Секція 4. ХІМІЧНІ, ФІЗИЧНІ, МАТЕМАТИЧНІ МЕТОДИ ДОСЛІДЖЕННЯ ЯКОСТІ ПРОДУКТІВ ХАРЧУВАННЯ

UDC 631.563.8:635.646

SUBSTANTIATION OF THE FILM-FORMING COMPOSITION FOR EGGPLANT FRUITS TREATMENT BEFORE STORAGE

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The micro- and mycobiota of the fresh eggplant fruits phyllosphere of different botanical varieties Valentyna and Samurai (Japanese agriculture), Clorinda (Egg agriculture), Solaris (American agriculture) was studied. The possibility of oak bark and leaves, juniper berries, St. John's wort, costmary, common plantain, wormwood and motherwort extracts use is considered. It is recommended to use extracts of oak bark and leaves, juniper berries and St. John's wort on the base of studies of medicinal and vegetable raw material extracts potential toxicity. The studied extracts have antimicrobial activity against 4 reference strains: E. coli ATCC 25922, S. aureus ATCC 25923, P. aeruginosa ATCC 27853, C. albicans ATCC 885-653. Fungal growth inhibition zones are identified in the studied samples compositions: Cladosporium from 15 mm to 28 mm, Fusarium from 18 mm to 30 mm, Rhizopus from 16 mm to 30 mm. The effect of the film-forming agent type on the fungal culture growth inhibition is studied. It is determined that the medicinal and vegetable raw material extracts composition with chitosan use as film-forming agent has the greatest fungistatic properties. The studies results show the dependence of respiratory intensity on the eggplant fruits variety. The use of film-forming composition of medicinal and vegetable extracts on the base of low molecular weight chitosan reduces the amplitude of eggplant fruits respiration and allows storage prolonging by 2,0–2,3 times.

Keywords: *eggplant, epiphytic microflora, toxicity, antimicrobial activity, film-forming agent, respiration rate, chitosan.*

ОБҐРУНТУВАННЯ СКЛАДУ ПЛІВКОУТВОРЮВАЛЬНОЇ КОМПОЗИЦІЇ ДЛЯ ОБРОБКИ ПЛОДІВ БАКЛАЖАНА ПЕРЕД ЗБЕРІГАННЯМ

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Досліджено мікро- та мікобіоти філосфери свіжих плодів баклажана різних ботанічних сортів. Визначено потенційну токсичність екстрактів лікарсько-технічної сировини. Обґрунтовано доцільність використання

екстрактів кори та листя дуба, ягід ялівцю і трави звіробою звичайного. Подано оцінку антимікробної активності екстрактів. Визначено фунгіцидні властивості композицій екстрактів із різними співвідношеннями компонентів. Досліджено вплив типу плівкоутворювача на затримку росту культур цвілевих грибків. Досліджено вплив плівкоутворювальних композицій на інтенсивність дихання плодів баклажана.

Ключові слова: *баклажан, епіфітна мікрофлора, токсичність, антимікробна активність, плівкоутворювач, інтенсивність дихання, хітозан.*

ОБОСНОВАНИЕ СОСТАВА ПЛЕНКООБРАЗУЮЩЕЙ КОМПОЗИЦИИ ДЛЯ ОБРАБОТКИ ПЛОДОВ БАКЛАЖАНА ПЕРЕД ХРАНЕНИЕМ

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Исследована микро- и микобиота филосферы свежих плодов баклажана разных ботанических сортов. Определена потенциальная токсичность экстрактов лекарственно-технического сырья. Обоснована целесообразность использования экстрактов коры и листьев дуба, ягод можжевельника и травы зверобоя обыкновенного. Дана оценка антимикробной активности экстрактов. Определены фунгицидные свойства композиций экстрактов с разными соотношениями компонентов. Исследовано влияние типа пленкообразователя на задержку роста культур плесневых грибков. Исследовано влияние пленкообразующих композиций на интенсивность дыхания плодов баклажана.

