour confectionery by applying possibly less nutritional ingredients and high portion of rye flour,
- investigating the qualitative properties of cupcake, particularly structural-mechanical and physicochemical indicators,
- identifying the interrelations between the aerated (whip) mass and dough density per the applied flour portion,
- estimating the optimal portion of rye flour and the opportunities of using the improver.

While evaluating the qualitative indicators of the finished product, the common research methods regulated through the GOST standards have been used. The research was conducted in line with the technical requirements set upon GOST 15052-2014. It should be noted that this standard is common for cupcake production (GOST 15052-2014).

In the result of the experimental research, it has been proved that as a high nutritional value product, considerable portions of rye flour can be used in flour confectionery production ensuring proper structural and mechanical indices in the finished product.

Results and discussions

While developing a new recipe for the cupcake product type, the density of the finished product has been studied, as it is considered to be one of the important indicators for this product.

During the research, two different methods for making cupcakes from the rye flour were considered: upon the first method only some portion of rye flour has been used, while in the second method the universal improver has been also used as a supplement together with the rye flour. For the control variant a cupcake was prepared with 100 % high quality wheat flour, 15.0 % egg products, 35.0 % sugar, 50 % margarine, 1 % emulsifier, 1 % baking powder per the flour mass.

In experimental samples, rye flour substituted the high quality wheat flour with fluctuating portions (25 %, 35 % and 55 %). In the result of investigations conducted within the frame of the first method, it has been found out (Figure 1) that along with the increase of rye flower amount, the dough density also grew up, which resulted in the reduction of specific volume of the finished product.

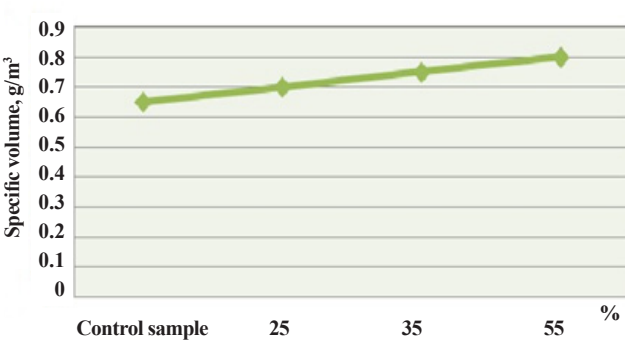

Figure 1. Content of rye flour (*composed by the authors*).

To reduce the density of the dough, we studied the opportunity of replacing the margarine with vegetable oil per fat content estimation. It has been disclosed that practically the dough density and the specific volume of the sample weren't subjected to any changes, which enabled to substitute the wheat flour with rye flour in the cupcake recipe. Nevertheless, final marketable appearance of the product was not ensured.

As it is shown in the diagram the density of the finished product in the control sample made 0.65 g/m^3, then, together with the increase of rye flour content it gradually amounted up to 0.80 g/m^3, which is a desirable indicator for this product type.

The study was also carried out for the cupcake product made via improver application. Since the optimal application dosage of this improver in the bread products manufacture is 0.1-0.5 % per 100 kg of wheat flour and it hasn't been used in the confectionery production before, we have chosen the dosage of 0.1 % per the flour mass. In this case again, rye flour with fluctuating contents (25 %, 35 % and 55 %) was applied instead of wheat flour.

Like in the first case, here again, the product density was first examined.

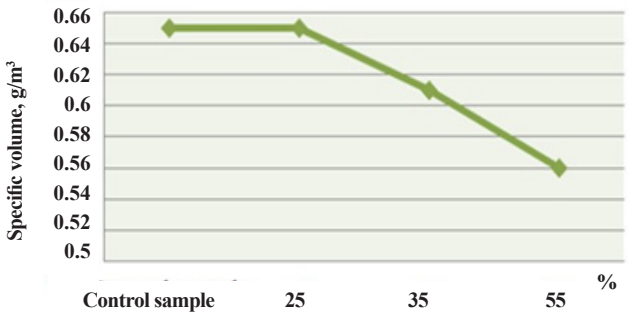

Figure 2. Content of rye flour, % (*composed by the authors*).

As it is shown in Figure 2, when using 0.1 % "HIT" improver the density of product underwent slight changes: from 0.65 g/m^3 to 0.56 g /m^3, which enabled to obtain high volume products.

Usually cupcake products are baked immediately after preparing the dough, i.e. for such products there is no maturation process planned upon the technology. However, given the fact that there is a baking improver (powder) in the experimental sample, the dough has also been maturated when performing the experiment. The impact of the improver on the duration of the fermentation has been studied. It turned out (Table) that the cupcake differed in volume, smooth top and high porosity when the dough was maturated for 90 minutes, which is not typical to those cupcakes produced through traditional recipes.

Table. The impact of dough maturation on the quality of cupcakes*

Indicator	Maturation duration, m			
	30	60	90	120
Specific volume, cm^3/g	1.5	1.6	2.1	1.5
Compressibility, scale point	13.0	15.0	17.2	16.2
Acidity degree	1.6	1.9	2.3	2.6
Humidity, %	18.1	18.8	20.1	22.3
Crumbiness, %	47.4	50.1	53.2	55.6

*Composed by the authors.

The best physicochemical indicators of the finished products were observed in case of 60-90 minutes of dough maturation in experimental samples, which intensified gas generation process and, hence, the dough mass significantly increased in size; nevertheless, after baking it was characterized with smooth top and high porosity, and therefore did not meet the overall requirements of the product.

Conclusion

As a result of experimental studies it was concluded that in the cupcake production process, wheat flour may be replaced with 55% rye flour content. It has been also proved that the use of improver in the rye flour cupcakes can provide relevant structural and mechanical properties of the finished product.

The research results have also indicated that the use of the bread baking improver has a positive effect on the structural indicators of cupcakes; particularly, the density of the cupcakes dough is reduced, as a result of which high quality products are obtained.

In case of improver application, an increase in the products specific volume has been recorded: from 1.5 cm^3/g

up to 2.1 cm^3/g, which could not be ensured in case of using only rye flour.

It has been also proved that the dosage of 0.1 % improver is an effective quantity, and as an additional raw material it won't affect the further cost price of the product.

Thus, the developed technology can be introduced in the production with no need for additional technological equipment and facilities.

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Assessing the Risk of Antibiotic Residues in Milk Produced in the Republic of Armenia

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ABSTRACT

This research sets out to assess both the antibiotic exposure via milk produced in the Republic of Armenia and the associated human health risks. As established, the milk of domestic production contains residual antibiotics (streptomycin, chloramphenicol, tetracyclines). The estimated daily intake (EDI) and the margin of exposure (MOE) for the antibiotics identified upon this research were assessed. It has been indicated that for the population of Yerevan, the daily intake of antibiotics via milk does not exceed the acceptable daily intake (ADI). Moreover, the derived MOE values point to the absence of health risks associated with shop-bought milk.

