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PERSPECTIVES OF THE USE OF PLANT RAW MATERIAL EXTRACTS FOR STORAGE OF TOMATOES

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Abstract. The paper presents the overview data of the diseases and major classes of microorganisms which cause tomato damage after harvesting. Generally accepted effective ways of storage of fruit and vegetable products are considered. These are cold storage and storage in the altered gas environment – regulated and modified (RGE and MGE). It is shown that technologies of storage of fruit and vegetable products with the use of film-forming substances are widely used abroad, and recently they have also been developed in Ukraine. In recent years, prior to the storage, fruits and vegetables have been processed with preparations which have protective properties, and also with antioxidants. Antioxidant compositions on the base of aqueous solutions of santochin, aminophenol, ionol, sorbic and benzoic acids are introduced in the field of fruit and vegetable products storage. There are no studies about the choice of film-forming compositions and antioxidant preparations which take into account the effect of specific microflora of individual fruits and vegetables, as well as the features of their chemical composition and physiological structure. Bacteria and fungi are the two main classes of microorganisms which cause tomatoes damage after harvesting. All diseases have certain manifestations, by which they are identified, and the characteristics of each disease agent, peculiarities of how it spreads and affects fruits are also very specific. Literature analysis has shown that the composition of extracts of ginger, orange peel and garlic bulbs can be an effective universal protection preparation during storage, which covers the whole spectrum of typical tomato diseases. Since the high water-solubility and safety are important characteristics of substances that have direct contact with food products, it is recommended to use aqueous and hydroglyceric alcoholic extracts of plant raw materials when developing the technology of preparation. Further microbiological and toxicological studies of the test samples are needed for determining of working concentrations of extracts and selection of an effective composition.

Key words: tomato, bacteria, fungi, storage, specific microflora, fungicidal action, antibacterial properties.

ПЕРСПЕКТИВИ ВИКОРИСТАННЯ ЕКСТРАКТІВ З РОСЛИННОЇ СИРОВИНИ ДЛЯ ЗБЕРІГАННЯ ТОМАТІВ

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Анотація. У роботі наведено данні оглядового характеру щодо хвороб та основних класів мікроорганізмів, які викликають псування томатів після збирання. Розглянуто загальновизнані ефективні способи зберігання фруктовоовочевої продукції: холодильне і в умовах зміненого газового середовища – регульованого та модифікованого (РГС і МГС). Показано, що технології зберігання фруктоовочевої продукції із застосуванням плівкоутворювальних речовин досить активно використовуються за кордоном, а останнім часом одержали розвиток і в Україні. В останні роки все більше застосовують обробку фруктів та овочів перед зберіганням препаратами, які мають захисні властивості, у тому числі і антиоксидантами. Антиоксидантні композиції на основі водних розчинів сантохіну, амінофенолу, іонолу, сорбінової та бензойної кислот впроваджені у галузі зберігання фруктоовочевої продукції. Відсутні дослідження з вибору плівкоутворюючих композицій та антиоксидантних препаратів, які б враховували б дію специфічної мікрофлори окремих фруктів та овочів, а також особливості їх хімічного складу та фізіологічної будови. Два основних класи мікроорганізмів, які викликають псування томатів після збирання – це бактерії та грибки. Усі захворювання мають певні ознаки проявів, за якими їх ідентифікують, при цьому характеристика кожного збудника хвороб, особливості його поширення і ураження плодів також дуже специфічні. Аналіз літератури показав, що композиція з екстрактів імбиру, шкірки апельсину й цибулин часнику може стати ефективним універсальним засобом для захисту під час збереження, що покриває увесь спектр розповсюджених хвороб плодів томату. Оскільки важливою характеристикою безпеки речовин, що контактують безпосередньо з продуктами харчування є висока водорозчинність й безпечність, для застосування в розробці технологій засобу рекомендовані водні та водно-спирто-гліцеринові екстракти рослинної сировини. Для встановлення робочих концентрацій екстрактів й вибору ефективної композиції потрібні подальші мікробіологічні та токсикологічні дослідження тест зразків.

Ключові слова: томат, бактерії, грибки, зберігання, специфічна мікрофлора, фунгіцидна дія, антибактеріальні властивості.

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Introduction. Formulation of the problem

Fruits and vegetables are essential component of a healthy diet. Their value is determined by the presence of vitamins, minerals and a complex of phytonutrients that can neutralize free radicals.

A comprehensive approach to solving the problem of providing consumers with vegetable products with a high content of biologically active substances is comprehensive analysis of finding new possibilities of production and storage of vegetables.

Preserving the high quality of fruits and vegetables is prerequisite for access to the European market for Ukraine as a country which is one of the world's leading producers of agricultural products and is focused on their export.

One of the generally accepted effective ways of preserving fruit and vegetable products is refrigeration and storing them in the conditions of an altered external gas environment – regulated and modified (RGE and MGE). Currently, producers, processing enterprises and trade organizations have low-power or no appropriate material and technical base for cold storage of products. RGE and MGE, besides being costly, are technologically complicated, because they require the completion and strict observance of the temperature and humidity and gas conditions, as well as they are non-ecological.

In recent decades, the evolution of technologies has gone from large-scale storage of fruits and vegetables (in conditions of artificial cooling, regulated gas environment) to a small-party (in a modified gas environment, biological vacuum). The modern direction of improving storage methods is the processing of fruits and vegetables by film-forming compositions. Technologies for storage of fruit and vegetable products with the use of film-forming substances are used extensively abroad, and recently they have been developed in Ukraine [1,2]. They are aimed primarily at maintaining the quality of the fruits of long-term storage for delivery in the off-season period. But polyvinyl alcohol, protexan, Na-CMC, polyvinylpyrgomedon, polyacrylamide, polyethylene oxides, spans, tweens are the most often used in their compositions. First of all, they are all dangerous. Secondly, none of them fully meets the requirements, especially in terms of versatility and applicability under different temperature and humidity conditions of storage.

Also, in recent years, processing of fruits and vegetables before storage by preparations with protective properties including antioxidants has been used more and more [3-7]. Antioxidant compositions on the base of aqueous solutions of santochin, aminophenol, ionol, sorbic and benzoic acids are introduced in the field of fruit and vegetable products storage. Their use allows not only maintaining high product qualities, but also obtaining a high economic effect. However, under the existing conditions, when the ecology is degraded and the human body is exposed to a variety of negative environmental factors, there is a necessity to find new sources of natural origin which would increase the output of standard products and maximize the taste, therapeutic and nutritional quality of fruits and vegetables. It should also be noted that there are no studies on the choice of film-forming compositions and antioxidant preparations which take into account the specific microflora of individual fruits and vegetables, as well as their chemical composition and physiological structure. Consequently, the development of new preparations for fruits and vegetables storage, which would be ecologically safe and highly effective, is particularly topical and requires theoretical substantiation and experimental implementation.

