Introduction of Elements of Precision Farming on the Basis of Unmanned Air Cargo Platforms in the Conditions of Mountain Winemaking

Angela N. Mayorova, Dmitry V. Nekhaychuk, Nikolay N. Oleinikov, Marina A. Ryndach, Igor A. Bukreev

1 V.I. Vernadsky Crimean Federal University, Simferopol, Russia
2 Plekhanov Russian University of Economics, Moscow, Russia
grishin.iuri2010@mail.ru

Abstract. The paper analyzes modern systems of farming and viticulture. A comparative assessment of traditional technogenic and precision viticulture is carried out. The fundamental features of the introduction in the southern regions of Russia of the latest high-tech elements of precision viticulture, including unmanned aerial platforms for vertical takeoff and landing SKYF, in the conditions of mountain winemaking have been determined. The identified advantages of using unmanned technological equipment will significantly improve the quality of wine products by reducing the time between grape harvest and processing and preserving the ecology of the environment, thanks to the environmental friendliness of SKYF unmanned platforms. The introduction of modern technical means of logistics, monitoring, and management systems is called upon to ensure the greatest efficiency of viticulture in the southern regions of Russia.

Keywords: Unmanned Aerial Cargo Platform for Vertical Take-Off and Landing, Grapes, Transportation, Processing, Unmanned Cargo Aerial Platform Control, Flavones, Hydroxycinnamic Acids, Hydroxybenzoic Acids.

1 Introduction

Agriculture has always been one of the most important sectors of the economy of the southern regions of Russia. Agriculture accounts for about 17% of the gross regional product. The agriculture of these regions is historically focused on the development of agriculture. The branches of his specialization are viticulture, gardening, cultivation of tobacco, essential oil crops, and grain farming. Thus, Crimea in 2014 ranked 3rd in Russia in terms of the gross harvest of grapes (13.4% of the gross harvest of grapes in Russia), was in the top ten regions in terms of the gross harvest of berries and fruits.
Global climate change caused by human impact on the environment, chemical and technogenic intensification of agriculture, emission of carbon dioxide, lead dioxide, and other harmful gases into the atmosphere that harm human health, leads to the reassessment of traditional systems of agriculture and viticulture and the development of new systems. Such systems are based on the biologization and ecologization of intensification processes in agroecosystems and agrolandscapes, mobilization of the adaptive potential of the most important biotic components of agrobiogeocenoses, more differentiated use of natural, biological, and technogenic resources [7-12].

Scientific and technological progress in the development of robotics, microelectronics, information, and telecommunications technology, the creation of positioning systems, and geoinformation systems have laid the fundamental foundations for the development and implementation of agricultural technologies differentiated in space and time. This qualitatively new, innovative technological complex was called "precision agriculture" [13-18].

In the subtropical conditions of the northern coast of the Black Sea, where the best European grape varieties Vitis Vinifera grow and wines with a worldwide reputation are produced, the vineyards are mostly located in mountainous areas. This causes an increase in the economic costs of transporting grapes in the absence of high-quality transport infrastructure, an increase in delivery time from the moment of grape harvest until the moment of its processing, which leads to a decrease in the quality of raw materials supplied for processing [19-22].

The purpose of the article is to compare the functionality of unmanned air cargo platforms in the conditions of mountain winemaking.

2 Main Content

Currently, more and more attention is paid to the issue of obtaining wines with high antioxidant properties that have a beneficial effect on human health [23-25].

According to the rules of technocchemical control of winemaking, the delivery time of grapes to the primary winemaking plant should not exceed 4 hours, and for the production of wines protected by appellations of origin - 2 hours [26].

The development of the Russian company ARDN Technology - the SKYF unmanned aerial cargo platform for vertical take-off and landing, is the first unmanned aerial vehicle of its kind for the transportation of agricultural products and has no analogs in the world. The use of the SKYF unmanned air cargo platform, equipped with specialized working bodies, will allow solving a wide range of tasks for the transportation and logistics processing of goods in the agricultural, and in particular, the wine industry (Fig. 1).
The conceptual innovative solution of the SKYF unmanned air cargo platform is a unique patented aerodynamic design based on the separation of the functions of the lifting and tail rotor. The internal combustion engine (ICE) directly drives the rotation of large fixed pitch propellers, resulting in the lifting force required for the platform to take off, while the auxiliary electric control screws provide the pitch and roll orientation of the platform (Fig. 2).
The use of such a control and launch scheme allows the use of DVG energy directly without additional electric sequential hybrid schemes, providing the SKYF unmanned air cargo platform with unique technical characteristics in terms of carrying capacity, fuel consumption, and flight range (Table 1).