Ключевые слова: *баклажан, эпифитная микрофлора, токсичность, антимикробная активность, пленкообразователь, интенсивность дыхания, хитозан.*

Statement of the problem. Vegetables are essential components of a healthy diet. Their value is conditioned by the vitamins, minerals and nutrients complex presence which have the ability of free radicals neutralizing. For Ukraine as country which focuses on the agricultural products export, vegetable products high quality is necessary condition for gaining access to the European market. According to FAO, 44% of all food resources losses are losses of fruits and vegetable raw material. The main reason of vegetables significant losses is their affection by microorganisms. The composition of the surface microflora is very diverse and random; it depends on the type of plant, geographical, climatic and other conditions.

Modern agricultural practice usually uses synthetic agents for food products processing, mostly contact fungicides with broad spectrum of action, which have unsatisfactory toxicological profile for the human body,

and in case of insufficient hygienic treatment by consumers can cause poisoning and health damage.

Therefore, the development of vegetables processing new agents on the base of harmless to human vegetable components is very important task of modern agricultural, phytochemical and biological industries.

Review of the latest research and publications. Currently, refrigerated storage is the main method of storing fresh fruits and vegetables. Despite the high cost, the efficiency of refrigerators use for fruits and vegetables storage is very high, because of natural weight loss and losses from microbiological and physiological diseases reduction. It also should be noted that the storage method in controlled gaseous medium has become widespread. The base of storage in the regulated gaseous medium is not the inhibition of phytopathogens of the microflora, but the regulation of metabolism, which prevents the occurrence of functional disorders and thus provides high resistance to infectious diseases. Another way of fruits' affecting during storage is treatment with chemicals. The following types of treatment are common: calcium preparations, synthetic antiseptics, ethylene-producing preparations, iodine-containing antiseptics, potassium metobisulfite.

The disadvantage of such technologies is the detrimental effects of these chemicals use on the human body. Innovative technologies of vegetable raw material storage by means of various physical factors of influence are currently developed. They include, for example, the technology of agricultural raw material long-term storage with use of raw material pre-treatment before storage by electromagnetic field [1–7]. Washing of vegetable raw material with tap, chlorinated, electroactivated and ozonated water has positive effect on microbiological purity and raw material quality during storage [8]. Different methods are used in addition to the use of various physical factors which affect on vegetable raw material for storage period increasing; these methods include not only the effect on the raw material, and also use of other various methods such as the bactericidal packaging, as well as various types of raw material pre-treatment before packaging [9–12]. Also natural extracts from various spicy-aromatic plants which have bactericidal effect are widely used in the food industry [13–15]. In addition currently storage methods on the base of various oxygen absorbents from packaging are used [16].

The objective of the research is the film-forming agent composition substantiation for eggplant fruits treatment before storage.

Purpose achieving includes the following tasks:

– study of fresh eggplant fruits composition epiphytic microflora;

– study of medicinal and technical raw material extracts potential toxicity;

– establishing of medicinal and technical raw material extracts antimicrobial activity;

– determination of medicinal and technical raw material extracts fungicidal properties;

– study of the film-forming agent type effect on the microorganisms growth;

– study of the fresh eggplant fruits, which are treated with film-forming composition respiration intensity.

Presentation of the research material. The research objects are: fresh eggplant fruits of Valentyna and Samurai varieties (Japanese agriculture), Clorinda (Egg agriculture), Solaris (American agriculture); extracts: oak bark and leaves, juniper berries, St. John's wort, costmary, common plantain, wormwood and motherwort; film-forming agents: chitosan, methylcellulose, sodium alginate; unprocessed eggplant fruits ($К_1$), eggplant fruits treated with «Tween» preparation ($К_2$), eggplant fruits treated with film-forming composition on the based of chitosan and medicinal and vegetable raw material extracts (Chitosan).