The purpose of the scientific work is analysis of literary sources about the specific microflora of tomato fruits and the effect of different medicinal and technical raw materials on it.

Tasks of the research:

1) to analyse the most common diseases of tomato fruits during storage;

2) to characterize the diseases' causative agents, to consider the peculiarities of their reproduction and distribution on vegetables;

3) to consider the basic modern methods of fruit and vegetable crops protection from pathogenic microorganisms;

4) to analyse the bactericidal properties of medicinal and technical raw material.

Diseases of tomato fruits and microorg anisms which cause their damage problem

Production of vegetables in sheltered ground provides people with vegetables throughout the year. The most common sheltered ground vegetables are tomatoes. Existing storage technologies for tomatoes do not always guarantee the environmental safety and proper preservation of the fruits biological value.

Unfortunately, just the observance of storage conditions by physical parameters (temperature, humidity, etc.) cannot completely prevent the development of microbiological damage of fruits. With taking into account the imperfection of modern methods of transportation of vegetables, fruits and berries, mechanical damage of fruits' integrity often occurs, which is also a trigger mechanism for the development of phytopathogens.

The tomato fruits are characterized by active processes of wound healing: a scar appears on the surface of the tomato fruit after it had been mechanically damaged, and serves as a barrier for the tissue splitting zone, so these fruits are more resistant compared with other cultures. But during the storage it should be taken into account that after harvesting, vegetables still have a limited lifetime: tomatoes no longer receive water or nutrients from plants and the factors of antimicrobial and antifungal immunity are not actively synthesized. Besides, the temperature of tomato harvest storage is ideal for the development of microorganisms (≈30°C) and differs sharply from the recommended temperature of tomatoes afterripening (≈20°C), which makes microorganisms easily penetrate into storage and ripening rooms for vegetables, although there are unfavourable conditions for them there [8].

Bacteria and fungi are the two main classes of microorganisms which cause tomato damage after harvesting. Some other types of plant pathogens, such as viruses and nematodes, can also be responsible for the harvesting losses, but after harvesting the damage symptoms become obvious and the fruits are not sent to afterripen because they are sorted out by the initial control [8,9].

Bacteria are unicellular organisms which can quickly multiply and spread, especially in a humid environment. Even thin coating of water on wet fruit or on different surfaces in the storage can provide the movement and spread of microorganisms. Bacterial colonies, as a rule, are slimy and with no clear structure, and biofilms can form on moist surfaces. These films are protective form of bacterial colonies, resistant to rinsing and some antimicrobial agents, and they are very difficult to remove from the fruit surface [8,10].

Warm and wet storage conditions cause bacterial invasion. Stems and stalks during wet weather can remain damp for several days, and they can be traumatized in the places where the plant was tied or where the stems were bent and cut off. Juice from damaged tissues, which was formed during the development of microorganisms, is very virulent to the neighbouring fruits and it is a factor of damage spreading throughout the storage room. Affection by bacterial infection can begin internally, if the fruits absorb infected juice, under wet scar contact and inoculantly from chewing insect pests [11].

A large group of bacteria which cause damage of tomato fruits during storage are combined on the base of the fruit disease feature which they can cause – soft (moist) rot. Pathogens of this disease liquefy the tissue of tomato by destroying intercellular bonds [12].

The most common and aggressive bacteria of soft rot are the strains *Pectobacterium carotovorum* (especially *Erwinia carotovora*). These strains of soft rot can grow on the surface of plants and cause disease of succulent parts of the plant, especially during wet weather. Despite the fact that these bacteria cannot penetrate directly through the waxy skin of tomatoes, minor injuries or small cracks in the cuticle allow bacteria to infect the fruit tissue. Besides *Pectobacterium*, soft rot can cause strains of the genus *Pseudomonas*, *Xanthomonas* and *Bacillus*. Thermophilic forms *Bacillus* can develop in a medium with high acidity, which allows them to infect green and unripe tomatoes [13].

Strains of soft rot are easily dispersed in aqueous medium and quickly spread by drops of water on the surface of plants, as well as through juice from the infected fruit. In storage, these bacteria can even move from one box to another through moisture in pallets and fibreboard. High relative humidity of the air (90–95 %) is often in the premises where tomatoes ripen in packed boxes or in the masses of vegetables of various kinds, and promotes the survival of these bacteria, as well as their virulence to traumatized fruits. Free water on the surface of the damage also contributes to contamination. Fruit temperature above 30°C is connected with the rapid development of bacterial soft rot, and the period between the infection and the appearance of visual manifestations of soft rot infection can be less than 18 hours [8,13].

Another type of bacterial affection of tomato fruits is diseases of the sour rot type which are caused by gram-positive bacteria which can produce lactic acid (*Lactobacillus spp*. and *Leuconostoc spp*.). These microorganisms are widespread, too, and they are yeast-like according to the nature of damage. They live in soil, on the surface of vegetables, in shelters and in rotten fruit fluid. These bacteria cause somewhat mild damage, like that by soft rot bacteria, but the liquid from the place of damage has acid pH and smells as though the tissues were marinated. Unlike diseases of sour rot which are caused by fungi, these fruits do not have fungal microorganisms, as fungi and lactobacilli show mutual antagonism and compete for nutrients [14].

Fungi which affect tomatoes have a micellar or yeast structure. Many types of fungi can cause fruit decay and, like bacteria, spread in warm and humid conditions. Fungi are usually more difficult to get rid of than bacteria, because harmful fungi cells are much larger, more resistant to disinfectants and create spores which are relatively resistant to drying and other environmental stresses [9].

The most common pathogen which causes sour rot in tomato is the *Geotrichum candidum* yeast fungus. Its colonies on the affected tomato fruits resemble thick, gelatinous mass. The affected spots first become watery, but later they are covered with a layer of the pathogen and the fruits remain relatively structurally integral if secondary infection by bacterial soft rot does not occur. The smell from the damaged spots is similar to the smell which is produced by lactic acid bacteria [15].

