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«DEVELOPMENT OF AN ELECTROCHEMICAL SENSOR PLATFORM FOR THE DETECTION OF BACTERIA USING MACHINE LEARNING METHODS»

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Ensuring the quality and safety of food is one of the top priorities of any manufacturer. The Koch cup method is used in the food industry to determine the number of lactic acid bacteria and pathogenic bacteria in products. Despite its widespread use, this method has several significant disadvantages. In particular, the Koch cup method requires a significant amount of time (2-3 days) and allows to determine the content of bacteria in a sample with an accuracy of one order of magnitude (10 or 100 CFU / ml), requires the maintenance of specialized (sterile) conditions, the availability of complicated and expensive equipment, as well as highly qualified specialists.

Thus, an actual task is the development of new express, sensitive, accurate, inexpensive, and easy-to-use methods, sensors, and devices for the determination of microorganisms in food systems. We suggest a novel electrochemical platform that is able to identify the number of bacteria by machine learning algorithms. Using such a platform, it is possible to obtain different I-V curves that are correlated with concentrations. When a potential difference is applied, a current flows through the system, as a result of which gallium is oxidized, and its cations begin to diffuse into the hydrogel. In the hydrogel, gallium cations interact with bacteria, their metabolites, and phosphate anions. As a result, we obtain I-V curves with different forms.

Such characteristics were used to create a database where currents are attributes and concentration is class. Machine learning models use attributes and find statistical weights for them to predict classes. In this research, I used several models, and the highest efficiency was demonstrated by the multilayer perceptron model - 94% correctly classified instances. Dividing the data into a training set (90%) and a test set (10%) allows you to check the accuracy of the model. This separation allows you to keep a sufficiently large number of values for training the model and does not greatly reduce the test suite. Multilayer Perceptron model was trained with the following parameters: learning rate - 0.1; impulse, - 0.1; the number of hidden layers, - 2; the number of nodes in the hidden layer, - 12. In four out of five cases, the Multilayer Perceptron model was most likely to give correct bacteria concentration results. You can reduce this inaccuracy, increase the database, and adjust the tuning of the selected machine learning model. In addition, further adding statistically significant values to the database will reduce statistical error.

This electrochemical system does a good job of detecting different concentrations of bacteria in gels by collecting large I-V data.

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