ISSN 1512-1461

UDC: 551

ADVANCED "OZONE GENERATION SYSTEMS" FOR THE CHALLENGES IN AGRICULTURE SECTOR

Giorgi Tsivtsivadze[*], Giorgi Burjanadze[**], Sophia Burjanadze[&], Lali Akhalbedashvili[&]

* Georgian Technical University. Scientific Tender for the Introduction of Innovative Technologies, Tbilisi, Georgia

** Tsulukidze Mining Institute, Water Quality Control Laboratory, Tbilisi, Georgia

& Iv. Javakhishvili Tbilisi State University, Electrical and Electronics Engineering Department, Tbilisi, Georgia

& Al. Tvalchrelidze Caucasus Institute of Mineral Resources, Iv. Javakhishvili Tbilisi State University

Abstract

Over the next decade, the European Commission calls for a 50% reduction in the use of pesticides, and in the next five years a 50% reduction in the sale of antimicrobials to farm animals and a 20% reduction in the use of fertilisers. Against this background, the share of organic farming will also increase from 10% to 25%.

The Bali G20 Declaration of 2022 calls for rapid and necessary actions to solve common challenges, to recover together stronger, by global supply chains, to support long-term growth, sustainable, green and just transitions, provide work, food and energy security, biodiversity and promote nutritious food for all, strengthen global, regional, and local food value chains, and accelerate efforts to reduce food loss and waste.

UN will continue to closely monitor the state of global food security and nutrition.

The presented article considers the solution of problems in various spheres of the national economy by means of an innovative, energy and cost-effective ozone generation system as an alternative to expensive and environmentally unfriendly disinfectants and pesticides.

Key words: ozone, Eco friendly, energy efficient, cost efficient, disinfection.

Introduction.

The use of toxic chemicals and pesticides in agriculture reduces the quality and yield of crops, impacts soil productivity, and our food systems account for approximately 34% of greenhouse gas emissions [1].

The rise of pests and growing resistance is not surprising given that 3 billion kg. of pesticides are used worldwide each year [2]. Other aspect of the pesticide problem is the harm to human health.

Besides the global pollution of the environment with pesticides, the negative impact on human health, it increase direct and so-called "hidden costs" of industrial and agricultural use, at all nearly 10% of global GDP.

General Problems

Water and air disinfection, disinsection, deodorization, decontamination of sewage and gas-chemical emission and organic waste, long-term storage of agricultural and food products, use of non-ecological poison-chemicals and pesticides are very expensive procedures, causes and has a direct negative impact on the economic results of the business.

An alternative to poison chemicals and pesticides is ozone, both in gas and aqueous state. It is known that ozone (O_3) is a triatomic, allotrope form of oxygen, which is a strongly reactive (less

ISSN 1512-1461

stable) and powerful versatile oxidizing agent, which is characterized by antiviral, antimicrobial and anti fungal activity, it is ecological, it does not cause the formation of carcinogenic substances and by-products, the induced-oxidative stress in living tissues causes an antioxidant reaction, and therefore ozone can be considered as an abiotic agent, so it can be considered as a universal disinfectant.

Unlike poison-chemicals and pesticides, the possibilities of ozone for food and agriculture: Disinfection of grain and food [3], fruit and vegetable, dairy products. [4], meat [5,6], for fish farming [7], food safety and sanitation, in the water bottling industry [8], for vineyard, wine and beer. [9,10]. Hydroponics, irrigation, drinking water of farm animals and odour control, soil remediation [11], disinfection of facilities and equipment, waste water treatment [12,13]. etc.

With the support of the Technical University of Georgia, on the target group selected in the vineyards of the Small Wine Producers Association of the Bolnisi region, the research conducted for 2 years on the use of aqueous ozone solution in viticulture, refined the technology of its use, confirmed the expectations and obtained the desired results.

Sample preparation and content measurement was carried out in the Atomic Absorption Spectrometry Department of the Academician Nodar Kekelidze Scientific Research Institute of Materials Research of the Faculty of Exact and Natural Sciences of Ivane Javakhishvili Tbilisi State University, on an atomic absorption spectrometer AAnalyst 800 (PerkinElmer Inc.) with software WinLab 32 and in the "Geoanalytic" laboratory of the Alexandre Tvachrelidze Mineral Resources Caucasus Institute. It was determined some mineral microelements and macroelements in vine leaves (tables 1 - 2).