The total bacteria number, composition of the micro- and mycobiota of fresh eggplant fruits epiphytic microflora are determined with use of standard methods which are recommended for food products sanitary and bacteriological control [17; 18].

Studies of medicinal and technical raw material extracts potential toxicity were carried out by the bacteriological method, namely, by 5% blood agar inoculation [19]. Antimicrobial activity tests were carried out by sanitary bacteriology methods [20]. The extracts' fungicidal properties were studied according to the experimental mycology methods [21].

Fresh vegetables losses main cause is microbial damage. For a long time, fresh vegetables remain viable; there are various physiological processes in fresh vegetables. However, in contrast to vegetative plants, dissimilation processes (respiration) predominate in the gathered vegetables, and they also retain transpiration functions (water evaporation). Deep and irreversible changes in vegetables occur under intense biochemical processes. The storage period decreases and appearance deteriorates under vegetables aging. They gradually loosen, lose flavor and nutritional value; ability to diseases resisting reduces; various microorganisms begin to develop on their surface.

The plants resistance to microbial lesions is explained by many factors. Their anatomical structure, especially the integuments structure has significant importance. Peels (their thickness, suberization cells presence,

cuticles and wax bloom) are powerful protective barrier to the microbes' penetration into the vegetables pulp. The chemical composition, substances which inhibit microorganisms' development, such as dyes (anthocyanins, flavonols), essential oils and especially phytoncides also play important role. Many of these substances are concentrated mainly in the vegetables peel and adjacent pulp cells.

Various microorganisms are constantly on the surface of vegetables, great part of which is not involved in the disease and spoilage processes, and it is in inactive state. If the peel isn't damaged, then there is usually small amount of nutrients in it, so only some species of microorganisms which make up the so-called epiphytic microflora can exist and multiply on its surface. Vegetables infection with microorganisms can be active – the pathogen penetrates into the tissues through intact integuments and passive – the pathogen penetrates through damaged areas. Significant part of these microorganisms is in inactive state and after a while dies because of insufficient conditions for their development.

We carried out the general contamination study of eggplant fruits different botanical varieties. The research results are presented in table 1.

Table 1

Study of myco- and microbiota of eggplant fruits phyllosphere

Indicator (CFU in 1 cm^3)	Botanical varieties			
	Valentyna	Samurai	Clorinda	Solaris
QMAFAM	$8{,}0x10^4$	$1{,}2x10^5$	$1{,}8x10^5$	$4{,}3x10^5$
Bacterium of intestinal bacillus	–	–	–	–
Pathogenic enterobacteria	–	–	–	–
Enterococus spp	–	–	–	–
Yeast fungi	–	–	–	–
Mold fungi	$6{,}0x10^4$	$4{,}1x10^4$	$1{,}2x10^5$	$6{,}7x10^4$
NFGNB	$2{,}2x10^2$	$4{,}4x10^2$	$6{,}1x10^2$	$4{,}1x10^2$

The total quantity of mesophilic aerobic and facultative anaerobic microorganisms (QMAFAM) is in the range from $8{,}0x10^4$ (Valentyna variety) to $4{,}3x10^5$ (Solaris variety). Bacteria of the Escherichia coli group, including coliform microorganisms, as well as pathogenic enterobacteria, including salmonella were not identified. However, during seeding on Endo medium, pink colonies with diameter of 1,0–1,5 mm in the amount of $2{,}2x10^2$ to $6{,}1x10^2$ CFU/g were identified. Under identifying these isolates on differential diagnostic media, they were classified as non-fermenting

gram-negative microorganisms. These microorganisms belong to the bacteria group which is the component of QMAFAM index. Bacteria of *Bacillus, Pseudomonas, Xanthomonas* genus were also identified on fruits surface. The study of the eggplant fruits phyllosphere mycobiota composition shows the fungi presence of *Botrytis, Alternaria, Fusarium, Aspergillus* and *Cladosporium* genus. The genus *Fusarium* was predominant; all other fungi were represented by single colonies.