Introduction

Milk and dairy manufacturing is one of the relatively developed branches in Armenia's agriculture and food industry (FAO, 2012). According to the data of Statistical Committee, in 2019, 667.9 thousand tons of milk were produced with 242 kg average annual per capita milk consumption (Armstat, 2019). It is well-known that milk and dairy products have a high nutritional value, contain vitally essential proteins, fats, vitamins, mineral salts, microelements, and, thus, are staple food in the consumer basket (Popescu, et al., 2019, Priyanka, et al., 2017). However, some studies suggest that, besides useful elements, milk may also contain harmful substances and antibiotics in particular (Bahmani, et al., 2020). The latter are known as antimicrobial medicines of natural or semi-synthetic origin widely applicable for different human and animal diseases to prevent and cure (Bacanli and Başaran, 2019, Bingyao, et al., 2019). Thus, the chief cause for antibiotics to enter milk content is the antibiotic treatment of dairy cattle. It is also a fact that, being heat resistant, antibiotic agents are not destroyed even when exposed to high temperatures when processing food (Hassan, et al., 2020). So, eating food contaminated with residual antibiotics may cause serious health effects: different allergic responses, insensitivity or super-susceptibility to antibacterial agents, disturbance of intestinal microflora and so on (Zhang, et al., 2010, Zhao, et al., 2021).

The issue of antibiotics in food and the health effects these

agents produce has been in the spotlight of many competent international institutions, such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), European Food Safety Authority (EFSA), US Food and Drug Administration (FDA), who often touch upon these topics in their reports (WHO, 2014, EFSA, 2012, US FDA, 2015, FAO, 2018). These topics are a concern to both developed and developing nations. One should stress that in the developing countries, including Armenia, scientifically robust data on antibiotic agents in foods consumed are yet too scarce to meet food safety challenges of the day. So, the main mission of this research was to fill up this information gap by adding newly generated food safety data to those currently available in Armenia.

Given the above, our research goal was to determine the presence of antibiotics (tetracyclines, streptomycin, chloramphenicol) in raw milk produced in Armenia and assess associated health risks exposure.

Materials and methods

Milk sampling and determining the presence of antibiotics

Raw milk was sampled in the frame of the program "Monitoring the Residues in Animal and Animal-Based Foods" implemented by Food Safety Inspectorate Body (FSIB) under the RA Government.

Milk samples were transported to RVSPCLS (Republican Veterinary-Sanitary and Phytosanitary Center of Laboratory Services, SNCO) at 4 ^{0}C to be then analyzed for residual tetracyclines, streptomycin and chloramphenicol. Prior to the analysis, the milk samples underwent pre-treatment in compliance with the methodical guideline on RIDASCREEN® enzyme immunoassay kits. The quantitative lab measurements of antibiotic residues were made by the enzyme-linked immunosorbent assay (ELISA).

The accuracy of testing results was verified through a high-performance liquid chromatography (HPLC) method.

Estimated daily intake (EDI) of antibiotics through milk

The daily intake of antibiotics through milk is estimated by the formula (1) as follows:

$$EDI = \frac{IR_{milk} \times C_{antibiotic}}{BW}, \quad (1)$$

where $\boldsymbol{IR_{milk}}$ is daily intake of milk, $\boldsymbol{C_{antibiotic}}$ – residual quantities of tetracyclines, streptomycin and chloramphenicol in the milk samples, ***BW*** - the average body weight, which is estimated as 65 kg for Armenia's adult population.

To specify the milk consumption data, we have surveyed females and males aged 18-65 using Food Frequency Questionnaire (FFQ). The survey was conducted among 400 Yerevanians in January-February, 2020. The survey data input and analysis were done through the SPSS program (SPSS Ins., version 22.0).

Margin of Exposure (MOE)

The margin of exposure was calculated with the formula (2):

$$MOE = \frac{HBGV}{EDI}, \quad (2)$$

where ***HBGV*** is a health-based guidance value. In this research we employed ADI (Acceptible Daily Intake) values as ***HBGV*** for tetracyclines and streptomycin equal to 0.03 and 0.05 mg/kg b.w., respectively (FAO, 1999), for chloramphenicol – RPA (Reference Point of Action) value - 0.0003 mg/kg b.w. (EFSA, 2018). ***MOE*** calculated for different substances may vary widely. Anyhow, low MOE - as compared with high MOE- is indicative of the higher risk (EFSA, 2012).

Results and discussions

The contents of antibiotics

The contents of tetracyclines, streptomycin and chloramphenicol identified in the milk samples are given in Table 1.

Technical Regulations of the Customs Union (TR CU 033/2013) and Commission Regulation (EU No 37/2010) ban on antibiotics in milk, meanwhile setting up the maximal threshold for their residual quantities.

Table 1. The contents of antibiotics in the studied milk samples*

N	Antibiotics	The contents of antibiotics (μ/kg)		
		Minimal	Maximal	Mean ± SD
1.	Tetracyclines	0.77	4.75	1.76 ± 1.09
2.	Streptomycin	94.19	519.72	209.27 ± 117.5
3.	Chloramphenicol	0.09	0.70	0.24 ± 0.19

Note: SD - standard deviation.

*Composed by the authors.

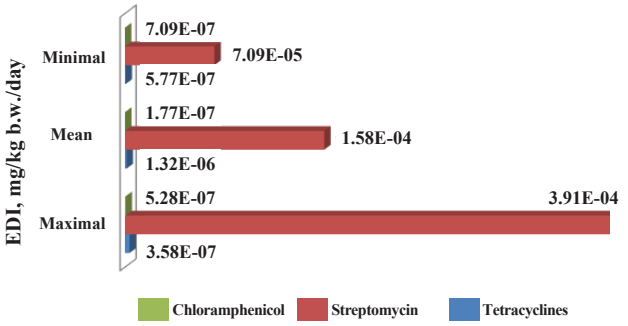

Figure 1. The estimated daily intake of antibiotics via milk by the adult population of Yerevan (*composed by the authors*).

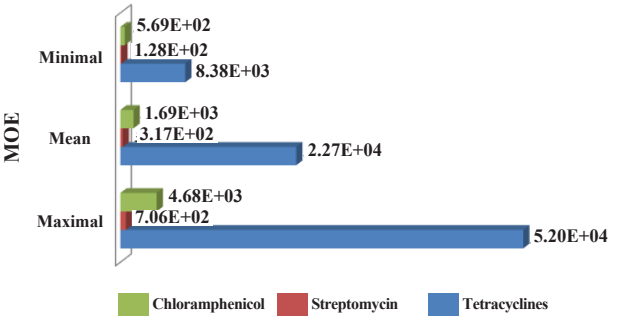

Figure 2. The margin of exposure to antibiotics (*composed by the authors*).

The results obtained have indicated that the contents of residual tetracyclines identified in the studied milk samples vary in the range of 0.77-4.75 μ/kg not exceeding however maximum residue limits – respectively 10 μ/kg and 100 μ/kg, as defined by Technical Regulations of CU and EU.

The mean residual content of streptomycin in the studied milk samples (209.27 μ/kg) exceeds the maximum residue limits - 200 μ/kg, whereas in some samples, its maximal contents overstep these limits several times.

Residual contents of chloramphenicol vary within 0.09 to 0.7μ/kg and exceed the allowable level set up by CU technical Regulation (CU TR 033/2013). This is evidence of the illegal use of this antibiotic.

Estimated daily intake (EDI)

Diet studies have indicated that for 2020 the average daily intake of milk in Yerevan is estimated as 0.049 kg/day. Data on the estimated daily intake of antibiotics via milk among the adult population of Yerevan are presented in Figure 1.