Rhizopus stolonifer is another common fungal pathogen of tomatoes. This causative agent is growing very aggressively. It visually appears as soaked liquid on the surface of tomato fruits. The surface of the affection can be covered with thin, cotton-like fungal structures. The fruit tissues inside the affection are usually held together by relatively rough filaments of fungi hyphae. Mycelium can infect adjacent fruits through natural openings or mechanical wounds, creating diseased fruits, and under favourable conditions, *Rhizopus* appears on dry surfaces such as pallets and cardboard boxes [13,15].

Representatives of the genus *Phytophthora* cause rotting of tomatoes through darkening and colonization with white mycelium. The causative agent is distributed with water. Initial symptoms appear as small spots on the surface of tomato fruits and may be unnoticed during the control [16].

Black rot may appear on the surface of tomato fruits with overcooling, calcium deficiency, frequent precipitation and use of phytotoxic pesticides. Several different pathogenic microorganisms can cause the appearance of black rot, but the main pathogens are *Alternaria arborescens*, *Stemphyllium botryosum* and *Stemphyllium consortiale*. This disease does not usually apply to all the fruits in the storage. Green tomato fruits are completely stable if they have not been cooled or damaged by certain spray mixtures [9].

In similar conditions, especially if the soil is low in calcium, and plants start to get old, grey forms of rot also appear. Their pathogen *Botrytis cinerea* is a very effective saprophyte. The disease of the fruits is difficult to diagnose at the initial stages of storage, but the infection continues to evolve during transportation to the trade enterprises and can spread inside a single box, which causes the fruits affection and makes them useless for sale [10].

Investigation of bactericidal properties of medicinal and technical raw material

Preparations on the base of quaternary ammonium compounds (QAC) are used in agriculture for disinfection storage facilities for tomato fruits storage. These agents are very effective especially for combating bacterial infection of tomatoes, but they cannot be recommended for direct contact with food products. Firstly, when incorrectly dosed, they cause chemical damage of tomatoes. Secondly, they must be thoroughly removed from all surfaces of the storage and the fruits, in case of contact, because they are extremely toxic for humans. Unfortunately, nowadays, the reality is that dishonest producers can pay not enough attention to eliminating strong disinfectants, or spray them directly into tomatoes to provide better storage of crops, thus causing damage to the health of consumers. Washing of so processed vegetables at home under running chlorinated water does not alleviate potential damage – ammonia compounds react quickly with chlorine and create chlorine-containing gases which are harmful for health [8].

Chlorothalonil, mephenoxam and boscalid are popular today among the fungicides for processing tomatoes during storage. These compounds are not fatal to humans, but have an adverse toxicological profile, can cause food poisoning, allergic reactions, irritate mucous membranes and accumulate in the body [17,18].

Thus, the development and introduction of a new effective non-toxic agent for tomato processing is important not only for agriculture and food industry, but also for the health sector. We analyse the effect of medicinal and plant raw material on specific microflora of the fruits to develop a technology of production of antimicrobial and fungicidal agents for spraying tomatoes during storage.

Ginger (Zingiber officinale) is a monocotyledonous evergreen plant of Zingiberaceae family. The root of this plant is used as an officinal and vegetable preparation in medicine and pharmacy. The phytochemical composition of the Zingiber officinale root includes the components of both mono- and sesquiterpenoids and phenolic compounds shogaol and gingerol, which are the most active chemical agents with antimicrobial and fungicidal action. These compounds have different ways of influencing the cells of microorganisms: they destroy and perforate the walls of cells and cell membranes, affect their permeability and release of toxic and unnecessary substances for the cell, impede such membrane functions as electrons transporting, nutrients absorption, protein and nucleic acids synthesis, and change enzyme activity. Thus, extracts on the base of ginger have several targets for influencing tomato pathogen life [19].

Foreign authors' studies show that ginger extracts have powerful antimicrobial properties against strains which are tomatoes' pests. Hiba Ali Hasan and his co-authors show that microorganisms of the genus *Pseudomonas* and *Candida*, with inhibition zone of colonies growth 12 and 14 mm, respectively, have sensitivity to ginger extracts (with different solvent polarity) at concentrations 50 mg/ml [20]. Experimental studies by Anwar Khalid and his co-authors have found out that Zingiber officinale aqueous and alcoholic extracts of 30 μL per disk could inhibit the growth of various strains of bacteria from 0.2 ml of a bacterial suspension in dilution 10^{-4}. The inhibition zone is 9–16 mm for bacteria of the genus *Pseudomonas* and 9–17 mm for bacteria of the genus *Bacillus* (depending on the nature and temperature of the extractant), which reaches a similar value for metronidazole that was investigated under similar conditions in the same experiment [21]. The general fungicidal action of a ginger extract *in vitro* is investigated by Supreetha S. and co-authors, they demonstrate not only the presence of pronounced fungicidal activity in ginger extracts, but also the relative stability of this activity for 48 hours, which is a very important factor under the choice of this officinal and vegetable raw material as an integral component of protective preparations for processing vegetables [22]. Another very important property of ginger has been considered in the study of Miloš Nikolić and co-authors. They show that ginger extracts are able to destroy biofilms and inhibit their formation in bacterial colonies [23].

Investigations of the use of extracts combinations which contain a ginger extract as a component show that its antibacterial activity is potentiated by the presence of a garlic extract, especially in relation to human gastrointestinal tract pathogens: *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Shigella sonnei*, *Staphylococcus epidermidis*, *Salmonella typhi* and *Helicobacter pylori*, which cause digestive disorders and food poisoning and can be rated as tomatoes' main pathogens [24,25]. It is established that the general antimicrobial properties of ginger root and garlic bulb aqueous and alcohol extracts can be the most active in concentrations of 0.01 to 100 mg/ml, but the minimum inhibitory concentrations of these extracts are in the range 0.05–1.00 mg/ml [24, 26].

Aqueous and alcohol extracts of ginger have repeatedly proved antibacterial properties in food industry and have been repeatedly used as preservatives and additional antimicrobial agents at concentrations 1–10% [26-29].

Besides, studies have already been carried out on the use of ginger extracts in the agricultural sector as fungicide in the storage of fruits after harvesting. The study of the general antifungal effect of the extract has been carried out on banana fruits. An alcohol extract of ginger in the mass concentration 0.5% inhibited the growth of mycelium of the fungus *Colletotrichum musae* by more than 80 % and practically completely inhibited spore formation. High efficiency of reducing the number of affected crops and reducing the manifestations of the disease by the integral scale was noted [30] after spraying banana fruits with this extract and further storage of the fruits in adequate conditions together with the source of the infection for 5 days.