It was determined also the content of resveratrol and quercetin in the leaves (Fig.1 and 2), because of due to the high antioxidant activity of resveratrol, as well as anticarcinogenic, antiviral, anti-inflammatory, cardioprotective activity, and quercetin helps to reduce cholesterol. The definition of resveratrol and quercetin content were carried out by HPLS method on Agilent 1200 Teechnologies chromatograph. The content of resveratrol in leaves reaches 3.4 mg/kg and content of quercetin 13.5 mg/kg. The target of this work is to create a complete cluster of macro-micro-ulrtamicro-elements in healing wine, both for adults and children, by removing ethanol from the same bio-wine. Therefore, we had to determine whether the chemical composition of grape leaves and wine changed as a result of treatment with ozonated water.

Table 1. Content of macroelements in leaves, mg/kg.

N	The name of the grape	Ca	Mg	Al	K	Si	P	S
1	Saperavi	32000	4800	270	6300	7354.7	580	988.56
2	Chinuri	28000	8000	450	4378	7214.7	260	1215.11
3	Rqatsiteli	32000	4800	<20	2450	5180.0	280	1160.19

ISSN 1512-1461

Table 2. Some mineral microcomponents content in leaves, mg/kg.

N	The name of the grape	Ni	Cd	Cu	Pb	Mn	Co	Zn	Cr	Fe common
1	Saperavi	27.32	0.56	9.32	1.38	564.5	2.64	7.77	1.75	352,8
2	Chinuri	25.46	0.52	9.41	4.82	120.7	2.44	4.95	2.34	560.0
3	Rqatsiteli	26.98	0.55	9.65	4.84	61.0	2.35	5.75	1.95	266.0

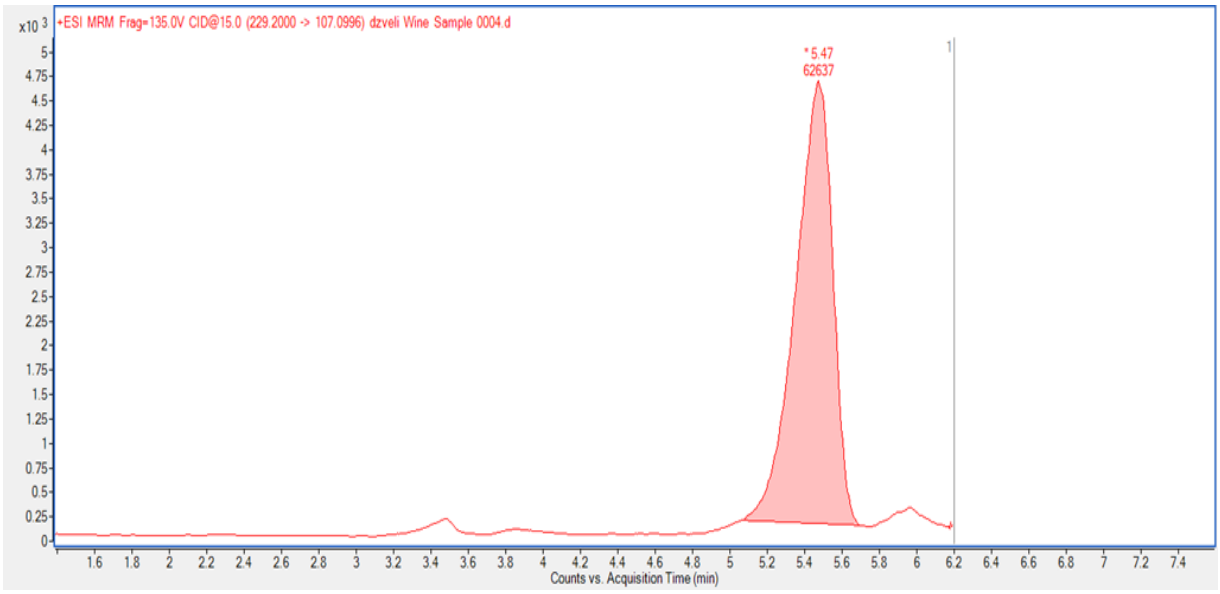

Fig. 1. Chromatogram of resveratrol ("Saperavi" from Bolnisi, 2021 harvest year).