The next step in the research was collating the data obtained on EDI of antibiotics via milk (Figure 1) with the respective health-based guidelines values. The results obtained have indicated that EDI (estimated daily intake) values for streptomycin and tetracyclines-respectively 0-0.05 and 0-0.03 mg/kg/b.w./day - are consistent with those of ADI (acceptable daily intake) set up by international organizations (FAO, 1999).

Collation between the EDI values for the studied antibiotics indicate that they are significantly lower in case of chloramphenicol. It should be also mentioned that no health-based guidance value i.e. ADI is set up for chloramphenicol.

Margins of Exposure (MOE)

The MOE values calculated for assessing the risk of antibiotics for the adult milk consumers in Yerevan are given in Figure 2.

The calculated MOE values for the antibiotics identified in milk are rather high. Low MOE is known to indicate higher risks than high MOE does. MOE <10 denotes that risk exposure by the given substance is well concerning. The results derived from this research (Figure 2) point to the absence of the risk exposure to antibiotic identified in milk content.

Conclusion

In the result of the conducted research, it has been found out that in some samples of shop-bought milk of domestic production, two of three studied antibiotics - streptomycin and chloramphenicol residues - exceed the maximum residue limits. However, exposure to antibiotics via milk poses no health risks to adult milk consumers in Yerevan. And finally, the presence of banned antibiotics in the studied milk samples makes it urgent to improve the milk and milk-based produce quality and to develop control measures in milk producers nationwide, as well as to pursue research aimed at food-associated health risk identification.

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Exposure Assessment of Trans-Fatty Acids through Consumption of Sour Cream in Yerevan

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ABSTRACT

The aim of the study is to assess the content of trans-fatty acids (TFA) present in the sour cream produced in the RA and conduct a dietary exposure assessment. Data on sour cream consumption has been gathered through food frequency questionnaire (FFQ). TFA contents in sour cream samples were determined using the method of gas chromatography. Daily intake of TFA through sour cream consumption has been estimated. TFA daily intake (E %) accounted for 0.03 %, 0.185 % and 0.457 % of total energy intake (kcal) for sour cream consumption Cluster 1, 2 and 3, respectively. It was discovered that TFA daily intake through sour cream consumption does not exceed the recommended threshold value (≤ 1 E %).

Introduction

Trans-fatty acid (TFA) is an unsaturated fatty acid produced industrially through partial hydrogenation of liquid vegetable oils. TFA may also occur naturally in the stomach of ruminants as a result of anaerobic bacterial fermentation (Lichtenstein, 2016, Longhi, 2019). According to many investigations, there is a link between TFAs and various diseases (particularly breast and large intestine cancer, nervous system disorders, obesity, allergy) (Hammad, et al., 2016, Nishida & Uauy, 2009, WHO, 2019). Therefore, in recent years, many countries have implemented polices towards limiting and reducing TFA contents in human diet. Every year, it becomes more widespread that dietary intakes of TFA should be as low as possible (ALAP). Many countries have implemented effective approaches to regulate TFA amounts in foods and impose mandatory labeling of products (EFSA, 2018, WHO, 2019).

Armenia is a member of Eurasian Economic Union (EEAU) and follows its Customs Union technical regulations for fat-and-oil products (CU TR 024/2011). The latter defines acceptable contents for TFAs and the requirement for mandatory labeling only for fat-and-oil products. However, there are no requirements for either TFA contents or labeling for other processed products rather than fats and oils. Therefore, it is important to investigate the presence of TFA not only in fat and oil products, but also in products for which the latter are

used as raw materials. Besides, foods that contain milk fat replacers (vegetable oils) and are consumed widely in Armenia during the recent years, can also be risky. Dairy products, sour cream, in particularly, are one of these food types. Recently, in Armenia, the production of sour cream has increased drastically. Compared to 2018, sour cream production has increased by 27.5 % in 2020, amounting to 4457 tons (SC, 2020a).

The above mentioned facts ascertain that in order to discover potential risks and implement preventive measures, it is important to implement investigations related to TFA content and its daily intake. Currently, there is no science-based data regarding TFA content of sour cream produced in Armenia. Hence, the present study aims to assess TFA content and its dietary exposure through the consumption of sour cream.

The investigation has been carried out through the funding of the Ministry of Education, Science, Culture and Sports of the RA, in the framework of 19YR-4A037 scientific theme.

Materials and methods

Sour cream sampling and determination of TFA content

Sour cream has been sampled from different selling points of Yerevan. In total, 11 of the most widely consumed sour cream samples have been collected (Table 1).

Table 1. Data on the investigated sour cream samples*

Sample numbers	Producer
SC_1	"Prostokvashino"
SC_2	"Biokat" LLC
SC_3	"Stepanavan Farm"
SC_4	"Chanakh" LLC
SC_5	"Dustr Marianna" LLC
SC_6	"Ashtarak Kat" CJSC
SC_7	"Tamara & Ani" LLC
SC_8	"Tamara" LLC
SC_9	"Bandivan" LLC
SC_10	"Marila" LLC
SC_11	"Bonilat" LLC

*Composed by the authors.

Determination of TFA contents was performed by an independent laboratory of "Standard Dialog" LLC accredited by ISO/IEC 17025:2005 standards. Investigations were carried out using gas chromatography accroding to GOST 31663-2012 and GOST 32261-2013 standards defined for determination of trans-fatty acid methyl esters (GOST 31663-2012, GOST 32261-2013). This method is designed to evaluate the level of trans-isomers as formed during hydrogenation of vegetable oils or fats.

Sour cream consumption and statistical data analysis

Sour cream consumption data has been collected using food frequency questionnaire (FFQ). Surveys have been conducted in 2020 by the Informational-Analytical Center for Risk Assessment of Food Chain of Center for Ecological Noosphere Studies of the RA. Four hundred residents of Yerevan city, aged from 18 to 65 took part in the survey. Statistical analysis of data was performed by SPSS software (SPSS Inc., version 22.0).

To get a normal distribution of consumption values, K-means Cluster analysis method was applied. This method was shown to be effective especially for the analysis of dietary patterns in a large population using FFQs. Moreover, a Cluster analysis method allows revealing homogenous groups of consumers and computes average consumption values more precisely (Ares, 2014).

Daily Intake of TFA

By combining data of TFA content and sour cream consumption, daily intake (DI) of TFA (g/day) is calculated through the following equation:

$$DI = C \times IR, \quad (1)$$

where C is the mean content of TFA in all studied sour cream products (g in 100 g), IR is the daily consumption of sour cream (g/day) for each Cluster.

Daily intake of TFA has been represented as a percentage of total energy using the following equation (Liu, et al., 2015):

$$E\% = \frac{Dl \times 9}{DE} \times 100, \quad (2)$$

where $E\%$ is the daily TFA intake as the percentage of total energy. Dl is the TFA intake per day (g/day). The energy transfer index of TFA is 9 kcal/g. DE is the total dietary energy intake (kcal). The average resident in Yerevan city consumes approximately 2047 kcal/day (SC, 2020b).

Results and discussions

Content of TFAs in sour cream

Fat content in sour cream samples ranged from 17-20 %. Based on these data, TFA content has been calculated in 100 grams of sour cream. According to the results, TFA content ranged from 0.0446 grams to 1.2414 grams. The average TFA content in 100 grams of sour cream was equal to 0.4711 grams (Table 2).