On the base of obtained data, we can conclude that the eggplant fruits epiphytic microflora is diverse; its composition has random character. With taking it into account, we used the principles of selection plants with the highest antimicrobial and antifungal activity against virulent pathogens of agricultural crops at the stage of film-forming composition for eggplant fruits treatment theoretical development. We considered the possibility of oak bark and leaves, juniper berries, common St. John's wort, costmary, plantain, wormwood and motherwort extracts use during the composition substantiation for eggplant fruits treatment. The potential toxicity of the samples was studied by extracts inoculating with 5% blood agar for herbal extracts safety assessment. Toxic compounds hemolyze erythrocytes and enlighten the bloodstream at the test site (erythrocyte lysis). The research obtained data are presented in table 2.

Table 2

Study of the medicinal and technical raw material extracts potential toxicity

№	Tested samples	The hemolysis zone diameter, mm
1	Oak bark and leaves	Hemolysis isn't observed
2	Common plantain	2
3	Juniper berries	Hemolysis isn't observed
4	Common St. John's wort	Hemolysis isn't observed
5	Costmary	5
6	Common wormwood	7
7	Motherwort	7

The study identified the blood agar lysis absence in samples № 1, 3, 4. Samples № 5, 6, 7 hemolyze erythrocyte cells, and relatively weak lysis was identified in sample № 2. Oak bark and leaves, juniper berries and common St. John's wort extracts were selected on the base of obtained results for eggplant fruits treatment and further research.

We used reference microorganisms' strains for the screening phase of the study for extracts antimicrobial activity assessment of medicinal and vegetable raw material. The reference rather than clinical strains of microorganisms use is one of the main requirements for the experimental conditions unification, which can significantly increase the reliability and comparability of the microbiological studies results. In accordance with the requirements of regulatory documentation, we used ATCC strains (American Type Culture Collection) of the following species of microorganisms: *E. coli* ATCC 25922, *S. aureus* ATCC 25923, *C. albicans* ATCC 885-653, *B. cereus* ATCC 537, *B. subtilis* ATCC 6633. The effect of medicinal and vegetable raw material extracts on the isolate, which is extracted from eggplants lavage fluid and the mold fungi isolate were also studied. The results are presented in table 3.

Table 3

Antimicrobial activity of the medicinal and vegetable raw material extracts

Reference strains and isolates	Oak bark and leaves extract	Juniper berries extract	St. John's wort herb extract
E. coli ATCC 25922	–	–	–
S. aureus ATCC 25923	–	–	–
P. aeruginosa ATCC 27853	–	–	–
C. albicans ATCC 885-653	-	–	–
B. cereus ATCC 537	+	+	+
B. subtilis ATCC 6633	+	+	–
NFGNB "B" isolate	–	–	–
Mold fungi isolate	–	–	–
– growth absence, + microorganisms' growth.			

With taking into account the obtained data, we can conclude that the studied extracts have antimicrobial activity against 4 reference strains, namely: *E. coli* ATCC 25922, *S. aureus* ATCC 25923, *P. aeruginosa* ATCC 27853, *C. albicans* ATCC 885-653, to the isolate which is sown from the eggplant fruits lavage fluid and from mold fungi isolate. The reference strains *B. cereus* ATCC 537 and *B. subtilis* ATCC 6633 are resident to the study extracts.

Fungicidal properties studies of the medicinal and vegetable raw material extracts compositions were carried out on pure cultures of fungi *Cladosporium*, *Fusarium*, *Rhizopus*. The research results are presented in table 4.