Orange peel (Citrus sinensis) is an affordable raw material, and in some types of production it is fruit waste. But the chemical spectrum of antibacterial and antifungal substances which it contains can make its extracts promising components for the development of protective preparations for spraying tomatoes. The phytochemical composition of this raw material includes many diverse active components: anthraquinones, phenolic compounds, tannins, terpenoids, flavonoids, but the main active ingredients are lemonen, β-myrcene , α- and β-pinene, sabinen, geraniol [31,32].

The main factor in choosing this component is the ability of orange peel extracts to suppress excessive growth of lactobacillus. Thus, Sapna B. Shetty and co-authors in their study have shown that aqueous and alcohol extracts of Citrus sinensis peel in concentration 25 mg/ml could actively suppress the development of colonies of the *Lactobacillus* bacteria family with inhibition zone of 11–12 mm [31]. The striking fungicidal effect of the essence from this raw material has been proved in studies by Maria José Velázquez-Nuñez and co-authors on fungi of the genus *Aspergillus* [32]. Besides, the essential oil has been successfully tested as an alternative to synthetic fungicides for the treatment of a potato disease caused by *Phytophthora infestans* [33].

It is established during the study of general antimicrobial properties on human pathogens (*Staphylococcus auricularis*, *Staphylococcus aureus*, *Streptococcus mitis*, *Klebseilla pneumoniae*, *Streptococcus salivarius*, *Streptococcus pneumoniae*, *Escherichia coli*), which today have high resistance to antibiotics and can adhere on the surface of food products, that alcoholic extracts (1:2) of orange peel have moderate bactericidal and bacteriostatic effect on gram-positive microorganisms, which in the process of storage can unite with infectious pathogens of the fruit or adhere on the fruit surface independently [34].

It should also be noted that the orange peel extract shows antinomatous action, which is a very useful co-effect for the developing agent; since the fruits infected by nematodes can still get to the storage. Aqueous extracts of 1:3 of this raw material were able to suppress the development and growth of nematodes by 80% for 48 hours, to reduce egg laying and to destroy parasites [35].

Garlic (Allium sativum) is a plant known for its antimicrobial and antifungal properties and used in both traditional and folk medicine. Allicin, ioen, allium and diallylsulphides are biologically active components of garlic bulbs [36].

Previous studies indicate that the aqueous and alcoholic extracts of garlic bulbs suppress the growth of bacteria of the genus *Xanthomonas* with inhibition zone of 10–20 mm depending on the type of extractant and they were suggested as preparations for the treatment of bacterial rot of pomegranate fruits [37]. Garlic bulb extracts are very effective against strains of the genus *Erwinia* and the inhibition zone of growth of this pathogen of about 20 mm was established during a microbiological study [38]. Allium sativum bulbs water extracts have the ability to combat plant diseases which are caused by fungi of the *Rhizopus* genus and to inhibit the spore formation of these microorganisms by more than 90%, which is an important property for protecting fruits during afterripening in storage facilities [39]. Also, aqueous and alcoholic extracts of garlic (individually and in combination with the ginger extract) at concentrations of 20–40% have shown their impressive effectiveness in inhibiting the growth of mycelium and spore formation of fungi of the *Alternaria*, *Stemphyllium*, *Botrytis Alternaria*, *Stemphyllium* and *Botrytis* genera, in some cases, the inhibition of mycelium growth was almost one hundred percent [40,41]. Some data allow suggesting that the garlic extract will be effective in combination with citrus peel extracts [42]. Besides, as it is mentioned above, garlic bulb extract potentiates the antimicrobial action of ginger extracts [24,27].

Studies of the use of garlic bulb extracts in the agrarian industry for spraying fruits during storage after harvesting already exist. Azucena Gándara-Ledezma and co-authors consider that the extracts from officinal and vegetable raw material of garlic are effective in controlling the grey forms of rot during storage of grape which are caused by *Botrytis cinerea*, which is also a common tomatoes pathogen [43]. Chanel Karousha Daniel in his work recommends the introduction of garlic extracts of different concentrations in the agricultural industry as protecting preparations for storage of apples which have many rot diseases common with those of tomato fruit [44].

It should be taken into account that the literature data point to the higher microbiological activity of alliin than terpenic and phenolic compounds, it grounds the theoretically possible reduction of the particle size of the garlic bulbs extract in the finished preparation. In addition, the number of biologically active components in extracts of the orange peel varies considerably, which should also be taken into account when developing a composition of the protective agent [45].

Conclusions

The most common diseases of vegetable cultures during storage have been investigated. It has been established that high water content, sensitivity to mechanical damage and weak natural immunity of vegetables provide their damage by many diseases during storage. It has also been researched that the main pathogens are viruses, bacteria and pathogenic fungi, the latter constituting the highest proportion of diseases. It has been investigated that the main diseases of the fruits during storage are late blight, alternaria, sclerotium, classosporia, as well as various kinds of rot, mould, and others. All diseases have certain manifestations, by which they are identified, and the characteristics of each disease agent, peculiarities of its spreading and affection of the fruits are also very specific. The analysis of modern methods of protection of fruit and vegetable crops from pathogenic microorganisms has been carried out. It has been established that today in Ukraine, all efforts to destroy and prevent the growth of pathogens are directed at the methods which are used during the cultivation. Chemical, biological and physical methods are used in the fight against damages during storage. It has also been established that the greatest part of modern methods is based on the use of chemicals which are dangerous and toxic for human health and life.

The bactericidal and fungicidal action of medicinal and technical raw material on microorganisms which cause tomatoes diseases has been analysed.

The analysis of professional literature shows that a composition of ginger, orange peel and garlic bulbs extracts can become an effective universal preparation for protecting during storage. The use of the above extracts allows inhibiting the whole range of common diseases of tomato fruits which cause fruit damage after harvesting, namely bacteria and fungi.

Since important characteristics of the safety of substances which are in direct contact with food products are high water solubility and minimal toxicity, aqueous and hydroglyceric alcoholic extracts of plant raw material are recommended for the use during the development of the preparation technology. Further microbiological and toxicological studies of the test sample are required for establishing the working concentrations of extracts and selecting an effective composition.