Table 2. The contents of TFA in sour cream*

Sample number	Content of fat in sour cream (%)	TFA content detected in sour cream (%)	TFA content in sour cream (g/100 g)
SC_1	17	3.074	0.5225
SC_2	18	4.549	0.8188
SC_3	18	0.339	0.0610
SC_4	18	2.654	0.4777
SC_5	20	0.223	0.0446
SC_6	25	1.191	0.2977
SC_7	18	1.955	0.3519
SC_8	20	6.207	1.2414
SC_9	18	1.784	0.3211
SC_10	18	2.505	0.4509
SC_11	20	2.987	0.5974
Average content of TFA in sour cream samples (g/100 g)			**0.4711**

*Composed by the authors.

According to a study conducted in Lithuania, in 2012, trans-fatty acids have been detected in different sour cream samples (with 30% fat content). The average TFA content was equal to 9.4 % (based on fat content) which is approximately 4 times higher than the average TFA content (2.4 %) determined in this study (Miežielienė, et al., 2012). Based on another investigation, sour cream samples collected in 2020, from 3 different sour cream producers of Hungary, contained various fats, including TFAs. The average content of TFA was estimated to be 2.66 g/100g (Izsó, et al., 2020), which is approximately 5 times higher than the average TFA content (0.4711 g/100 g) determined in this study.

There is no regulation regarding TFA content in sour cream sold in Armenia. Therefore, in order to understand whether the detected TFA contents represent a risk for the population, it is crucial to estimate the daily intake of TFA through sour cream consumption.

Sour cream consumption

The results of K-means Cluster analysis revealed 3 Cluster groups for sour cream consumption. In case of Cluster 1, 2 and 3, the average daily sour cream consumption was equal to 14.64 g/day, 89.13 g/day and 220.8 g/day, respectively (Figure 1).

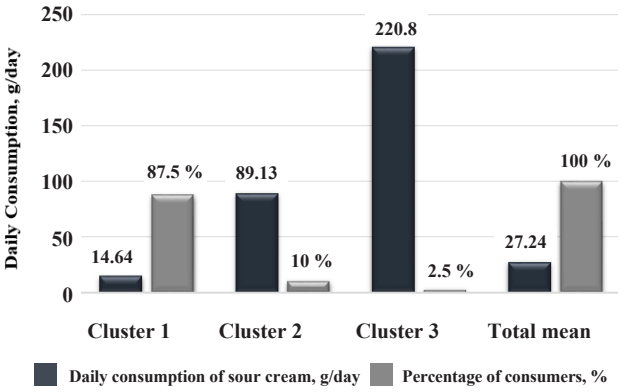

Figure 1. Daily consumption of sour cream (*composed by the authors*).

Cluster 1 is characterized with the lowest consumption value, but includes the majority of sour cream consumers (87.5 %), whereas Cluster 3 is characterized with the highest consumption value, but includes only 2.5 % of consumers. Cluster 2 includes 10 % of the consumers.

DI of TFA

To regulate TFA content in the diet, in many countries (such as Germany, Austria, Sweden, Belgium, Netherlands, Spain, Australia, Canada) it is required that the average daily intake of trans-fats should not exceed 1 % of daily total energy (≤ 1E%). The latter is the threshold value recommended by the World Health Organization (WHO, 2019). However, in some countries, such as France and United Kingdom, the required threshold for TFA is less than 2 % of daily total energy (≤ 2E%) (EFSA, 2018).

In order to carry out a dietary exposure assessment, daily intake was calculated (Figures 2 and 3) and compared with WHO's recommended level of less than 2.2 g/day for total TFA intake, which is equal to less than 1% of total energy intake (WHO, 2019). In case of the largest Cluster of sour cream consumption, daily intake of TFA exceeds the values for Cluster 1 and 2 by 15 and 2.5 times, respectively.

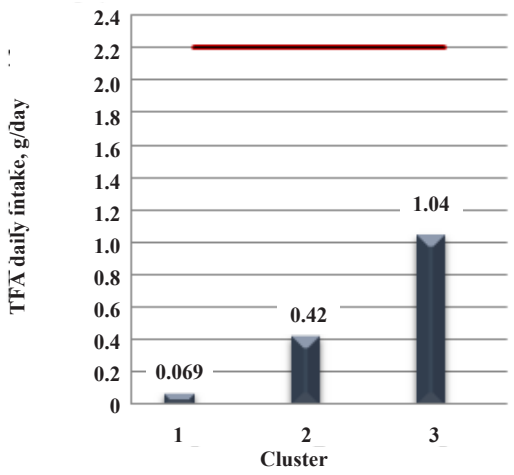

Figure 2. Daily intake of TFA (g/day) for each Cluster (*composed by the authors*).

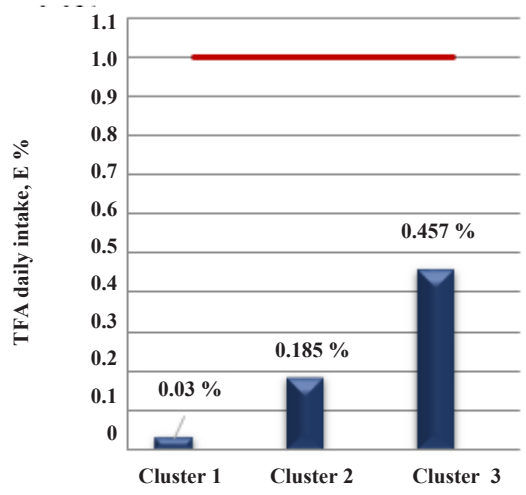

Figure 3. Daily intake of TFA as a percentage of total energy (*composed by the authors*).

As Figure 3 indicates, daily intake of TFA for sour cream consumption in Clusters 1, 2 and 3 accounts for 0.03 %, 0.185 % and 0.457 % of the total energy intake, respectively. These values do not exceed the WHO's recommended limit (≤ 1E%), however, in case of only sour cream consumption, daily intake of TFA for Cluster 3 accounts for approximately 45 % of the threshold value. It should be noted, that according to another investigation conducted in Yerevan city, in 2020, TFAs have been found in ice-cream samples. The daily intake of TFA (calculated for summer season) accounted for 0.041 % of the total energy intake (Pipoyan, et al., 2020).

Conclusion

The results of the current study indicate that sour cream samples sold in Armenia, contain trans-fatty acids. Although, daily intake values of TFA do not exceed the WHO's recommended limit of 1 % of total energy intake, in case of Cluster 3, TFA DI accounts for around 45 % of the threshold value. Considering the fact, that there can be other products in the market that contain TFA, it is crucial to conduct continuous and large-scale dietary exposure assessment studies.

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Development of New Meat Product Technology via Tea Plants Application

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ABSTRACT

The aim of the current research is to develop a new technology for smoked/cured meat production from the poultry meat, while reducing the ageing period and supplementing the product with proteins and carbohydrates needed for the regular life activity of human organism.

To this end we have developed a technology for manufacturing new variety of smoked product via the use of herbaceous plants, which reduce the ageing times of cured meat in 2 times.

The recipe and technological phases for the new type of smoked product manufacture was established. Besides, its physicochemical indices and shelf life was determined and the energy value was estimated.

