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SUBSTANTIATION OF STORAGE PARAMETERS OF THE SOUR-MILK INFANT DRINK «BIOLAKT»

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Abstract. Changes in the quality indicators of sour-milk infant drink «Biolakt» characterized by high probiotic and immunomodulatory properties and low allergic effect that were made according to the improved technology and stored in sealed-off containers at temperature (4±2) °C during 28 days have been studied: organoleptic properties of taste and odour, consistency and appearance; physical and chemical properties – titrated acidity, °T; active acidity, pH units; moisture retention property, %; microbiological properties – number of living cells of mixed cultures *B. bifidum 1 + B. longum Ya3 + B. infantis 512*, CFU/cm³; the most probable number of living cells of monocultures *L. acidophilus La-5*, CFU/cm³; presence of coli form bacteria in 0.3 cm³; presence of *Salmonella* in 50 cm³; biochemical properties – antioxidant activity, activity units; and maximum possible content of malondialdehyde at complete oxidation of the product ingredients, mg/100 g. It is proved that under indicated conditions in the course of 24 days the studied samples of target products possess high organoleptic and standardized for sour-milk infant drinks physical, chemical, biochemical and microbiological indicators and are, also, characterized by high content of probiotics: (0.43 – 8.60)·10⁹ and (0.25 – 1.10)·10⁹ CFU/cm³ of living cells of bifidus bacteria and lactobacilli, accordingly.

It has been established that the limit storage period of sour-milk infant drink «Biolakt» produced according to the improved technology and stored at temperature (4±2) °C should not exceed 12 days with due account of the safety margin for sour-milk infant drinks (provided they are kept in sealed-off containers). It has been proved that the target product formulas should include lactulose, polyunsaturated fatty acids omega-3 FT EU of «Fortitech» company (Denmark), vitamin complex FT 041081EU of «Fortitech» company (Denmark) and/or complex of mineral substances FT 042836EU of «Fortitech» company (Denmark).

Keywords: infant food, sour-milk drink «Biolakt», storage, organoleptic characteristics, acidity, biochemical indicators, lactulose, probiotic properties.

ОБҐРУНТУВАННЯ ПАРАМЕТРІВ ЗБЕРІГАННЯ НАПОЮ КИСЛОМОЛОЧНОГО ДИТЯЧОГО ХАРЧУВАННЯ «БІОЛАКТ»

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Анотація. Досліджено зміну показників якості напоїв кисломолочних дитячого харчування «Біолакт» з підвищеними пробіотичними й імуномодулюючими властивостями та зниженим алергенним ефектом, вироблених за удосконаленою технологією, при зберіганні у герметичній тарі за температури (4±2) °C протягом 28 діб: органолептичних – смаку та запаху, кольору, консистенції та зовнішнього вигляду; фізико-хімічних – титрованої кислотності, °T; активної кислотності, од. рН; вологоутримуючої здатності, %; мікробіологічних – кількості життєздатних клітин змішаних культур *B. bifidum 1 + B. longum Я3 + B. infantis 512*, КУО/см³; найбільш вірогідне число життєздатних клітин монокультур *L. acidophilus La-5*, КУО/см³; наявності бактерій групи кишкових паличок у 0,3 см³; наявності *Salmonella* у 50 см³; біохімічних – антиоксидантної активності, од. акт.; максимально можливого вмісту малонового діальдегіду при повному окисненні інгредієнтів продукту, мг/100 г. Показано, що при зазначених умовах протягом 24 діб досліджені зразки цільових продуктів мають високі органолептичні, нормовані для кисломолочних напоїв дитячого харчування фізико-хімічні, біохімічні та мікробіологічні показники, а також характеризуються високим вмістом пробіотиків: (0,43 – 8,60)·10⁹ та (0,25 – 1,10)·10⁹ КУО/см³ життєздатних клітин біфідобактерій та лактобацил, відповідно.