List of references:

1. Дятлов В.В. Наукові основи обробки та зберігання плодоовочевої продукції із застосуванням плівкоутворюючих композицій: автореф. дис. ... д-ра техн. наук: 05.18.03: захист 22.03.2006 / наук. конс. Литовченко О.М. Херсон: ХНТУ, 2006. 38 с.
2. Медведкова І.І. Якість і збереженість свіжих тепличних томатів із застосуванням обробки плівкоутворювальною композицією: автореф. дис. … канд. техн. наук: 05.18.15: захист 25.10.2007 / наук. кер. Дятлов В. В. Донецьк: ДонНУЕТ, 2007. 22 с.
3. Мироничева О.С. Обґрунтування використання антиоксидантних препаратів для тривалого зберігання плодів яблуні: автореф. дис. … канд. с.-г. наук: 05.18.03: захист 27.02.2003 / наук. кер. Іванченко В. Й. Мелітополь: ТДАУ, 2003. 20 с.
4. Гапріндашвілі Н.А. Обґрунтування використання нових антиоксидантних препаратів природного походження для тривалого зберігання плодів груш: автореф. дис. ... канд. с.-г. наук: 06.01.15: захист 21.06.2011 / наук. кер. Сердюк М.Є. Мелітополь: ТДАУ, 2011. 23 с.
5. Жукова В.Ф. Обґрунтування використання нових антиоксидантних композицій для зберігання плодів томату: дис. … канд. с.-г. наук: 06.01.15: захист 14.03.2012 / наук. кер. Прісс О.П. Київ: НУБПУ, 2012. 250 с.
6. Безменнікова В.М. Обґрунтування використання нових антиоксидантних препаратів для зберігання плодів абрикоса: дис. … канд. с.-г. наук: 06.01.15: захист 25.05.2010 / наук. кер. Калитка В.В. Київ: НУБПУ, 2010. 290 с.
7. Герасимчук О.П. Збереження якості плодів чорної смородини з післязбиральною обробкою речовинами антимікробної дії та в продуктах переробки: дис. … канд. с.-г. наук: 06.01.15: захист 18.06.2009 / наук. кер. Осокіна Н.М. Умань: УДАУ, 2009. 379 с.
8. Tong Geon Lee. CRISPR – A Technical Breakthrough for Tomato Research // New and Revised Publication. University of Florida magazine website. February 2018. URL: http://edis.ifas.ufl.edu/hs1314/
9. Bartz J.A., Sargent S.A., Scott J.W. Postharvest Quality and Decay Incidence Among Tomato Fruit as Affected by Weather and Cultural Practices. Gainesville: University of Florida Institute of Food and Agricultural Sciences. http://edis.ifas.ufl.edu/
10. Jones J.B., Jones J.P., Stall R.E., Zitter T.A., eds. Compendium of Tomato Diseases. St. Paul, MN: The American Phytopathological Society, 1991. http://www.apsnet.org/
11. Goodrich Schneider R., Schneider K.R., Archer D.L. Food Safety on the Farm – An Overview of Good Agricultural Practices. FSHN06-01. Gainesville: University of Florida Institute of Food and Agricultural Sciences, 2011. https://edis.ifas.ufl.edu/pdffiles/FS/FS15000.pdf
12. McColloch L.P., Cook H.T., Wright W.R. Market diseases of tomatoes, peppers, and eggplants // U.S. Dept. Agric. Agric. Handb.1968. № 28. 88 p.
13. Wingard S.A. Bacterial soft-rot of tomato // Phytopathology. 1924. № 14. P. 2-44. https://books.google.com.ua/books?id =tSOED1q2xaYC&pg
14. Conn K.E., Ogawa J.M., Manji B.T., Adaskaveg J.E. Leuconostoc mesenteroides susp. mesenteroides, the first report of a coccoid bacterium causing a plant disease // Phytopathology. 1995. № 85. P. 593–599. https://www.cabdirect.org/cabdirect/abstract/19952309347
15. Butler E.E. Pathogenicity and taxonomy of Geotrichum candidum // Phytopathology. 1960. № 50. P. 665–672. https://www.cabdirect.org/cabdirect/abstract/19611101058
16. Butler E.E., Bracker C.E. The role of Drosophila melanogaster in the epidemiology of Geotrichum, Rhizopus and other fruit rots of tomato // Phytopathology. 1963. № 53. P. 1016–1020. https://books.google.com.ua/books?id=WK-Scwl9skYC&pg=PA81&lpg=PA81&dq=Phytopathology
17. Stevenson W.R. Buckeye rot and Phytophthora Root Rot // Compendium of Tomato Diseases / J.B. Jones, J.P. Jones, R.E. Stall, T.A. Zitter (eds.). St. Paul, MN: APS Press, 1991. P. 11.
18. Ганиев М.М., Недорезков В.Д. Химические средства защиты растений. Москва, 2006. 248 с.
19. Голышин Н.М. Фунгициды. Москва, 1993. 319 с.
20. Anti-inflammatory effect of the hydralcoholic extract of Zingiber officinale rhizomes on rat paws and skin edema / Penna S.C. et al. // Phytomedicine. 2003. № 10. P. 381–385. DOI:10.1078/0944-7113-00271
21. Chemical Composition and Antimicrobial Activity of the Crude Extracts Isolated from Zingiber Officinale by Different Solvents / Hiba Ali Hasan et al. // Pharmaceut Anal Acta. 2012. № 3. P. 9. doi: 10.4172 / 2153-2435.1000184
22. Antibacterial activity analysis of extracts of various plants against gram -positive and -negative bacteria / Anwar Khalid et al. // African Journal of Pharmacy and Pharmacology. 2011 № 5 (7). http://www.academicjournals.org/ajpp. DOI: 10.5897/AJPP11.215.