Introduction

Poultry meat is a high-value food with its chemical composition, succulence, tenderness, nutritional value and dietary features.

Unlike the meats of other farm animals, the poultry meat contains much of muscle tissue and little of poorly developed connective tissue, hence, it comprises a great amount of complete proteins (15.8-24.5 %) and less amount of incomplete proteins (elastin, collagen).

Fat content in the poultry meat makes 11-16 %. Poultry fat has a low melting point (36.5 ^{0}C), which stimulates its high assimilation in the body. Fats contain a number of unsaturated fatty acids, which are not sufficiently synthesized in the organism (linolenic, linoleic and arachidonic).

Poultry meat is close to slaughter animal meat regarding the quantity of mineral matters. It contains high amount of enzymes among which phosphatase, amylase, endoprotease, peroxidase and catalase are of high significance. Nitrogen-free extractive substances, which improve the meat flavor, constitute 1 % of the poultry meat (glycogen, glucose, lactic acid) and are very important during meat ageing.

Meat is the main source of vitamin B complex for humans (Danilova, 2008).

Nowadays, apart from the meat raw material, plant-based supplements are also widely used, which exert positive effect on the organoleptic indices, yield, production duration and other indices of the finished meat product.

Tea shrub is native to Asia. *Camellia* is a species of evergreen shrubs or small trees in the flowering plant family *Theaceae*. The main widely used varieties are *Camellia sinensis*, which is mostly used in China, Formosan and Japan, and the variety *Assamica* is mostly common in India.

Coffein constitutes 3 % of the tea dry weight. In the tea mixture there is a considerable amount of polyphenol, which is a denser combination of leaves making up 30-40 % of the mixture. Tea also contains small amounts of theobromine and theophylline.

Thyme is the herb (dried aerial parts) of some members of the genus *Thymus* of aromatic perennial evergreen plants or half-shrubs in the mint family *Lamiaceae*. It is widely spread and used by Armenian population. Thyme contains 0.5-1 % essential oils which comprise thymol, carvacrol, cymol, terpinene, borneol and zingiberene. It also contains chemical elements such as potassium, calcium, magnesium. For medicinal purposes the aboveground part of thyme is used, which is cut during the plants flowering period and dried out in the outdoor conditions. Thyme comprises vegetable gum, organic acids, flavonoids, vitamins *B* and *C*.

Peppermint is a herbaceous rhizomatous perennial plant of the family *Lamiaceae*. The cultivated peppermint (Latin name - *Mentha Piperita L.*) has oval or lance-shaped leaves with inversely arranged, toothed acute margins and reddish small veins.

The aboveground mass of the plant contains essential oil, the amount of which in the flowers makes 4-6 %, in leaves they are 2.4-2.75 % and in stalks – up to 0.3 %. It is produced out of the water vapors with infusion method. Its main constituent (41-65 %) is the secondary alcohol (41-65 %) menthol. The plant also contains menton, pinene, limonene, dipentene, cineole and other valuable substances.

The plants leaves are used for medicinal purposes. Not only the herbal substances, but also the produced essential oil is used in medicine. Peppermint has been known to mankind from time immemorial. In medieval times there was an opinion that peppermint flavor activates the brain work.

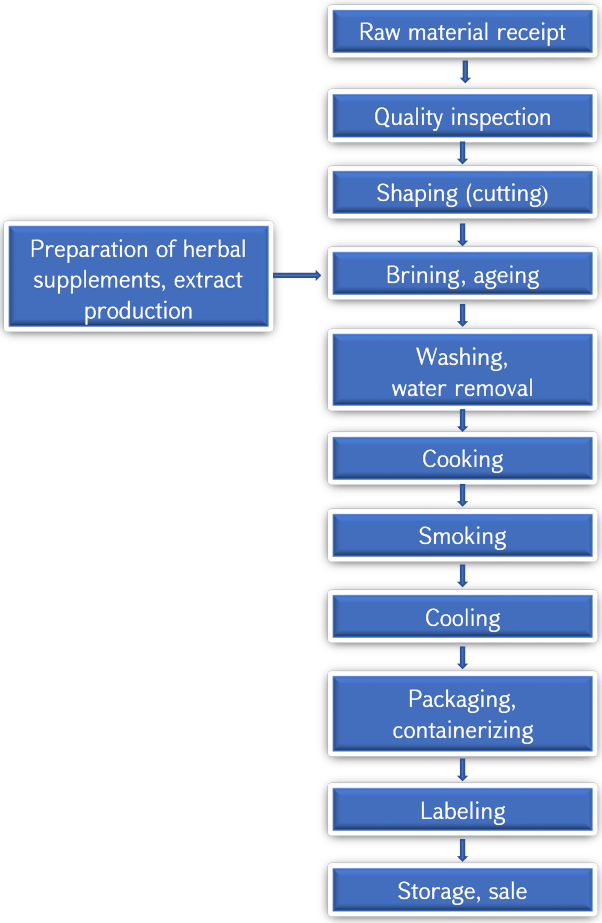

Diagram. Technological scheme for new smoked product manufacture (*composed by the authors*)

Materials and methods

The first stage of our investigations was implemented with the introduced technological scheme (Diagram).

The laboratory research and pilot experiments related to the current work have been conducted in the laboratory of the chair of "Animal-Based Foodstuff Processing Technology", ANAU.

The organoleptic and physicochemical indicators of the finished product has been examined. The energy value of the meat product has been also estimated. The laboratory investigation of the manufactured product has been implemented in three replications and the arithmetic mean has been taken as a final outcome (Antipova, et al., 2001).

The new meat product has been manufactured from the raw material of local chicken meat. The meat carcass of the local broilers has been used as a raw material.

As it has been already mentioned, along with the main raw material (chicken meat), tea plants have been also applied in the recommended technology for producing cured meat product, the water infusion of which has been used for raw material ageing.

After veterinary sanitary examination, the raw material (chicken meat) was subjected to physicochemical and organoleptic investigations, thereafter the raw material underwent cutting (splitting).

According to the raw material type the carcass was divided into 8 anatomical pieces, anyhow, the use of entire carcass and half-carcass is more preferable (Zonin, 2006).

After splitting the raw material, brining (salting) and ageing processes were simultaneously implemented. This process is the most important stage in the foodstuff production, since it determines the latter's flavor and qualitative indicators, as well as its shelf life.

In the result of multiple experiments the optimal salt amount in salt water was considered to be 2 kg.

Results and discussions

As it has been already mentioned, tea plants have been used in the manufacture of new types of cured meat. It was mostly in the form of black tea, thyme and peppermint mixture. The optimal quantity of the tea plants has been determined, the results of which are introduced in Table 1. The calculation has been conducted for 100 L water. The results of numerous trials and the organoleptic indicators of the finished product have served as a background to identify the ratio of the tea plants mixture (Table 1).

Table 1. Determination of optimal quantity of tea plants*

Name of the tea plant	Quantity, g	Organoleptic indicators
Black tea	500	Well distinguished tea plants taste and flavor with yellowish tinge
Thyme	300	
Peppermint	150	

*Composed by the authors.

So, the optimal salt water content per 100 kg raw material has been determined for the experimental sample:

Edible salt – 2 kg

Sugar – 0.1 kg

Black tea – 0.5 kg

Thyme – 0.3 kg

Peppermint – 0.15 kg

After drawing out the brine ingredients the experimented samples were subjected to wet brining. The samples were submerged in the respective salt water at 2-4 ^{0}C and the process of their ageing was studied based on the taste, color, pH and consistency indexes.