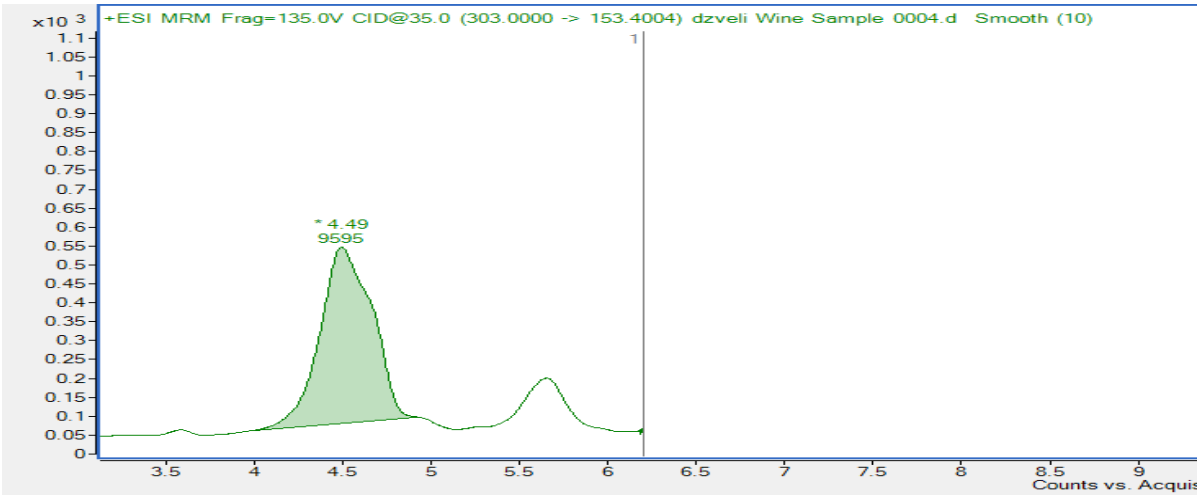

Fig. 2. Chromatogram of quercetin ("Saperavi" from Bolnisi, 2021 harvest year).

Wine is rich in various microelements and minerals that come from the soil, and their diversity largely depends on the mineral composition of the soil. Grapes grown, for example, on calcium or

ISSN 1512-1461

siliceous soils will be rich in these microelements, which can be felt in the aroma and taste of the wine. In addition, the variety, degree of ripeness (late-harvested berries have much more), cultivation method (whether mineral fertilizers are used or not), and processing methods are important.

In addition to influencing taste characteristics and participating in various biochemical processes occurring in wine, mineral substances and microelements have great nutritional and biological value. For the human body, mineral substances are the main and most important participants in all the main physiological processes occurring in cells, organs and tissues. In total, up to 30 microelements are found in wine. And although wine contains almost 50% less minerals than grapes (this is due to their precipitation in the form of salts during fermentation, processing, and storage), their absorption with moderate wine consumption occurs more effectively.

Ozonation is used in post-harvest processing because ozone has a positive effect on polyphenols, increases the concentration of aromatic compounds, and helps reduce yeast fungi. It is also already being used on the vines themselves by irrigation for an invigorating effect and to improve the health of the grafts.

Methodology

The most common methods of generating Ozone are of two types: 1) Using ultraviolet radiation; 2) Electric discharge between two electrodes. The main problems of mass production are: a) High cost of technology; b) High energy consumption.

The main problems of mass production of ozone generators in the world are: high cost of technology and high energy consumption. The company "Hydrogen Technology" has created advanced "Ozone Generating System", and received the patents of the National Intellectual Property Center of Georgia P 2021 7302 B, and (WIPO) [14].

Through the use of aqueous ozone solution in viticulture, refined the phisical characteristics of the “Ozone Generation System” technology and its use:

1. Ozone concentration in water at 0.03 mg/l is the minimum allowable indicator at 20-30 ^{0}C-temperature (while flowering is used in cases of particularly bad weather);
2. Ozone concentration in water at 0.05 mg/l is an optimal indicator at a temperature of up to 25 ^{0}C, during average periodic rains;
3. Ozone concentration in water at 0.06 mg/l is an optimal indicator at a temperature of up to 20 ^{0}C, in the period of frequent rains;
4. The concentration of ozone in water at 0.09 mg/l is the critical maximum allowable level, which damages vine leaves and culture;
5. It was determined that vines should be treated with ozonized water solution before the appearance of diseases, for the purpose of prevention. (7-10-14-21 once a day, depending on the weather).
6. Ozone-treated vine leaves, which contain the best spectrum of specific microelements, are ideal bio-fertilizers for the same grape variety, that is why they are processed with Georgian wormwood, whose coprolites as a bio-fertilizer are a world innovation for the sustainability of vineyard soil fertility and strengthening the immune defense system of the grape variety and its to create fertility stability.

