ABSTRACT AND REFERENCES

TECHNOLOGY AND EQUIPMENT OF FOOD PRODUCTION

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CONSTRUCTION OF A METHOD FOR PREDICTING THE NUMBER OF ENTEROBACTERIA IN MILK USING ARTIFICAL NEURAL NETWORKS (p. 6-13)

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It is now established that artificial neural networks (ANNs) provide better simulation and prediction of the number of microorganisms in raw materials and foodstuffs. In this case, ANNs could be used as informative, fast, and cost-effective means. According to the European requirements to food products, basic microbiological indicators are the total number of microorganisms and bacteria from the Enterobacteriaceae family, since they are most commonly associated with food-borne diseases and poisonings. The aim of this work was to devise a method for predicting the number of bacteria from the Enterobacteriaceae family in raw milk at its chilled storage and to estimate the predictive capability of ANN. Construction of the method included 4 stages. At the first stage, we examined the number of enterobacteria depending on the physical-chemical composition of raw milk, temperature and duration of storage in a refrigerator. At the second stage, we compiled a base of experimental data obtained from research models. At the next stage, we introduced the received database to ANN. And at the last stage we assessed effectiveness of the predicting technique. The constructed ANN consists of three layers: an input layer (5 ыparameters: milk storage temperature (4 6, 8, and 10 °C), duration of milk storage (from 1 to 48 hours); the acidity of milk (17–20 %), the fat content (3.2; 3.6; 4.0; 4.5 %) and protein content (2.9; 3.0; 3.3 %) in milk; hidden layers (with 30 neurons) and the output layer (the projected number of bacteria). In order to train and optimize the ANN, we used 1,200 experimental data, which revealed that the prediction had the highest rate of deviation of 2.497 % (or 370 bacterial cells per 1 ml). Thus, the devised predicting method could be used to predict the number of bacteria taking into consideration the complex of environmental variables in different food products. In addition, a given approach could be employed as artificial intelligence when assessing microbiological risks and for quick monitoring of food safety.

Keywords: Enterobacteriaceae, raw milk, artificial neural networks, predicting the number of bacteria.

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MODELING THE PROCESS OF MICROBIAL BIOFILM FORMATION ON STAINLESS STEEL WITH A DIFFERENT SURFACE ROUGHNESS (p. 14-21)

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This paper reports a study into the process of bacteria adhesion to surfaces of different roughness depending on sizes and shapes. It was determined that at the surface of stainless steel with a roughness of 2.687±0.014 μm, the film formation process in *E. coli* and *S. aureus* occurred equally over 3 to 24 hours and did not depend on the size of bacteria. This makes it possible to argue that rod-shaped and coccal bacteria freely attach themselves in the grooves of roughness, followed by the initial process related to the first stage of a biofilm formation. During sanitization, the hollows of roughness could host both the coccal and rod-shaped bacteria. At the surface of steel with a roughness of 0.95±0.092 μm the process of film formation in *S. aureus* occurred more intensely than in *E. coli*. Within 3 h of incubation, density of the formed biofilms *S. aureus* was 1.2 times larger compared to the biofilms *E. coli*. Over the following 15 hours of incubation, the biofilms *S. aureus* were on average 1.3 times denser. This suggests that *S. aureus*, due to a spherical form, can stay put in the hollows of roughness of 0.95±0.092 μm and quicker attach to the surface. At the same time, E. coli, owing to a rod-shaped shape, would attach at such a surface roughness to the hollows lengthwise only. It has been proven that at a surface roughness of 0.63±0.087 μm the intensity of the *S. aureus* film formation was on average 1.4 times faster than in *E. coli*. However, at a roughness of 0.16±0.018 μm the process of film formation occurred equally in *E. coli* and *S. aureus*, but the biofilms demonstrated lower density compared to those that formed at a roughness of 0.63±0.087 μm.

Thus, the use of equipment with a roughness of less than 0.5 μm in the dairy industry will make it possible to reduce the attachment of microorganisms to surface and to decrease contamination of dairy products.

Keywords: microbial adhesion, formation of biofilms, roughness of stainless-steel surface, a film formation process.