Table 2. Brining and ageing indicators of the raw material*

Brining duration, day	Temperature, ^{0}C	*pH*	Organoleptic evaluation
1	2-4	6.0	Thick consistency, with light yellowish color, poorly aged
2	2-4	5.8	Stiff consistency, intensely colored (yellow-golden tinge), well-aged
3	2-4	5.6	Stiff consistency, dark brown, well-aged

*Composed by the authors.

Based on the data of Table 2, the optimal brining and ageing time is considered to be 2 days, where the environmental *pH* equaled to 5.8, consistency was firm with well-aged flavor and yellow-golden color. The further technological processes were implemented based on the traditional technological parameters of manufacturing smoked products from the chicken meat (http:/mirknig.com/). Taking into account that no preservation agents were applied during the food production the shelf life of the finished product has been set up from 3-4 days at the temperature of 0-6 ^{0}C.

After developing the technology of the manufactured food product and determining the technological parameters (Table 3), the recipe of producing new type of smoked product from the poultry meat per 100 kg raw material was introduced (Table 4).

Table 3. Production and storage parameters for new type of poultry meat product*

Name of the products and actions	Indicator
Poultry raw material cutting, half-carcass/semi-carcass	2
Optimal quantity of tea plants, g	
Black tea	500
Thyme	300
Peppermint	150
Water amount, L	100
Infusion duration, h	3-4
Salt water/brine amount	
Water, L	100
Edible salt, kg	2
Sugar, kg	0.1
Brining	
Brining, ^{0}C	3-4
Duration, h	48
Cooking	
Temperature, ^{0}C	75-85
Duration, h	48-50
Temperature in the center of product, ^{0}C	69-70
Smoking/curing	
Temperature, ^{0}C	30-35
Duration, h	3-4
Cooling	
Temperature, ^{0}C	0-4
Duration, h	3-4
Temperature in the centre of product, ^{0}C	4±4
Storage, sale	
Temperature, ^{0}C	0-6
Duration, h	48

Table 4. The recipe of the finished product per 100 kg uncured raw material (poultry meat)*

Seasonings and agents	Quantity, g
Edible salt	2000
Sugar	100
Black tea	500
Thyme	300
Peppermint	150

*Composed by the authors.

The yield of finished product against the raw material makes 70-75 %. The finished product has been investigated per its humidity, protein, fat, mineral matters and edible salt content. The energy value of the new smoked product has been also estimated (Antipova, et al, MacCance & Widdowson's Handbook, 2006).

The finished product was subjected to degustation and assessed with 30-point scale, getting scored with 28 points, which is considered as an excellent index for meat product. All investigations were conducted with triple replications and the arithmetic mean was assumed as the final result and recorded in Table 5 (Zonin, 2006).

Table 5. The summary indices of chemical composition and calorific value for the new smoked/cured product manufactured from the poultry meat*

Content, %				Energy value	
Humidity	*Protein*	*Fat*	*Ash+NaCl*	*kcal*	*KJ*
50.33	22.57	22.41	4.69	291.97	1223.35

*Composed by the authors.

The data of Table 5 indicate that in the investigated sample the protein (22.57 %) and fat (22.41 %) content is rather high, which provides the high calorific capacity (291.97 kcal) of the new type of smoked chicken meat product.

As it was stated in the tea plants description, they contain multiple enzymes, the activities of which result in the change of brine microflora. During the ageing process of the raw material, apart from enzymatic activities, lactic acid bacteria growth was also observed, which is proved upon the data on *pH* (5.8) provided on the second day of ageing (Danilova, 2008).

During the brining period, changes in the poultry meat water absorption capacity also take place, which enables to state on the proper meat ageing course.

The research results have reaffirmed the miscellaneous beneficial properties of poultry meat and tea plants. The recommended technology is considered to be relevant, since such type of meat production ensures, first, utilization of local/domestic raw material, second – expansion of the meat product range and last but not least – manufacture of new type of meat food product.

Conclusion

The effectiveness of applying poultry meat carcass in the production of the cured/smoked meat food is scientifically justified and experimentally proved. The use of tea plants in the smoked products manufacturing process is also well grounded upon the fact that they enhance the organoleptic indicators of the finished product.

The technological process and recipe for the manufacture of new meat product has been developed. It has been proved that during the mentioned food production process physicochemical changes take place which enhance the qualitative indices of the manufactured product. The latter is also endowed with high energy value which amounts to 291.97 kcal and 1223.35 KJ. The new product has been also subjected to expert tasting as a result of which, it has scored 28 point in 30-point assessment scale. The developed production technology enables to reduce the ageing time in about 2 times, which promotes more efficient exploitation of production surfaces.

Thus, it is recommended to organize the manufacture of new meat product in the production units affiliate to the poultry factories.

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Selection of Natural Fruit Ingredients for the Production of Wine Cocktails with High Organoleptic Properties

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ABSTRACT

The aim of the research is to identify and select natural fruit ingredients for the production of wine cocktails with high organoleptic properties via investigating the chemical and organoleptic indices of the produced cocktails. Dried apricots and kumquat fruits have been selected as fruit ingredients. They have been mixed with the dry white wine materials with the doses of 10 g/dm^3 and 20 g/dm^3 respectively.

Introduction

The consumption and target areas of the contemporary alcoholic products are quite different. There are many low-alcohol beverages in the world market the list of which has been headed by the beer products for many years. Currently, energy drinks and cocktails are alternatives to beer, and due to the low alcohol and sugar content they are in high demand among the consumers (Samuel and Znak, 1994).

Due to the combination of wine with other drinks (alcoholic and non-alcoholic) it becomes possible to develop new technologies for palatable cocktail production. Many of these recipes have become famous worldwide, while some of them are quite new and haven't gained wide consumption frames yet (Borisenko, 2002).

The cocktails available in the domestic and foreign markets contain only liquid ingredients. Besides, the beverages with no synthetic food additives and multi distilled ethyl alcohol are of special significance. The production of wine cocktails with solely natural raw material and with higher organoleptic properties (appearance and taste) is an issue to be addressed by both the consumers and the branch industry.

Materials and methods

For the production of wine cocktails dry table wine material extracted from the grape, fresh citrus (kumquat fruits), dried apricots, grapes and apples prepared in natural conditions have been used (Burich, 1978). All ingredients complied with the requirements set for these products in the Republic of Armenia.

The dried fruits were sorted, washed and treated in microwave oven with high frequency radiation (Artikov, 1992). Each of the selected ingredients was placed in an individual container and then they were supplemented

with wine material. Different doses of wine material (5 g/dm^3, 10 g/dm^3, 20 g/dm^3, 30 g/dm^3) were applied for each dried fruit variety. The optical density of the obtained solution ceased to change 5-6 days after its production in case of two wavelengths (420 nm and 520 nm) of spectrophotometer. Just at this moment of physical equilibrium the mass concentration of dry matters and titratable acids was determined (Artikov, 1992).

Dried apricot, grape and apple fruits, kumquat fruits, dry white table wine material (control variant), the mixtures of fruit ingredients and different doses of wine materials, as well as wine cocktails have served as a study object.