23. Antifungal Activity of Ginger Extract on Candida Albicans: An *in vitro* Study / Supreetha S. et al. // Journal of Dental Sciences and Research. 2011. Vol. 2, Issue 2. P. 1-5. http://www.ssdctumkur.org/jdsr4_05.pdf
24. Antibacterial and anti-biofilm activity of ginger (Zingiber officinale (Roscoe)) ethanolic extract Kragujevac / Nikolich M. et al. // J. Sci. 2014. № 36. P. 129-136. https://www.pmf.kg.ac.rs/KJS/images/volumes/vol36/ kjs36nikoliccomic129.pdf
25. Antimicrobial effects of Citrus sinensis peel extracts against dental caries bacteria: An *in vitro* study / Sapna B. Shetty et al. // J Clin Exp Dent. 2016. № 8 (1). P. 71-77. DOI: 10.4317/jced.52493
26. Maria José Velázquez-Nuñez, Raúl Avila-Sosa, Enrique Palou, Aurelio López-Malo. Antifungal activity of orange (Citrus sinensis var. Valencia) peel essential oil applied by direct addition or vapor contact // Food Control. 2013. Vol. 31, Issue 1. P. 1-4. DOI: 10.1016/j.foodcont.2012.09.029
27. Messgo-Moumene, S., Li, Y., Bachir, K., Houmani, Z., Bouznad, Z., Chemat, F. (Auteur de correspondance) Antifungal power of citrus essential oils against potato late blight causative agent // Journal of Essential Oil Research. 2015. № 27 (2), P. 169-176. DOI : 10.1080/10412905.2014.982877 https://prodinra.inra.fr/record/ 294632
28. Bulbs V. Viswanathan, Phadatare A.G., Alka Mukne. Antimycobacterial and Antibacterial Activity of *Allium sativum* // Indian J Pharm Sci. 2014. № 76 (3). P. 256–261. https://www.ncbi.nlm.nih.gov/pmc/ articles/PMC4090836/
29. Alane S.K., Swami C.S. Antibacterial activity of plant extracts against Xanthomonas axonopodis Pv. Punicae causing bacterial blight of Pomegranate (Punica granatum L.) // Bioscience Discovery. 2016. № 7 (1). P. 70-73. https://biosciencediscovery.com/Vol%207%20No%201/Alane%2070-73.pdf
30. Isolation, Identification, *In Vitro* Antibiotic Resistance and Plant Extract Sensitivity of Fire Blight Causing *Erwinia amylovora* / Islam M.A. et al. // J Plant Pathol Microb. 2014. № 5. P. 233. DOI: 10.4172/2157-7471.1000233
31. Wani A.H., Mir R.A. Antimycotic activity of plant extracts on the spore germination of some pathogenic fungi Taskeen-Un-Nisa // Mycopath. 2010. № 8 (2). P. 65-69. http://pu.edu.pk/images/journal/impp/PDF-FILES/3_Vol_8(2)_2010.pdf
32. Daniel C.K., Lennox C.L., Vries F.A. In-vitro effects of garlic extracts on pathogenic fungi *Botrytis cinerea, Penicillium expansum* and *Neofabraea alba* // S Afr J Sci. 2015. № 111 (7/8). 8 p. DOI: http://dx.doi.org/10.17159/ sajs.2015/20140240.
33. Mudyiwa R.M., Chiwaramakanda S., Manenji B.T., Takawira M. Anti-*Alternaria solani* Activity of Onion (*Allium cepa*), Ginger (*Zingiber officinale*) and Garlic (*Allium sativum*) *In vitro* // International Journal of Plant & Soil Science. 2016. № 10 (4). P. 1-8. DOI: 10.9734/IJPSS/2016/24488.
34. Inhibitory effect of Allium sativum and Zingiber officinale extracts on clinically important drug resistant pathogenic bacteria / I. Gull et al. // Annals of Clinical Microbiology and Antimicrobials. 2012. Vol. 11. P. 8. DOI: 10.1186/1476-0711-11-8.
35. Bactericidal and anti-adhesive properties of culinary and medicinal plants against Helicobacter pylori / R. O'Mahony et al. // World Journal of Gastroenterology. 2005. Vol. 11, № 47. P. 7499-7507. DOI:10.3748/wjg.v11.i47.7499
36. Kamrul Islam, Asma Afroz Rowsni, Md. Murad Khan, Md. Shahidul Kabir. Antimicrobial activity of the extract (Zingiber Officinale) on productive and protective pathogen bacteria // International Journal of Science, Environment and Technology. 2014. Vol. 3, № 3. P. 867. DOI **:** http://dx.doi.org/10.13005/bpj/1424
37. Deokar S.B., Pawar R.M., Tambe A.R. Antimicrobial activity of the extract (Zingiber Officinale) on productive and protective pathogen bacteria // International Journal of Allied Practice, Research and Review Website. 2017. № 4. URL: www.ijaprr.com
38. Sherifa Mostafa M. Sabra, Luluah Mohammed R. Al-Masoudi, Samer Ahmed H. Al-Gehani, Alaa Ali O. Abu-Harbah. Page Comparative Laboratory Study on Antimicrobial Effects of Fresh and Dry Ginger (Zingiber officinale) // IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). 2014. Vol. 8, Issue 9. P. 114-123. URL: www.iosrjournals.org
39. Sediek L., Abozeid W., Alkhalifah D., Farad S. Efficacy of ginger extract (Zingiber officinale) and gamma irradiation for quality and self-stability of processed frozen beef sausage // Life Sci. J. 2012. № 9. P. 448-461. http://www.lifesciencesite.com.
40. Dawa Dolma Bhutia, Yeka Zhimo, Ramen Kole, Jayanta Saha. Antifungal activity of plant extracts against Colletotrichum musae, the post harvest anthracnose pathogen of banana cv. Martaman // Nutrition & Food Science. 2016. Vol. 46, Issue 1. P. 2-15. DOI: https://doi.org/10.1108/NFS-06-2015-0068.
41. Bie Yun Tsai. Effect of peels of lemon, orange, and grapefruit against Meloidogyne incognita // Plant Pathology Bulletin. 2008. № 17. P. 195-201. DOI: 10.5897/AJAR11.218
42. Adam I., Avin N. Comparative Antimicrobrial Activity of Peel and Juice Extract of Citrus Fruits Growing in Kurdistan // American Journal of Microbiological Research. 2015. Vol. 3, № 5. P. 155-159. https://www.journals.elsevier.com/journal-of-microbiological-methods
43. Cruz, M.E.S., Schwan-Estrada, K.R.F., Clemente, E., Itako, A.T., Stangarlin, J.R., Cruz, M.J.S. Plant extracts for controlling the post-harvest anthracnose of banana fruit // Rev. Bras. Pl. Med., Campinas. 2013. Vol. 15, № 4. P. 727-733. DOI**:** http:// dx.doi.org/10.1590/S1516-05722013000500013.
44. Azucena Gándara-Ledezma, Consuelo Corrales-Maldonado, Marisela Rivera-Domínguez, Miguel Ángel Martínez-Téllez Post-harvest control of gray mold in table grapes using volatile sulfur compounds from Allium sativum // J Sci Food Agric. 2015. Vol. 95, № 3.P. 497-503. DOI**:** 10.1002/jsfa.6757.
45. Chanel Karousha Daniel. The effect of garlic extracts on the control of postharvest pathogens and postharvest decay of apples. Copyright © 2014 Stellenbosch University All rights reserved. http://scholar.sun.ac.za/.