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STUDYING THE LOSS OF MASS BY CAULIFLOWER DEPENDING ON AGROBIOLOGICAL FACTORS, VARIETAL FEATURES, AND PACKAGE TECHNIQUE (p. 22-31)

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The aim of this study was to scientifically substantiate influence of weather conditions during vegetation season of cauliflower, the content of some components of the chemical composition, physical properties, as well as packaging techniques, on the intensity of loss of cauliflower heads during storage. We established that the following types of loss occur during storage of cauliflower: weight loss due to a decrease in dry matter, weight loss due to partial evaporation of water, development of microorganisms and physiological disorders.

Weather conditions over the years of study were very variable. The sum of average daily temperatures ranged from 1,743.4 to 2,544.3 °C over the years of study, it exceeded the upper limit of the optimal amount by 58.9–380.3 °C. HTC (hydrothermal coefficient) was 0.58–1.10. Humidity was sufficient during the vegetation period. Conditions of the vegetation period affected weight loss of late-ripening cauliflower heads during storage in the following way: the greatest loss was 12.8–16.9 % in control in 2015, it was less in 2016 – 11.7–13.8 %, depending on a hybrid. The difference between hybrids over the years of study was significant. The natural decreases in weight loss of cauliflower heads during unpacked storage were for Casper F_1 hybrid – 13.7 %, for Santamaria F_1 – 12.7 %, for Skywalker F_1 – 15.5 % in 2015–2017.

The intensity of moisture reduction when cauliflower was stored at a temperature of 1±0.5 °C ranged from 0.27 to 9.3 %, depending on the packaging technique. The intensity of moisture evaporation in all hybrids was the same and it was 0.3 % per day under packaging by stretch film. Perforated stretch film increased the moisture evaporation slightly, from 0.37 % in Casper F_1 hybrid to 0.43 in Skywalker F_1 hybrid. The ratio of moisture loss to the loss of dry matter ranged from 11.2 in heads of Santamaria F_1 to 13.2 in heads of Casper F_1 during storage without packaging. And it was 0.23–0.23 when stored under SF, and 0.35–0.43 during storage under PSF.

We found out the correlation between cauliflower weight loss during storage on HTC, average daily temperature, and relative humidity of air in the vegetation period and on dry matter content, volume, and porosity of a head. The regression equations made it possible to forecast cauliflower weight loss during storage, depending on weather conditions of the vegetation period and on the dry matter content and physical indicators of heads.

Keywords: cauliflower, weight loss, weather conditions, water evaporation, types of packaging.

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SEPARATION OF TERPENES FROM LEMON ESSENTIAL OIL BY SELECTIVE FRACTIONATION UNDER A VACUUM (p. 32-36)

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The paper reports basic modern methods for isolating terpenes, outlines the advantages and reasons for this particular technological processing of essential oils, specifically lemon oil. The qualitative composition and quantitative ratios of components in lemon essential oil were determined by gas chromatography on a packed column (the stationary phase-dinonylphthalate). Based on the chromatographic profile, it was found that the key component of the oil is monoterpene d-limonene (70.60±4.61 %), which masks a harmonious manifestation of lemon flavor.

The paper reports results from theoretical calculations of selective fractionation under a vacuum that have been tested at a laboratory installation for the fractional distillation of essential oils, which simulates a full cycle of fractionation. The basic nodes of the installation were aligned with the schemes of universal plants that are common in industry.

The optimal modes for the selection of terpenes and terpenoid factions are given, namely the value for the limit and working reflux number, pressure, and boiling temperature ranges.

The fraction of terpene, selected at a cube temperature from 67 °C to 70 °C, under a pressure of 2.64 kPa at a reflux ratio of 1:3, makes up 30.0 % by weight. The fraction of terpenoids, selected at a cube temperature from 84 °C to 96 °C, under a residual pressure from 0.33 to 0.66 kPa and at a reflux ratio of 1:14, makes up 60.0 % by weight.

Following the organoleptic study, it was established that the terpene fraction has a lemon flavor, due to the high content (80.0 %) of limonene, with notes of bergamot (β-myrcene – 5.12 %). Among other terpenoids, citral adds a muscat tone to the aroma, which, together with geraniol and linalool, acquires a noble aroma of citrus with a fine floral note.

All fractions of essential oils should be used in the food and cosmetic technology because the fraction of terpenes could be a valuable component in the creation of original composite fragrances.