Встановлено, що граничний термін зберігання напоїв кисломолочних дитячого харчування «Біолакт», вироблених за удосконаленою технологією, за температури (4±2) °C не повинен перевищувати 12 діб із врахуванням коефіцієнту запасу для кисломолочних продуктів дитячого харчування (за умови зберігання у герметичній тарі). Доведено, що рецептури цільових продуктів повинні включати лактулозу, поліненасичені жирні кислоти omega-3 FT EU фірми «Fortitech»

(Данія), комплекс вітамінів FT 041081EU фірми «Fortitech» (Данія) та/або комплекс мінеральних речовин FT 042836EU фірми «Fortitech» (Данія).

Ключові слова: дитяче харчування, напій кисломолочний «Біолакт», зберігання, органолептичні характеристики, кислотність, біохімічні показники, лактулоза, пробіотичні властивості.



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Introduction. Formulation of the problem

The infant food market is one of the most sensible subjects for an Ukrainian producer and consumer, and is referred more to the social problems of our society than to the commercial domain. The infant health preservation, i.e., preservation of the nation's genetic pool, necessitates to develop appropriate measures of a complex nature that should include both general measures aimed at achieving higher life standards and quality of the families with children and the special measures connected with assurance of steady development of domestic production of high-quality infant products [1,2]. To this end, the Ministry of Agrarian Policy of Ukraine initiated development of the national target program for the development of childhood nutrition in Ukraine for 2012 – 2016 which provides for an increase of domestic production and extension of the infant product range [3]. Accomplishment of this program facilitated extension of the product range and build-up of production capacities for infants and children. During 2011 – 2014 production of sour-milk cheese and infant food based on sour-milk cheese increased 3.2 times, the processed liquid milk for infants increased by 35.8 % and juices for infants – by 98.8 % [4]. Production growth of infant milk products in Ukraine was still facilitated after two specialized infant milk enterprises were commissioned in Ukraine in 2012: the specialized infant food plant (SIFP) «Yagotynske for Infants» of «Milk Alliance» company and SIFP «Agusha» of «Wimm Bill Dann Ukraine» [1,2,5]. It is evident that nowadays the strategic road of the milk industry development linked with the infant food production is challenging and timely.

Analysis of Literature

Regular consumption of milk and sour-milk products is an indispensable condition for a normal development of an infant [2,6-8]. Nowadays, despite the Ukrainian market of domestic specialized sour-milk infant products has considerably extended the product range and built-up its capacities for the last 5 years almost four-fold, it still suffers a substantial deficit [4,5]. The produced infant food volume does not meet the demands of the country infants and children. This group of products is represented in the Ukrainian market by sour-milk drinks – kefir, infant yoghurt, infant drinks «Agusha», «Yagotynske for Infants», «Biolakt» etc., sour-milk cheese and cheese desserts. However, it should be mentioned that not all sour-milk drinks produced виробляють SIFP «Agusha», SIFP «Yagotynske for Infants» and PJSC «Kombinat Prud-

niprovskiy» meet the developmental requirements of infant's organism after 8 months of age [4]. Accordingly, at the Chair of Milk, Fats and Perfumery and Cosmetic Technology (ONAFТ), fermenting compositions for producing sour-milk infant products, having high probiotic and immunomodulating properties, longer storage period and low allergic effect, that include lactic bacteria (mixed cultures of mesophilic sour-milk lactococci with high probiotic and immunomodulatory properties (*L. lactis ssp. lactis*, *L. lactis ssp. cremoris*, *L. lactis ssp. diacetylactis*) і *Leu. mesenteroides* included in the direct application starters *FD DVS CH-N 11*, *F DVS C-303* or *F DVS C-301* and/or monocultures (MC) *L. acidophilus La-5* in the form of bacteria concentrates *FD DVS La-5* or *F DVS La-5*) and bifidus bacteria (mixed cultures (MixC) of probiotic cultures *B. bifidum 1* + *B. longum Ya3* + *B. infantis 512* that colonize infants' intestines) [2,10-12]. Probiotic bacteria included in the fermenting compositions used for making sour-milk infant products facilitate normalization of intestine microbiocenosis, improve immune status of infants and make it possible to make products with longer storage period that will be competitive on the consumer market of the country [6,8,10,12-17]. Researches have developed technologies for making new sour-milk infant products – the drink and protein sour-milk pastes [18,19] as well as improved technologies for making infant sour-milk cheese and sour-milk infant drink (SMID) «Biolakt» [2, 20].

