



УДК 614.9:578. 62:613, 289:613,267.5

## EFFECTIVENESS OF USING SUBSTANCES FOR BIODEGRADABLE PACKAGING

## ЕФЕКТИВНІСТЬ ВИКОРИСТАННЯ РЕЧОВИН ДЛЯ БІОДЕГРАДАБЕЛЬНОГО ПАКУВАННЯ

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Publons: AAF-5445-2019

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**Annotation.** Based on the analysis of literary sources, a generalized classification of antimicrobial substances, which should be included in biodegradable packaging, is proposed. It was established that the introduction of antimicrobial biodegradable packaging TiO<sub>2</sub> in the amount of 1% into the composition of the molding solution allows to give the developed material antibacterial properties, since the vital activity of some microorganisms is suppressed. Research results show that TiO<sub>2</sub> as part of the packaging really inhibits the development of bacteria *Escherichia coli* IEM-1, *Bacillus subtilis* BT-2, as there is a delay in the growth of their colonies. Therefore, the results of the study make it possible to recommend TiO<sub>2</sub> as an effective tool to combat potato disease.

**Key words:** microorganisms, biodegradable packaging, potato disease, antimicrobial substances, vital activity.

Packaging is a mirror of global social trends. In the food industry at the current stage, special attention is paid to the creation of fundamentally new packaging materials, non-toxic, easily disposed of, able to provide effective protection of food against microbial damage, exposure to oxygen, prevent product drying during production and storage [1, 2],

Based on the analysis of literary sources, we have proposed a generalized classification of antimicrobial substances that should be included in biodegradable packaging.

It is known [4] that an antimicrobial substance that deserves the attention of developers is titanium dioxide (TiO<sub>2</sub>), which is an approved food additive (E 171) in accordance with EU Regulation No. 1333/2008 of the European Parliament and the Council of December 16, 2008 on food additives (Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives) without limiting daily consumption. Antibacterial properties of TiO<sub>2</sub> are explained primarily by atomic oxygen, which is released during exposure to



light, especially UV irradiation [5]. In addition, most researchers suggest combining TiO<sub>2</sub> with other carriers of antibacterial properties [1, 3].

**Table 1 - Classification of antimicrobial substances for biodegradable**

Originally:							
	<i>acids and their derivatives</i>	<i>essential oils</i>	<i>enzymes</i>	<i>peptides</i>	<i>amino carbohydrates</i>	<i>aldehydes</i>	<i>phenol derivatives</i>
<b>Organic</b>	benzoin; head, lemon; propion; sorbinov; sodium benzoate; calcium propionate; potassium sorbate; sodium salts of sulfamines and their derivatives; succinic anhydride	bergamot; carnations; eugenol; cinnamon; lemon grass; - oregano; rosemary; garlic; thyme; Mentha pulegium; Myrcia ovata Cambessedes; Zataria multiflora Boiss	glucose oxidase; lactoperoxidase; lysozyme and catechin-lysozyme; chitinase	nisin; lactocin; pediocin	chitosan	cinnamon	triclosan
<b>Inorganic</b>	modifications of Ag, TiO <sub>2</sub>						
By microbiological effect on:							
	Pathogen	conditionally pathogenic	molds	gram negative bacteria	gram positive bacteria		

Determination of antagonistic properties of antimicrobial biodegradable packaging with TiO<sub>2</sub> nanodisperse powder was carried out by the method of agar discs. Under sterile conditions, cut discs of TiO<sub>2</sub> film were placed on the medium with culture (MPA during the determination of bacteria, and Saburo when determining fungi and yeast). It was transferred to a thermostat (30 °C) and after 24 hours the diameter of the growth retardation zone of microorganisms was measured [2, 5].

Provocative testing to detect the antagonistic effect of TiO<sub>2</sub> on *Bacillus subtilis* was carried out as follows[6]. White wheat bread was cut into pieces 2 cm thick. The density of the 17-hour broth culture of *Bacillus subtilis* (DSM 10AG 276351, Korea) was adjusted to 0.5 according to the McFarland turbidity standard. Control samples were prepared as follows: *Bacillus subtilis* suspension in the amount of 0.1 cm<sup>3</sup> was evenly distributed on the surface of pieces of bread with an area of 10 cm<sup>2</sup>. It was established that the introduction of antimicrobial biodegradable packaging TiO<sub>2</sub> in the amount of 1% into the composition of the molding solution allows to give the developed material antibacterial properties, since the vital activity of some microorganisms is suppressed.

Table results. 2 show that TiO<sub>2</sub> in the package really inhibits the development of bacteria *Escherichia coli* IEM-1, *Bacillus subtilis* BT-2, as there is a delay in the growth of their colonies.

According to the obtained results of provocation testing, antimicrobial biodegradable packaging with a content of 1% TiO<sub>2</sub> has an inhibitory effect on *Bacillus subtilis*, since the increase in the number of microorganisms occurs many



times less intensively compared to a sample without biodegradable packaging with TiO<sub>2</sub>.

**Table 2 - Zone of inhibition of growth of microorganisms (n=3, p≤0.05)**

Test culture	KMAFaM without packaging, CFU/g	Zone of growth retardation, mm		
		Antimicrobial biodegradable packaging, % TiO <sub>2</sub>		
		0	0,5	1,0
<i>Escherichia coli</i> IEM-1	$(3,5\pm 0,02)\times 10^3$	0	9±1	15±2
<i>Bacillus subtilis</i> БТ-2	$(2,7\pm 0,02)\times 10^3$	0	6±1	7±1
<i>Candida albicans</i> Д-6	$(1,4\pm 0,01)\times 10^3$	0	0	0
<i>Aspergillus niger</i> Р-3	$(1,3\pm 0,06)\times 10^3$	0	0	0

Therefore, the results of the study make it possible to recommend TiO<sub>2</sub> as an effective tool to combat potato disease. Biodegradable packaging with a TiO<sub>2</sub> content of 1% in the molding solution, provided it is applied to sliced bread, will directly contact the place of development of the disease of wheat bakery products, which is most relevant in the warm period of the year.

### Література

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**Анотація.** На основі аналізу літературних джерел запропоновано узагальнену класифікацію антимікробних речовин, які доцільно вводити у склад біодеградабельного пакування. Встановлено, що введення до складу формувального розчину антимікробного



біодеградабельного пакування  $TiO_2$  у кількості 1 % дозволяє надавати розробленому матеріалу антибактеріальних властивостей, оскільки пригнічується життєдіяльність деяких мікроорганізмів. Результати досліджень показують, що  $TiO_2$  у складі пакування дійсно ригнічує розвиток бактерій *Escherichia coli* IEM-1, *Bacillus subtilis* BT-2, оскільки спостерігається затримка росту їх колоній. Отже, результати дослідження дають можливість рекомендувати  $TiO_2$  як дієвий засіб для боротьби з картопляною хворобою.

**Ключові слова:** мікроорганізми, біодеградабельне пакування, картопляна хвороба, антимікробні речовини, життєдіяльність.