ISSN 1512-1461

7. Macro and microelements were determined in vine leaves, because they ensure the normal functioning of all the main systems of a living organism: immune, nervous, endocrine, digestive, cardiovascular, muscular.

Conclusions

The advantages of "Ozone Generating System" are the following: Is cost and energy-efficient, competitive, ozone generated by barrier and corona discharge and ultraviolet radiation; ozone formation is regulated by airflow, as well as electrical mode of operation; for special requirements, the ozone generator also works on oxygen; the ozone generator is portable, the electric source could be supplied by the vehicle; technology is protected by warranty and post-warranty services; the company is ready to license the technology;

The „Ozone Generating Systems" of the "**Ozone Georgia**" brand, created by "**Hydrogen Technology**" are implemented in Georgia in many directions in agriculture.

Acknowledgement. This work was supported by Shota Rustaveli National Science Foundation of Georgia - SRNSFG (Grant number AR-22-2370).

References:

1. *Crippa M., Solazzo E., Guizzardi D., Monforti-Ferrario F., Tubiello F. N., LeipA.* (2021). Food systems are responsible for a third of global anthropogenic GHG emissions, Nature Food 2: 198–209.
2. *Tudi M., Ruan H.D., Wang L., Lyu, J., Sadler R., Connell D., Chu C., Phung D.T.* (2021). Agriculture Development, Pesticide Application and Its Impact on the Environment, the J. of (PMC) PubMed.
3. *Tiwari B.K., Brennan C.S., Curran T., Gallagher E., Cullen P.J., O' Donnell C.P.* (2010). Application of ozone in grain processing, the J. of Science Direct.
4. *Varga L., Szigeti J.* (2016). Use of ozone in the dairy industry: A review, the J. of International Journal of Dairy Technology 69(2):157-168.
5. *Giménez B., Zaritzky N., Graiver N.* (2024). Ozone treatment of meat and meat products: a review, the J. of Front. Food. Sci. Technol. Sec: Food Packaging and Preservation: Vol.4.
6. *Fuhrmann H., Rupp N., Büchner A., Braun P.* (2010). The effect of gaseous ozone treatment on egg components, he J. of The Science of Food and Agriculture, 90(4):593-8.
7. *Yamada T., Rosadi M.Y., Hudori H., Suzuki Y., Ito E., Li F.* (2019). Characteristics of dissolved organic matter in a water purification plant and distribution pipes, the J. of EDP Sciences, Article Number 03007: 1-7.
8. *Bollyky L.J., Johnson B.* (2023). The Role of Ozone in Water Bottling, the J. of Water World.
9. *Raio A., Feliciani A., Ferri V., Carboni C.* (2016). Integrated vineyard management trials using ozonated and electrolized water. The J. of Infowine. Internet J. Enol. Viticulture 2/6: 1-6.
10. *Englezos V., Rantsiou K., Cravero F., Torchio F., Giacosa S., Segade S.R., Gai G., Dogliani E., Gerbi V., Cocolin L., Rolle L.* (2019). Minimizing the environmental impact of cleaning in winemaking industry by using ozone for cleaning-in-place (CIP) of wine bottling machine. The J. of Cleaner Production 233:582-589.

ISSN 1512-1461

11. *Aidoo O.F., Osei-Owusu J., Chia S.Y., Dofuor A.K., Antwi-Agyakwa A.K., Okyere H., Gyan M., Edusei G., Ninsin K.D., Duker R.Q., Siddiqui S. A., Borgemeister Ch.* (2023). Remediation of pesticide residues using ozone: A comprehensive overview. The J. of Science Direct.
12. *Hossen A., Ahmed F., Saha S.S., Mondal I.H.* (2023). Advantages of ozone disinfection method for water purification over chlorine disinfection, Natural Resources Conservation and Research 6(2):2090:1-4.
13. *Boner M., Lau P.J.* (1999). Wastewater Technology Fact Sheet - Ozone Disinfection, EPA 832-F-99-063.
14. *Burjanadze S., Burjanadze J., Burjanadze G., Tsivtsivadze G.* (2021). Ozone Generating System. World Intellectual Property Organization (WIPO). WO/2021/255659

Article received 2025-04-17