rations with the various biological properties. Thus, when receiving surfactants, the precipitated cells can be used to purify water from oil; the obtained supernatant of the cultural liquid – for further separation of the surfactants with anti-adhesive and antimicrobial properties (including against the phytopathogenic bacteria). Aqueous phase, which remains after extraction of the surfactants, contains the phytohormones of auxin, cytokinin and gibberellic nature. It can be used to stimulate the growth of the plants and increasing the yield.

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BIOSYNTHESIS OF BIOSURFACTANTS BY CULTIVATION OF *NOCARDIA VACCINII* IMV B-7405 ON TOXIC INDUSTRIAL WASTE

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The possibility of using mixture of technical glycerol (waste product of biodiesel production) and fried sunflower oil as a substrate for the synthesis of the extracellular surfactants by *Nocardia vaccinii* IMV B-7405 was investigated. The maximum concentration of surfactants synthesized by *N. vaccinii* IMV B-7405 (5,0 g/l), was reached in the medium with technical glycerol (3,25%, v/v) and fried oil (0,75%, v/v).

Keywords: Nocardia vaccinii IMV B-7405, surfactants, mixture of frying sunflower oil and crude glycerol.

Introduction. Previous studies have shown the possibility of using fried sunflower oil and technical glycerol (waste of biodiesel production) as a substrate for the synthesis of the extracellular surfactants by *Nocardia vaccinii* IMV B-7405 [1]. Cultivation on a mixture of these substrates allows not only to utilize toxic industrial waste, but also is one of the effective approaches to the intensification of the synthesis of biosurfactants [2]. Therefore, the purpose of this work is to establish the possibility of intensification of the synthesis of surfactants by *N. vaccinii* IMV B-7405 on a mixture of fried sunflower oil and technical glycerol.

Materials and methods. The strain *N. vacinii* IMV B-7405 was grown on the synthetic nutrient medium containing (g/L): $NaNO_3$ – 0.5; $MgSO_4 \cdot 7H_2O$– 0.1; $CaCl \cdot 2H_2O$ – 0.1; KH_2PO_4 – 0,1; $FeSO_4 \cdot 7H_2O$ – 0.01, yeast autolysate – 0.5%., v/v. Monosubstrates (technical glycerol and fried sunflower oil) at a concentration of 4%., v/v and a mixture of technical glycerol (1.0–3.25%., v/v) and fried oil (0.75 – 3.0%., v/v) was used. The culture in exponential growth phase, grown in a medium with technical glycerol, fried oil at a concentration of 0.5% v/v and a mixture of technical glycerol (0.25%, v/v) and fried oil (0.25%., v/v) were used as inoculum. Concentration of inoculum was 10%, v/v. Cultivation of the strain IMV B-7405 was carried out in flasks (750 ml) with 100 mL of medium in the shaker (320 rpm) at 30 ºC for 120 hours. The surfactants concentration was determined by gravimetrically after extraction from the supernatant of the culture liquid with a modified mixture of Folch (chloroform – methanol =2:1, pH 4.0‒4.5 with addition of 1N HCl).

Results and Discussion. At the first stage of experiments we investigated the optimal method of preparation of inoculum. It was established that the highest concentration of surfactants (3.3 g/L) which were synthesized by the strain IMV B-7405, in a medium with mixture of fried sunflower oil (2%, v/v) and technical glycerol (2%, v/v), were observed when the technical glycerol and a mixture of technical glycerol and fried oil was used for inoculum preparation. In subsequent studies, the inoculum was grown on technical glycerol. It is known [2] that the efficiency of technologies of microbial product synthesis on mixed substrates depends both on the molar ratio of monosubstrates in the mixture and on their concentration. Therefore, at the next stage, the effect of various concentrations of technical glycerol and fried sunflower oil in the mixture on the synthesis of surfactant by the strain IMV B-7405 was investigated. Experiments have shown that increasing the concentration of monosubstrates in a mixture from 1% to 2.5% was accompanied by an increase of the concentration of surfactants from 2.4 to 3.6 g/L In the case of further increase in the concentrations of fried sunflower oil and technical glycerol, the biosurfactant synthesis rates decreased. In our opinion, this may be due to the low content of the nitrogen source in the media. On the third stage, we investigated the amount of surfactants synthesized by the IMV-B-7405 strain in the medium with different ratios of the concentrations of fried oil and technical glycerol in the culture medium. Experiments have shown that maximum concentration of surfactant (5.0 g/L) was observed when the strain IMV

B-7405 was grown on a mixture of 3.25% technical glycerol and 0.,75% of fried oil (volume ratio 1:0.2), and was higher than in case when the monosubstrates was used in equimolar carbon concentration (2.4–4 g/l).

Conclusions. Thus, as a result of this work, the possibility of the use of mixture of toxic industrial waste for synthesis of surfactant by *N. vaccinii* IMV B-7405 has been shown. The highest concentration of surfactant was observed when the inoculum was grown on technical glycerol. It has been established that using mixture of fried sunflower oil and technical glycerol as a substrate for biosynthesis of the surfactants by *N. vaccinii* IMV B-7405 will allow not only to utilize toxic industrial waste, but also increase the concentration of the biosurfactant to 18-52% compared to the monosubstrates.

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AUTOMATED FEEDING SYSTEM FOR AQUATIC ANIMALS IN THE CLOSED ENVIRONMENT

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Just like all other animals, fish require food in order to grow and propagate. It provides energy to maintain metabolic processes and, besides that, contains everything necessary for the growth and development of tissues. Fish differ from other vertebrates in relative amount of nutrients they need.

Keywords: automated feeder, stepping engine, microcomputer, microcomputer, automated system, feed.

In the wild fish consume different feed, thereby, considering the diversity of it, in the closed environment such as aquarium it must get constant supply. It's highly important to provide all inhabitants with sufficient amount of food. There are three main types: processed, fresh and frozen feeds. It is not always possible to feed them with proper amount of food at proper time. For that reason there are feeding systems (feeders). To exclude the human factor while feeding the fish, there are special automated systems.

Automated system based on the Arduino microcontroller was developed during this work. Arduino is a small processor board with memory. The board contains contacts for connecting needed components. The most popular microcontroller is Arduino Nano, which has 14 digital inputs/outputs (6 of them can be used as PWM outputs), 6 analog inputs, quartz resonator (16 MHz), Mini-USB connector, power connector, connector for in-circuit programming (ICSP) and a reset button.

Automated feeder moves above the aquarium by stepping rail, attached to glass vessel walls. The feeder includes stepping engine, moving it; rails, on which the system is located, two part feed compartment (upper and lower). When the feeding time comes, the food falls from the upper compartment to the lower, where all necessary gets to the aquarium. The feeder distributes the food evenly over the entire length.

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