The humidity and sulfur anhydrite of dried fruits and kumquat fruits, their sugar content, chemical indices of dry matters in white table wine, the mass concentrations of titratable acids and dry matters of fruit ingredient and wine material mixtures, as well as chemical indices and bottling stability of wine cocktails have been investigated. All investigated samples have been subjected to degustation.

The generally accepted standard methods stated in the normative documents and in winemaking branch currently practiced in Armenia have been applied for the research (Simonyan and Manukyan, 2011).

The organoleptic evaluation of the wine cocktails produced in the result of the experiments and available in the domestic market has been conducted by the professional degustation committee consisting of 10 members with 10-point rating scale (Simonyan and Manukyan, 2011, AST 271-2007: The alcohol production and raw material for its manufacture, methods for determination of titrating acids).

Results and discussions

The tasted wine cocktail samples available in the market were endowed with disadvantages peculiar to grape or fruit wine materials, i.e., lack of taste completeness and the presence of oxidized hues in the taste and flavor. In the foreign sample unpleasant bitter taste was felt due to the use of synthetic colorants and flavorings. Hence, by rejecting the use of synthetic components, the wine cocktail production could obtain an attractive direction.

The fruit ingredients of the wine cocktail meet the requirements set for their physicochemical properties (Table 1).

Table 1. The physicochemical indicators of the fruit ingredients in wine cocktails*

Indicators	Fruit ingredients			
	Raisin	Dried apricots	Dried apples	Kumquat
Humidity mass, %	17	19	19	80
Sulfur anhydrite, %	0.01	0.01	0.01	0.01
Sugar substances, %	30	35	12	9

*Composed by the authors.

The dry wine material of the white grape applied for the cocktail production was endowed with the organoleptic properties peculiar to white wine materials and had the following chemical composition: ethyl alcohol - 9.5 %, mass concentration of the titratable acids - 7.2 g/dm^3, sugar mass concentration - 2.7 g/dm^3.

The changes of dry matters and titratable acids mass concentration in the mixture of wine materials and fruit ingredients depending on the doses of fruit ingredients are introduced in Table 2.

Table 2. The changes of dry matter and titratable acid mass concentration in the mixture of wine materials and fruit ingredients depending on the doses of fruit ingredients*

Ingredients	Doses of fruit ingredients, g/dm^3							
	Mass concentration of dry matters, %				Mass concentration of titratable acids, g/dm^3			
	5	10	20	30	5	10	20	30
Dried apricots	8.6	10.2	14.1	15.3	5.8	6.3	6.2	6.5
Raisin	10.4	12.2	12.5	17.6	5.2	6.1	6.2	6.5
Dried apples	9.6	10.7	12.7	16.7	6.0	6.3	6.8	6.7
Citrus (kumquat fruit)	7.0	7.5	10.4	12.3	5.8	5.8	5.9	6.2
Control sample	6.8				5.8			

*Composed by the authors.

Table 3. Qualitative indices of wine cocktails*

Indicator	Wine cocktails			
	With dried apricots	With raisin	With dried apples	With kumquat
Ethyl alcohol volume, *%*	8	8	8	7
Mass concentration of sugars, *g/dm³*	50	50	45	45
Mass concentration of titratable acids, *g/dm³*	5.0	4.3	4.6	5.5
Mass concentration of the total sulfur dioxide, *mg/dm³*	138.2	145.7	143.2	125.6
Degustation evaluation, *point*	8.4	8.3	8.2	8.4
Bottling stability	No more than 6 months	No more than 6 months	No more than 6 months	No more than 8 months

*Composed by the authors.

Upon the interfusion of kumquat fruits and wine material it became clear that when increasing the fruit dose up to 20 g/dm³, the organoleptic indicators also improve, but in case of 30 g/dm³ the wine material acquired bright citrus tints and yellow coloring. Extraction of dry matters was also observed; their quantity increased in about 1.7 times, besides, the mass concentration of the titratable acids almost remained unchanged.

In the result of raisin and wine material interfusion raisining hues in the flavor and taste were recorded when preparing solution with 5 g/dm³ and 10 g/dm³ doses of raisin, while in case of applying 20 g/dm³ and 30 g/dm³ ingredient, unpleasant sweetness and bitter aftertaste was felt. Growth in the mass concentration of the dry matters was recorded and the acidity increased by 0.7 g/dm³.

Similar organoleptic patterns have been recorded in case of applying dried apricots and apples.

The most intensive growth in the content of dry matters has been observed upon the interfusion of dried apples and wine material, when the increase of titratable acidity amounted to 0.7 g/dm³.

The favorable dose for the kumquat fruits as a fruit ingredient is assumed as 20 g/dm³, while for the dry apricots and apples it is 10 g/dm³.

The qualitative indicators of the wine cocktail are introduced in Table 3. The highest organoleptic indices have been recorded in the cocktails produced via citrus fruit and dry apricots. They were distinguished by typical consistent fruit flavor. These ingredients can be used in the recommended technology of wine cocktail production.

The demand for such product types is drastically growing in the world market; anyhow they haven't found broad application in Armenia yet. Thus, the methods and technology recommended in the current article could greatly contribute to the branch development.

Conclusion

Based on the retrieved experimental data, it can be inferred that dry matter extraction upon the interfusion of citrus and wine material is recorded; its amount increases in 1.7 times as a result of which the mass concentration of the titratable acids almost stays unchanged. An increase in the mass concentration of dry matters is also observed upon the interfusion of wine material and raisin in case of which the titratable acidity grows up by 0.9 g/dm³. The most intensive growth in the content of dry matters is recorded when using dried apples in case of which the titratable acidity increases by 1 g/dm³.

The organoleptic analysis of semi-finished products has indicated that in case of increasing the doses of all ingredients, organoleptic indicators improve, as well as intensification of sweetness and bitter aftertaste is felt.

It has been also found out that in case of citrus and wine material interfusion, well distinguished bright citrus tints and yellowish color emerge.

The demand for such products is rapidly growing in the world market but they aren't widely used in Armenia yet. Hence the recommended technology could surely promote the branch development.

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ՑՈՒՑՈՒՄՆԵՐ ՀԵՂԻՆԱԿԻՆ | УКАЗАНИЯ АВТОРУ | AUTHOR GUIDELINES

ՊԱՐԲԵՐԱԿԱՆԸ ՆԵՐԱՌՎԱԾ Է ԴՈԿՏՈՐԱԿԱՆ ԵՎ ԹԵԿՆԱԾՈՒԱԿԱՆ ԱՏԵՆԱԽՈՍՈՒԹՅՈՒՆՆԵՐԻ ԱՐԴՅՈՒՆՔՆԵՐԻ ԵՎ ԴՐՈՒՅԹՆԵՐԻ ՀՐԱՊԱՐԱԿՄԱՆ ՀԱՄԱՐ ՀՀ ԿԳՄՍՆ ԲՈԿ-Ի ԿՈՂՄԻՑ ԸՆԴՈՒՆԵԼԻ ԳԻՏԱԿԱՆ ՀԱՆԴԵՍՆԵՐԻ ՑԱՆԿՈՒՄ:

ИЗДАНИЕ ВКЛЮЧЕНО В ПЕРЕЧЕНЬ ВЕДУЩИХ НАУЧНЫХ ЖУРНАЛОВ ВАК МНОКС РА, В КОТОРЫХ ДОЛЖНЫ БЫТЬ ОПУБЛИКОВАНЫ ОСНОВНЫЕ РЕЗУЛЬТАТЫ И ПОЛОЖЕНИЯ ДИССЕРТАЦИЙ НА СОИСКАНИЕ УЧЕНОЙ СТЕПЕНИ ДОКТОРА И КАНДИДАТА НАУК.