Fungal cultures growth inhibition zones were noted in the studied samples of extract compositions: *Cladosporium* from 15 mm (oak bark and leaves, juniper berries and common St. John's wort extracts ratio is 1:1:1) to 28 mm (ratio 2:1:2); *Fusarium* from 18 mm (extracts' ratio is 1:1:1 and 1:1:2) to 30 mm (extracts' ratio is 2:1:2); *Rhizopus* from 16 mm (extracts' ratio is 1:1:1 and 1: 1: 2) to 30 mm (extracts' ratio is 2:1:2). It should be noted that the juniper berry extract concentration increasing has almost no effect on cultures' growth inhibiting. Oak bark and leaves and common St. John's wort extracts concentrations increasing in the composition allows the growth inhibition zone diameter increasing by 60–80%.

Table 4

Determination of compositions' fungicidal properties of oak bark and leaves, juniper berries and common St. John's wort extracts

Extracts composition	The diameter value of growth inhibition zone, mm		
	Cladosporium	*Fusarium*	*Rhizopus*
Oak bark and leaves, juniper berries and common St. John's wort extracts 1:1:1	15±0,38	18±0,41	18±0,40
Oak bark and leaves, juniper berries and common St. John's wort extracts 2:1:1	19±0,42	25±0,50	16±0,40
Oak bark and leaves, juniper berries and common St. John's wort extracts 1:2:1	19 ±0,41	20 ±0,50	18 ±0,41
Oak bark and leaves, juniper berries and common St. John's wort extracts 1:1:2	25 ±0,51	18 ±0,42	16 ±0,40
Oak bark and leaves, juniper berries and common St. John's wort extracts 2:1:2	28 ±0,53	30 ±0,44	20 ±0,41

The results of film-forming agent type effect on the mold fungi cultures' growth inhibiting are presented in table 5.

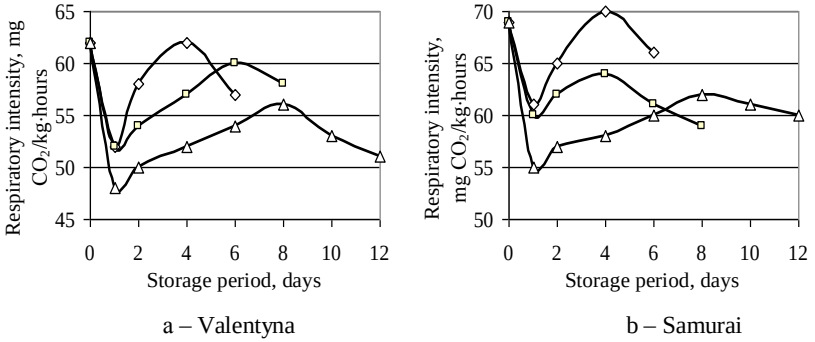
Table 5

Determination of film-forming agent type effect on the mold fungi cultures' growth inhibiting

The film composition	The diameter value of growth inhibition zone, mm		
	Cladosporium	*Fusarium*	*Rhizopus*
Extracts composition + chitosan	34,1±0,53	35,0±0,50	26,4±0,47
Extracts composition + methylcellulose	14,0±0,12	16,0±0,14	12,3±0,13
Extracts composition + sodium alginate	0,0±0,00	0,0±0,00	0,0±0,00

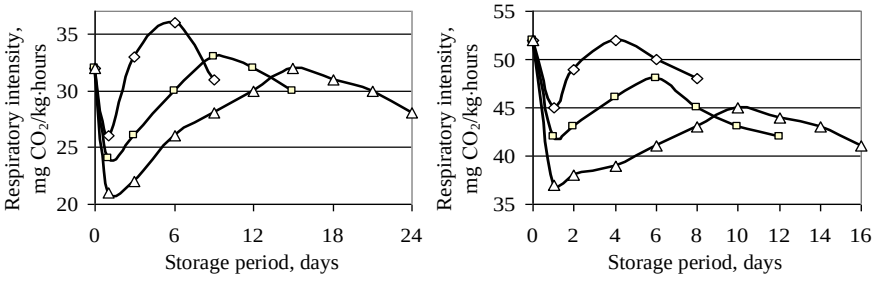
The obtained data analysis allows concluding that the film-forming composition on the chitosan base has the greatest fungistatic effect. Fungi growth inhibition zones are *Cladosporium* – 34,1 mm, *Fusarium* – 35,0 mm, *Rhizopus* – 26,4 mm. The methylcellulose adding reduces extracts' effect on microorganisms' growth inhibition. The film-forming composition with sodium alginate adding as a film-forming agent hasn't antimicrobial activity.