Reference:

1. Dyatlov VV. Naukovi osnovy obrobky ta zberihannya plodoovochevoyi produktsiyi iz zastosuvannyam plivkoutvoryuyuchykh kompozytsiy [author's thesis]. Kherson: KHNTU; 2006.
2. Medvedkova II. Yakist i zberezhenist svizhykh teplychnykh tomativ iz zastosuvannyam obrobky plivkoutvoryuvalnoyu kompozytsiyeyu [author's thesis]. Donetsk: DonNUET; 2007.
3. Myronycheva OS. Obgruntuvannya vykorystannya antyoksydantnykh preparativ dlya tryvaloho zberihannya plodiv yabluni [author's thesis]. Melitopol: TDAU; 2003.
4. Haprindashvili NA. Obgruntuvannya vykorystannya novykh antyoksydantnykh preparativ pryrodnoho pokhodzhennya dlya tryvaloho zberihannya plodiv hrush [author's thesis]. Melitopol: TDAU; 2011.

5. Zhukova VF. Obgruntuvannya vykorystannya novykh antyoksydantnykh kompozytsiy dlya zberihannya plodiv tomatu [dissertation]. Kiev: NUBPU; 2012.
6. Bezmennikova VM. Obgruntuvannya vykorystannya novykh antyoksydantnykh preparativ dlya zberihannya plodiv abrykosa [dissertation]. Kiev: NUBPU; 2010.
7. Herasymchuk OP. Zberezhennya yakosti plodiv chornoyi smorodyny z pislyazbyralnoyu obrobkoyu rechovynamy antymikrobnoyi diyi ta v produktakh pererobky [dissertation]. Uman: UDUA; 2009.
8. Tong Geon Lee. CRISPR – A Technical Breakthrough for Tomato Research. New and Revised Publication. University of Florida magazine website [Internet]. February 2018. Available from: http://edis.ifas.ufl.edu/hs1314/
9. Bartz JA, Sargent SA, Scott JW. Postharvest Quality and Decay Incidence Among Tomato Fruit as Affected by Weather and Cultural Practices. Gainesville: University of Florida Institute of Food and Agricultural Sciences [Internet]. 2012. Available from: http://edis.ifas.ufl.edu/
10. Jones JB, Jones JP, Stall RE, Zitter TA, eds. Compendium of Tomato Diseases [Internet]. St. Paul, MN: The American Phytopathological Society; 1991. Available from: http://www.apsnet.org/
11. Goodrich Schneider R., Schneider K.R., Archer D.L. Food Safety on the Farm – An Overview of Good Agricultural Practices. FSHN06-01. [Internet]. Gainesville: University of Florida Institute of Food and Agricultural Sciences; 2011. Available from: https://edis.ifas.ufl.edu/pdffiles/FS/FS15000.pdf
12. McColloch LP, Cook HT, Wright WR. Market diseases of tomatoes, peppers, and eggplants. U.S. Dept. Agric. Agric. Handb.1968; 28: 88.
13. Wingard SA. Bacterial soft-rot of tomato. Phytopathology. 1924; 14: P. 2-44. Available from: https://books.google.com.ua/books?id =tSOED1q2xaYC&pg
14. Conn KE, Ogawa JM, Manji BT, Adaskaveg JE. Leuconostoc mesenteroides susp. mesenteroides, the first report of a coccoid bacterium causing a plant disease. Phytopathology. 1995; 85: 593-599. Available from: https://www.cabdirect.org/cabdirect/abstract/19952309347
15. Butler EE. Pathogenicity and taxonomy of Geotrichum candidum. Phytopathology. 1960; 50: 665-672.
16. Butler EE., Bracker CE. The role of Drosophila melanogaster in the epidemiology of Geotrichum, Rhizopus and other fruit rots of tomato. Phytopathology. 1963; 53: 1016-1020. Available from: https://books.google.com.ua/books?id=WK-Scwl9skYC&pg=PA81&lpg=PA81&dq=Phytopathology
17. Stevenson WR., Jones JB., Stall RE., Zitter TA. (eds.). Buckeye rot and Phytophthora Root Rot. Compendium of Tomato Diseases. St. Paul, MN: APS Press; 1991.
18. Hanyev MM., Nedorezkov VD. Khymycheskye sredstva zashchyty rastenyy. Moscow; 2006.
19. Holyshyn NM. Funhytsydy. Moscow; 1993.
20. Penna SC, et al. Anti-inflammatory effect of the hydralcoholic extract of Zingiber officinale rhizomes on rat paws and skin edema. Phytomedicine. 2003; 10: 381-385. Available from: https://www.ncbi.nlm.nih.gov/pubmed/ 12834002
21. Hiba Ali Hasan, et al. Chemical Composition and Antimicrobial Activity of the Crude Extracts Isolated from Zingiber Officinale by Different Solvents. Pharmaceut Anal Acta. 2012; 3: 9. Available from: DOI: 10.4172 / 2153-2435.1000184
22. Anwar Khalid, et al. Antibacterial activity analysis of extracts of various plants against gram -positive and -negative bacteria. African Journal of Pharmacy and Pharmacology [Internet]. 2011; 5(7). Available from: http://www.academicjournals.org/ajpp. DOI: 10.5897/AJPP11.215
23. Supreetha S., et al. Antifungal Activity of Ginger Extract on Candida Albicans: An *in vitro* Study. Journal of Dental Sciences and Research. 2011; 2(2): 1-5. Available from: http://www.ssdctumkur.org/jdsr4_05.pdf
24. Nikolich M., et al. Antibacterial and anti-biofilm activity of ginger (Zingiber officinale (Roscoe)) ethanolic extract Kragujevac. J Sci. 2014; 36: 129-136. Available from: https://www.pmf.kg.ac.rs/KJS/images/volumes/vol36 /kjs36nikoliccomic129.pdf
25. Sapna B Shetty, et al. Antimicrobial effects of Citrus sinensispeel extracts against dental caries bacteria: An *in vitro* study. J Clin Exp Dent. 2016; 8(1): 71-77. DOI: 10.4317/jced.52493.
26. Maria José Velázquez-Nuñez, Raúl Avila-Sosa, Enrique Palou, Aurelio López-Malo. Antifungal activity of orange (Citrus sinensis var. Valencia) peel essential oil applied by direct addition or vapor contact. Food Control. 2013; 31(1): 1-4. Available from: DOI: 10.1016/j.foodcont.2012.09.029
27. Saida Messgo-Moumene, Ying Li, Kamilia Bachir, Zahia Houmani, Zouaoui Bouznad, Farid Chemat. Antifungal power of citrus essential oils against potato late blight causative agent. Journal of Essential Oil Research. 2015, 27 (2): 169 – 176. Available from: DOI : 10.1080/10412905.2014.982877 https://prodinra.inra.fr/record/ 294632
28. Bulbs V Viswanathan, Phadatare AG, Alka Mukne. Antimycobacterial and Antibacterial Activity of *Allium sativum*. Indian J Pharm Sci. 2014; 76(3): 256-261. Available from: https://www.ncbi.nlm.nih.gov /pmc/articles/PMC4090836/
29. Alane SK, Swami CS. Antibacterial activity of plant extracts against Xanthomonas axonopodis Pv. Punicae causing bacterial blight of Pomegranate (Punica granatum L.). Bioscience Discovery. 2016; 7(1): 70-73. Available from: https://biosciencediscovery.com/Vol%207%20No%201/Alane%2070-73.pdf
30. Islam MA, et al. Isolation, Identification, *In Vitro* Antibiotic Resistance and Plant Extract Sensitivity of Fire Blight Causing *Erwinia amylovora*. J Plant Pathol Microb. 2014; 5: 233. Available from: DOI: 10.4172/2157-7471.1000233.
31. Wani AH, Mir RA. Antimycotic activity of plant extracts on the spore germination of some pathogenic fungi Taskeen-Un-Nisa. Mycopath. 2010; 8(2): 65-69. Available from: http://pu.edu.pk/images/journal/impp/PDF-FILES/3_Vol_8(2)_2010.pdf
32. Daniel CK, Lennox CL, Vries FA. In-vitro effects of garlic extracts on pathogenic fungi *Botrytis cinerea, Penicillium expansum* and *Neofabraea alba*. S Afr J Sci. 2015; 111(7/8): 8. DOI: http://dx.doi.org/10.17159/ sajs.2015/20140240.
33. Mudyiwa RM, Chiwaramakanda S, Manenji BT, Takawira M. Anti-*Alternaria solani* Activity of Onion (*Allium cepa*), Ginger (*Zingiber officinale*) and Garlic (*Allium sativum*) *In vitro*. International Journal of Plant & Soil Science. 2016; 10 (4): 1-8. DOI: 10.9734/IJPSS/2016/24488
34. Gull I, Saeed M, Shaukat H, Aslam SM, Samra ZQ, Athar AM. Inhibitory effect of Allium sativum and Zingiber officinale extracts on clinically important drug resistant pathogenic bacteria. Annals of Clinical Microbiology and Antimicrobials. 2012; 11: 8. DOI: 10.1186/1476-0711-11-8
35. O'Mahony R, et al. Bactericidal and anti-adhesive properties of culinary and medicinal plants against Helicobacter pylori. World Journal of Gastroenterology. 2005; 11(47): 7499-7507. DOI:10.3748/wjg.v11.i47.7499