THE JOURNAL IS INVOLVED IN THE LIST OF SCIENTIFIC PERIODICALS RELEVANT FOR PUBLICATIONS OF THE RESULTS AND PROVISIONS OF DOCTORAL AND PHD THESES AND APPROVED BY THE HIGHER EDUCATION QUALIFICATION COMMITTEE OF THE RA MoESCS.

ՀՈԴՎԱԾՆԵՐԻ ԸՆԴՈՒՆՄԱՆ ԿԱՐԳԸ

1. Հոդվածներն ընդունվում են հայերեն, ռուսերեն և անգլերեն լեզուներով:
2. Հոդվածի առավելագույն ծավալը չպետք է գերազանցի 10 համակարգչային էջը (ներառյալ ամփոփագրերը):
3. Հեղինակների թիվը չպետք է գերազանցի չորսը:
4. Հեղինակների տվյալներում պետք է ներառվեն հեղինակ(ներ)ի անունը, ազգանունը, հայրանունը, գիտական աստիճանը, աշխատավայրը, էլ. հասցեն:
5. Հոդվածը ներկայացվում է տպագիր և էլեկտրոնային (WORD ձևաչափով) տարբերակներով:
6. **Հոդվածը շարադրվում է հետևյալ կառուցվածքով.** վերնագիր, 5 բանալի բառ, «Նախաբան», «Նյութը և մեթոդները», «Արդյունքները և վերլուծությունը», «Եզրակացություն», «Գրականություն»:
7. Գրականության հղումները կատարվում են տեքստում՝ փակագծում նշվում են հեղինակը և հրատարակման տարեթիվը:
8. Հոդվածները պետք է ունենան ամփոփագրեր. հայերենով և ռուսերենով ներկայացված հոդվածների դեպքում՝ հայերեն, ռուսերեն և անգլերեն, անգլերենի դեպքում՝ անգլերեն լեզվով:
9. Յուրաքանչյուր լեզվով ներկայացված ամփոփագրի ծավալը չպետք է գերազանցի 600 նիշը (առանց բացատների):
10. Հայերեն և ռուսերեն հոդվածների վերնագրերը, հեղինակ(ներ)ի տվյալները և բանալի բառերը ներկայացվում են հայերեն, ռուսերեն և անգլերեն լեզուներով:
11. Գրականության ցանկը ներկայացվում է այբբենական կարգով:
12. Էլեկտրոնային հղումը որպես աղբյուր մեջբերելիս գրականության ցանկում նշվում է դիտման ամսաթիվը:

Հոդվածներին ներկայացվող տեխնիկական պահանջներն են. անգլերեն և ռուսերեն հոդվածների տառատեսակը՝ Times New Roman, հայերեն հոդվածներինը՝ GHEA Grapalat, տառաչափը՝ 12, միջտողային տարածությունը՝ 1.5, վերնագիրը՝ մեծատառերով, գծապատկերները՝ Word, Excel ծրագրերով, աղյուսակները՝ ուղղահայաց դիրքով (Portrait), բանաձևերը՝ Microsoft Equation 3.0 ձևաչափով:

Կարգին չհամապատասխանող հոդվածները չեն ընդունվում: Հոդվածներն ուղարկվում են գրախոսման: Մերժված հոդվածները չեն վերադարձվում հեղինակին: Հոդվածները չեն հրատարակվի, եթե ամբողջությամբ կամ համառոտ տպագրված լինեն այլ պարբերականում:

ПОРЯДОК ПРИЁМА СТАТЕЙ

1. Статьи принимаются на армянском, русском и английском языках.
2. Объём статьи не должен превышать 10 компьютерных страниц (включая аннотации).
3. Число авторов не должно превышать четырёх.
4. В сведениях об авторах должны быть включены имя (имена), фамилия, отчество, научная степень, место работы, эл.адрес.
5. Статья представляется в печатном и электронном (в формате WORD) вариантах.
6. **Статья должна быть изложена следующим образом:** заглавие, 5 ключевых слов, «Введение», «Материал и методы», «Результаты и анализ», «Заключение», «Литература».
7. Ссылки на литературу производятся в тексте с указанием в скобках автора и год издания.
8. Статьи, написанные на русском и армянском языках, должны содержать аннотацию на армянском, русском и английском языках, в статье на английском аннотация пишется на английском языке.
9. Объём представленных аннотаций на каждом языке не должен превышать 600 знаков (без пробелов).
10. Заглавия, данные автора (авторов) и ключевые слова статей на армянском и русском языках представляются на армянском, русском и английском языках.
11. Список литературы представляется в алфавитном порядке, сначала на языке статьи, затем на иностранном языке.
12. При ссылке в статье на интернет-ресурс как источник информации, в списке литературы необходимо отметить дату просмотра.

Технические требования к статьям: для статей на английском и русском языках - шрифт Times New Roman, для армянского - GHEA Grapalat; размер букв - 12; межстрочное расстояние - 1.5; заголовок - прописными буквами; графические изображения - программой Word, Excel; таблицы - вертикально (Portrait); формулы - в формате Microsoft Equation 3.0;

Статьи, не отвечающие требованиям, не будут приняты. Статьи передаются на рецензирование. Статьи, не принятые к печати, не возвращаются автору. Статьи не будут опубликованы, если ранее были полностью или частично опубликованы в других периодических изданиях.

THE STANDARDS FOR SUBMITTING ARTICLES

1. The articles are accepted in Armenian, Russian and English languages.
2. The size of the article shouldn't exceed 10 PC pages (including summaries).
3. The number of authors should not exceed four.
4. Full name, academic degree, workplace and e-mail of the author (s) should be included in the information about the authors.
5. The article is submitted in a hard copy and electronically (WORD format).
6. **The article should have the following structure:** title, 5 keywords, "Introduction", "Materials and Methods", "Results and Discussions", "Conclusion", "References".
7. References to the literature should be indicated in the text (the author and the date of publication in the parentheses).
8. Articles should have abstracts; for Armenian and Russian articles they should be in Armenian, Russian and English languages, for English articles only abstracts in English language are required.
9. The volume of the abstracts presented in each language should not exceed 600 characters (no spaces).
10. The titles, information about the author(s) and keywords should be presented in Armenian, Russian and English languages.
11. The list of references should be arranged in alphabetical order.
12. When citing internet links as a literature source the date of access should be mentioned.

Technical requirements for articles: font for English and Russian articles: Times New Roman, for Armenian articles: GHEA Grapalat, font size: 12, interstitial spacing: 1.5, title: with capital letters, charts: with Word, Excel, tables: vertical (Portrait), formulas: in Microsoft Equation 3.0 format.

Articles that do not meet the requirements are not accepted. Articles are sent for review. Refused articles are not returned to the authors. The articles which are already published in other scientific journals (completely or partially) can't be valid for publication in our journal.

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