Keywords: lemon essential oil, fractionation, deterpenation, gas chromatography, packed column, limonene.

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ELECTROPHORETIC SYSTEM FOR EXPRESS ANALYSIS OF WHEY PROTEIN FRACTIONS (p. 37-44)

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Fractional specificity of biological action and ability to form bioactive peptides, which have a positive effect on different physiologi-

cal systems of the body in the processes of proteolysis and digestion, are characteristic for whey proteins. Prospects for the production and application of whey protein fractions are related to the necessity of their composition control.

The comparative analysis of the electrophoretic systems previously used for the milk protein analysis was carried out for the creation of an express analysis method of whey protein fractions. These are the anode disc electrophoresis system in the presence of sodium dodecyl sulfate, the Davis disc electrophoresis system for acidic proteins in native conditions, the system in a homogeneous polyacrylamide gel with urea. The Davis disc electrophoresis system for acidic proteins was chosen as the basis. For the adaptation of this system to the requirements of express analysis, the stacking polyacrylamide gel was removed from its composition and the concentration of the separating gel was reduced. The difference in the composition of electrode buffer and gel buffer ions was used to provide the high separation efficiency of protein fractions. This allows saving the effect of protein concentration in the whey sample on the first stages of electrophoresis. The position of the basic whey protein fractions on electrophoregrams was established with the help of homogeneous marker proteins (β-lactoglobulin and whey albumin).

An accessible electrophoresis system in the slabs of a homogeneous polyacrylamide gel for serial express analysis of the fractional composition of whey proteins has been proposed as a result of researches. The system allows reliable identification of four protein fractions (α-LA, β-LG, BSA and IG). Close average values and standard deviations of the content of these fractions in 15 whey samples of one milk batch, obtained by the densitometry of three electrophoregrams: β-LG (37.3±4.2, 36.5±2.8; 38.3±2.7), α-LA (15.8±1.5, 15.8±1.3, 16.4±1.1), BSA (8.2±1.1, 8.0±1.0, 9.4±1.1), IG (17.6±1.9, 17.4±1.5, 16.8±1.5) testify about good reproducibility of the method. The proposed method may be useful for the express identification of the basic whey protein fractions, which are precursors of biologically active peptides.

Keywords: milk whey protein fractions, polyacrylamide gel electrophoresis, express analysis, densitometry.

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FORMING THE STRUCTURE OF WHIPPED DESSERTS WHEN INTRODUCING THE FOOD ADDITIVE "MAGNETOFOOD" TO THEIR FORMULATION (p. 45-55)

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The food additive "Magnetofood", in the form of a nanopowder with particles the size of (70–80) nm, has been designed and proposed as an improver for the structure of whipped desserts. "Magnetofood" can both independently form the structural and mechanical properties of whipped masses and influence a gel-forming agent, participating in chemical and electrostatic interactions with it. Therefore, the food additive "Magnetofood" can simultaneously influence several technological properties in the food disperse system: it can become a stabilizer, thickener, foam- and jelly-forming agents. Owing to Fe (II), nano dimensions, and the developed active surface, "Magnetofood" acquires sorption, complexing, emulsifying, moisture retaining, fat retaining, water-binding, stabilizing, structure-forming properties. That allows us to recommend "Magnetofood" as an additive with a comprehensive effect in order to form the structure of whipped desserts and to improve the quality of whipped dessert products. It has been established that introducing the additive "Magnetofood" to the samples of berry-fruit mousses and fruit-and-egg white jellies in the amount of 0.10 %, 0.15 %, 0.20 % by weight of the formulation mixture improves the structural-mechanical properties of whipped desserts. Using the additive "Magnetofood" decreases density by (29±1) kg/m^3 – for mousses, by (26±1) kg/m^3 – for fruit-and-egg white jellies, as well as the duration of whipping by ~15 % compared to control. It has been proven that introducing the additive "Magnetofood" contributes to an increase in: plastic strength – by 1.23 times; porosity – by (14.3±0,7) % for mousses and by (12.7±0.6) % – for fruit-and-egg white jellies; foam stability by (22.5±1.1) % compared to control. In addition, a foam-forming capacity increases by (40±2) % for mousses and by (55 3) % for fruit-and-egg white jellies; effective viscosity – by (4.4 0.2) % for mousses and by (4.1±0.2) % – for fruit-and-egg white jellies compared to control. We have established that the rational content of the food additive "Magnetofood" equals 0.15 % of formulation composition.