36. Kamrul Islam, Asma Afroz Rowsni, Md. Murad Khan, Md. Shahidul Kabir. Antimicrobial activity of the extract (Zingiber Officinale) on productive and protective pathogen bacteria. International Journal of Science, Environment and Technology. 2014; 3(3): 867. DOI: http://dx.doi.org/10.13005/bpj/1424
37. Deokar SB, Pawar RM, Tambe AR. Antimicrobial activity of the extract (Zingiber Officinale) on productive and protective pathogen bacteria. International Journal of Allied Practice, Research and Review Website. 2017; 4. Available from: www.ijaprr.com.
38. Sherifa Mostafa M. Sabra, Luluah Mohammed R. Al-Masoudi, Samer Ahmed H. Al-Gehani, Alaa Ali O. Abu-Harbah. Page Comparative Laboratory Study on Antimicrobial Effects of Fresh and Dry Ginger (Zingiber officinale). IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). 2014; 8(9): 114-123. Available from: www.iosrjournals.org
39. Sediek L, Abozeid W, Alkhalifah D, Farad S. Efficacy of ginger extract (Zingiber officinale) and gamma irradiation for quality and self-stability of processed frozen beef sausage. Life Sci. J. 2012; 9: 448-461. http://www.lifesciencesite.com.
40. Dawa Dolma Bhutia, Yeka Zhimo, Ramen Kole, Jayanta Saha. Antifungal activity of plant extracts against Colletotrichum musae, the post harvest anthracnose pathogen of banana cv. Martaman. Nutrition & Food Science. 2016; 46(1): 2-15. DOI: https://doi.org/10.1108/NFS-06-2015-0068.
41. Bie Yun Tsai. Effect of peels of lemon, orange, and grapefruit against Meloidogyne incognita. Plant Pathology Bulletin. 2008; 17: 195-201. DOI: 10.5897/AJAR11.218
42. Adam I, Avin N. Comparative Antimicrobrial Activity of Peel and Juice Extract of Citrus Fruits Growing in Kurdistan. American Journal of Microbiological Research. 2015; 3(5): 155-159. https://www.journals.elsevier.com/journal-of-microbiological-methods
43. Kruz MES, et al. Plant extracts for controlling the post-harvest anthracnose of banana fruit. Rev. Bras. Pl. Med., Campinas. 2013; 15 (4): 727-733. DOI: http:// dx.doi.org/10.1590/S1516-05722013000500013.
44. Azucena Gándara-Ledezma, Consuelo Corrales-Maldonado, Marisela Rivera-Domínguez, Miguel Ángel Martínez-Téllez. Post-harvest control of gray mold in table grapes using volatile sulfur compounds from Allium sativum. J Sci Food Agric. 2015; 95 (3): 497-503. DOI: 10.1002/jsfa.6757
45. Chanel Karousha Daniel. The effect of garlic extracts on the control of postharvest pathogens and postharvest decay of apples [Internet]. Available from: Copyright © 2014 Stellenbosch University All rights reserved. http://scholar.sun.ac.za/.

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