Table 1. Technical characteristics of the unmanned air cargo platform SKYF

<table>
<thead>
<tr>
<th>Technical characteristics</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall dimensions of the platform</td>
<td>5.2 x 2.2 meters</td>
</tr>
<tr>
<td>Maximum takeoff weight</td>
<td>up to 650 kg</td>
</tr>
<tr>
<td>Carrying capacity</td>
<td>up to 400 kg</td>
</tr>
<tr>
<td>Range of flight</td>
<td>up to 350 km</td>
</tr>
<tr>
<td>Flight duration</td>
<td>up to 8 hours</td>
</tr>
<tr>
<td>Gasoline consumption for 1 hour of operation</td>
<td>30 liters AI-95</td>
</tr>
<tr>
<td>Engine power</td>
<td>220 h.p.</td>
</tr>
</tbody>
</table>

Operations for the control of the unmanned air cargo platform SKYF are fully automated, the flight mission approved in the control center is protected with a cryptographic signature. Thus, the launch of the platform in potentially dangerous areas and directions is excluded. The SKYF unmanned air cargo platform has an autonomous parachute rescue system for the vehicle along with the cargo. Information control of the platform operation is carried out in real-time, by transferring information to the SKYF chain blockchain platform (Fig. 3).

Fig. 3. The center for information control of the SKYF work
The mass concentration of phenolic substances was determined by the colorimetric method. The qualitative and quantitative composition of phenolic compounds was determined by HPLC methods using an Agilent Technologies chromatographic system (model 1100) with a diode array detector (a Zorbax SBC18 chromatographic column was used to separate substances). The study of antioxidant activity was carried out on an amperometric flow-through analyzer "Tsvet Yauza-01-AA" with special software for collecting and processing data by the amperometric method, based on measuring the electric current arising during the oxidation of the test sample on the surface of the working electrode at a certain potential and comparing the obtained signal with a signal from a standard (quercetin) under the same measurement conditions.

The phenolic composition and the value of the antioxidant activity of samples of wine materials obtained from grapes of white technical European varieties of the species Vitis Vinifera, delivered for processing using an air cargo platform and without using it, are presented in Table 2.

<table>
<thead>
<tr>
<th>Name of wine material</th>
<th>Mass concentration, mg/dm³</th>
<th>Analysis with Skyf</th>
<th>Analysis without Skyf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flavones</td>
<td>2,5</td>
<td>2,9</td>
<td></td>
</tr>
<tr>
<td>Flavan-3-ols</td>
<td>89,6</td>
<td>98,6</td>
<td></td>
</tr>
<tr>
<td>Hydroxybenzoic acids</td>
<td>24,8</td>
<td>25,8</td>
<td></td>
</tr>
<tr>
<td>Hydroxycinnamic acids</td>
<td>106,2</td>
<td>129,9</td>
<td></td>
</tr>
<tr>
<td>Caftaric acid</td>
<td>88,3</td>
<td>108,2</td>
<td></td>
</tr>
</tbody>
</table>

The phenolic component composition and AOA of wine samples obtained from grapes of white technical European varieties of the Vitis Vinifera species, delivered for processing using an air cargo platform and without using it, are presented in Table 3.

<table>
<thead>
<tr>
<th>№</th>
<th>Name of wine material</th>
<th>Mass concentration, mg/dm³</th>
<th>AOA, g/dm³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Analysis results without Skyf</td>
<td>167,3</td>
<td>1,14</td>
</tr>
<tr>
<td>2</td>
<td>Analysis results using Skyf</td>
<td>175,2</td>
<td>1,26</td>
</tr>
</tbody>
</table>

The use of the Skyf unmanned air cargo platform during the transportation of grapes makes it possible to obtain a wine material containing 1.15 times more monomeric forms of phenolic compounds and having a 1.11 times higher value of the antioxidant activity.
activity index than in wine material obtained using the traditional method of grape delivery and the subsequent process of its processing.

In the course of the research, it was found that the mass concentration of caftaric acid in the wine material prepared using transportation for processing by an unmanned air cargo platform Skyf is 18% higher than that in the wine material obtained from grapes, the delivery of which was carried out traditionally. Based on these data, it can be concluded that the use of the Skyf air cargo platform makes it possible to obtain wine materials with a lower degree of oxidation of phenolic compounds and, as a consequence, exhibiting greater antioxidant activity.

3 Conclusions

The time and conditions of transportation are of paramount importance for obtaining high-quality wines, this is primarily because grapes are characterized by a strong enzymatic-oxidative system. When using traditional methods of grape delivery in difficult mountainous conditions, the process of mechanical damage to grape bunches takes place, which leads to intensive oxidation of phenolic compounds, which are the source of antioxidant properties of wines, to quinones, caused by the oxidative enzyme phenoloxidase. The SKYF unmanned air cargo platforms described in this article can effectively solve both the problem of speed and the cost of delivery of grapes for processing.

References


22. Wiangtong, T., Sirisuk, P.: IoT-based Versatile Platform for Precision Farming, 18th International Symposium on Communications and Information Technologies (ISCIIT), pp. 438-441 (2018), DOI: 10.1109/ISCIIT.2018.8587989