The obtained experimental data could be applied when developing technologies for whipped dessert products.

Keywords: food additive "Magnetofood", whipped desserts, stabilizing and structure-forming properties.

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ESTIMATION OF TECHNOLOGICAL PROPERTIES OF NUT MEALS AND THEIR EFFECT ON THE QUALITY OF EMULSION FOR BUTTER BISCUITS WITH LIQUID OILS (p. 56-64)

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We have examined the technological properties of cedar nut meal (CNM) and walnut nut meal (WNM). It was established that nut meals are the highly dispersed powders whose degree of dispersion exceeds that of wheat flour. The size of 69 % of CNM is up to 40 μm, 72 % of WNM, and only 35 % of flour.

Compared with wheat flour, nut meals exposed to temperatures of 20...60 °C are characterized by better water-retaining capacity. When exposed to temperatures of 90 °C, meals and flour have close values for water-retaining capacity. It was noted that nut meals are better at emulsifying liquid fats than solid that are traditionally used in the technology of butter biscuits (margarine and butter). It is shown that meals are characterized by high fat-retention capacity (FRC) relative to liquid vegetable oil. It is noted that the value of FRC for nut meals in the temperature range 20...60 °C increases by 1.9 times; in the range 60...80 °C, FRC of the examined samples almost does not change; and when exposed to temperatures of 100...140 °C, it starts to decrease.

We have studied the quality of emulsions for butter biscuits for the case when 30 % of margarine are replaced with liquid vegetable oil while adding various amounts of nut meals. It was established that stability of the emulsion in which 30 % of margarine were replaced with liquid vegetable oil is 37.5 % less compared to control based on margarine. The introduction of CNM and WNM improves

the stability of such an emulsion. It was noted that the samples of emulsion with the addition of 40 % and 50 % of CNM and WNM in terms of the value for an indicator of stability are maximally close to the control whose fat base was margarine. This is confirmed by the results from studying the dispersion, the effective viscosity of emulsions, and by results from microscopy.

The obtained results are of practical significance in order to improve the technology of butter biscuits towards a partial substitution of margarine with liquid oils. That would improve the nutritional and biological value of butter biscuits.

Keywords: meal, walnut, cedar nut, water-retaining capacity, fat-retention capacity, fat-emulsifying capacity, emulsion, butter biscuits.

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STUDYING THE EFFECT OF THE INTEGRATED BREAD BAKING IMPROVER «MINERAL FRESHNESS SUPER» ON CONSUMER PROPERTIES OF WHEAT BREAD (p. 65-72)

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Scientists from the National University of Food Technologies (Ukraine) developed the integrated bread baking improver "Mineral Freshness Super" whose formulation includes nutritional supplements with the GRAS status. The integrated bread baking improver is composed of a functional base, white pharmacopoeial clay, and an active part – the enzymatic preparations Alphamalt VC 5000 and Novamil 1500MG, maltodextrin, sunflower-derived fat-free lecithin, apple pectin, dry wheat gluten and ascorbic acid. Technological efficiency has been proven to use the integrated bread baking improver "Mineral Freshness Super" in the amount of 1.5 % by weight of flour in order to slow the staling of wheat bread, baked according to the accelerated technology.

We have determined regularities in the influence of the integrated bread baking improver "Mineral Freshness Super" on quality of wheat bread. It was established that introducing it to dough results in an increase in the relative volume of products, improves shape formation, porosity, and reduces the duration of fermentation by three times, specifically to 20 min.

It has been proven that products with the addition of the integrated bread baking improver "Mineral Freshness Super" retain freshness better, which is confirmed by the increase in the overall deformation of crumb, by a smaller layer under the crust, and by fewer layers of air in the products' crumb. We have observed more accumulation of dextrins and bisulfite binding substances in products when using integrated bread baking improver "Mineral Freshness Super", indicating the inhibition of staling and improvement in consumer properties.

Results of our study prove the expediency of using the integrated bread baking improver "Mineral Freshness Super" in the technology of wheat bread to prolong its freshness up to 72 h when storing unpacked.

Keywords: integrated bread baking improver, wheat bread, staling, under-the-crust layer, bound moisture.

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