During fruits storage, respiratory gas exchange is generalizing indicator which reflects the metabolic processes intensity during storage. Undesirable overripeness and aging of fruits can be delayed by respiratory activity reducing, which helps to extend the storage period.



a – Valentyna b – Samurai

Fig. 1 Respiratory intensity dynamics of variety eggplants: a – Valentyna; b – Samurai; ◇ – К$_1$, □ – К$_2$, △ – chitosan



a – Solaris b – Clorinda

Fig. 2 Respiratory intensity dynamics of variety eggplants: a – Solaris; b – Clorinda; ◇ – $К_1$, □ – $К_2$, △ – chitosan

Figures 1, 2 present studies results of eggplant fruits respiratory intensity. Results analysis shows that eggplant fruits respiratory intensity depends on their variety. At the beginning of storage period the respiration rate of Solaris variety fruits (American agriculture) is 32,0 mg CO_2/kg·h; Clorinda variety (Egg agriculture) is 52,4 mg CO_2/kg·h; Valentyna and Samurai varieties (Japanese agriculture) are 62,4 and 69,0 mg CO_2/kg·h respectively. The film-forming composition on the base of low molecular weight chitosan use reduces respiratory intensity amplitude and allows storage period increasing by 2,0–2,3 times.

As research result the film-forming composition with antimicrobiological activity for eggplant fruits treatment on the base of medicinal and vegetable raw material extracts with use of low molecular weight water-soluble chitosan as a film-forming agent, was theoretically substantiated and experimentally proved.

Conclusion. The developed film-forming composition on the chitosan base allows it recommending for fresh eggplant fruits treatment with the aim of longer and better storage on the base of conducted researches and a number of positive results obtaining, namely, lack of toxicity, tested vegetables improved storage conditions compared to control sample and a wide range of antimicrobial activity.

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DOI: 10.5281/zenodo.3937790

УДК 664.8.03:665.112:664.34

ЗМІНИ ВМІСТУ ВІТАМІНУ Е ПІД ЧАС ЗБЕРІГАННЯ МАЙОНЕЗІВ НА ОСНОВІ ОЛІЙ КУПАЖОВАНИХ

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Досліджено вміст вітаміну Е в майонезній продукції на основі олій купажованих залежно від співвідношення соняшникової та ріпакової олії. Проаналізовано зміни вмісту вітаміну Е під час зберігання майонезів. Показано, що всі зразки майонезів на основі олій купажованих після 90 діб зберігання містять значно більше вітаміну Е, ніж свіжовиготовлений зразок майонезу на основі рафінованої соняшникової олії. Зроблено висновок про доцільність використання олій купажованих у виробництві майонезної продукції.

Ключові слова: *олії купажовані, ріпакова олія, поліненасичені жирні кислоти ряду ω-3 та ω-6, автоокиснення, α-токоферол, β-токоферол, δ-токоферол, γ-токоферол, гальмування автоокиснення.*

ИЗМЕНЕНИЕ СОДЕРЖАНИЯ ВИТАМИНА Е ПРИ ХРАНЕНИИ МАЙОНЕЗОВ НА ОСНОВЕ МАСЕЛ КУПАЖИРОВАННЫХ

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Исследовано содержание витамина Е в майонезной продукции на основе масел купажированных в зависимости от соотношения подсолнечного и рапсового масла. Проанализированы изменения содержания витамина Е при