When developing new and improving the existing infant milk product technologies there is an important stage – substantiation of the storage parameters that can ensure preservation of the rated physical, chemical, rheologic and microbiological quality indicators, high organoleptic, probiotic and biochemical characteristics of the product [2]. As the SMID «Biolakt» technologies developed by authors of the fermenting compositions that include MC *L. acidophilus La-5* і 3К *B. bifidum 1* + *B. longum Ya3* + *B. infantis 512* and introduction of various formula compositions in the enriched milk base aimed at the target product production, it is required to study the storage process of the product and substantiate its limit storage period [9,10,20].

The **goal** of this study is to substantiate the limit storage period of SMID «Biolakt» produced according to the improved technology and packed in sealed-off containers.

To achieve this goal, the following **tasks** have been set and solved:

– to study changes in organoleptic, physical, chemical, microbiological and biochemical indicators

of SMID «Biolakt» produced according to the improved technology and stored in sealed-off containers;

- to substantiate the limit storage period length of the target product in a sealed-off container with due account of the safety margin;

- to determine the impact of the formula ingredients on the quality indicator changes at storage and give recommendations as to application of prebiotics, polyunsaturated fatty acids (PUFA), vitamins and mineral substances in infant drinks.

Research Materials and Methods

In order to study the storage process, SMID «Biolakt» was produced by tank method in a laboratory. Altogether, eight test samples of SMID «Biolakt» have been prepared plus one control sample of the product: *control sample*: SMID «Biolakt» obtained from cow milk with a mass fraction of fat 3.2 %; *test sample 1-1*: milk-based SMID «Biolakt» containing partially hydrolyzed protein enriched with fructose and PUFA omega-3 FT EU of «Fortitech» (Denmark) with addition of lactulose as part of «Laktusan» syrup containing 40 % mass fraction of lactose (LLC «Felicata Ukraina», Kyiv, Ukraine); *test sample 1-2*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose and PUFA omega-3 FT EU and FT 041081EU vitamin complex of «Fortitech» (Denmark) with addition of lactulose; *test sample 1-3*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose and PUFA omega-3 FT EU and FT 042836EU mineral complex of «Fortitech» (Denmark) with addition of lactulose; *test sample 1-4*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose and PUFA omega-3 FT EU, FT 041081EU vitamin complex and FT 042836EU mineral complex with addition of lactulose; *test sample 2-1*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose and PUFA omega-3 FT EU; *test sample 2-2*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose, PUFA omega-3 FT EU and FT 041081EU vitamin complex; *test sample 2-3*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose, PUFA omega-3 FT EU and FT 042836EU mineral complex; *test sample 2-4*: milk-based SMID «Biolakt» obtained from cow milk containing partially hydrolyzed protein enriched with fructose, PUFA omega-3 FT EU, FT 041081EU vitamin complex and FT 042836EU mineral complex.

For studying the storage process of SMID «Biolakt», four test samples were prepared first: the enriched milk base (EMB) with mass fraction of fat of 3.2 % was made based on skimmed cow milk with partially hydrolysed protein (protein hydrolysis was ac-

complished with the use of beef pepsin at 40 °C during 40 min) enriched with fructose (Trading House «Semargl», Kyiv, Ukraine) being a bifidogenic factor (mass fraction of fructose – 0.1 %). Skimmed milk with hydrolyzed protein was normalized with enriched cream of 45% fat mass fraction (cream was obtained by separating extra grade full cow milk which was added with PUFA omega-3 as FT EU complex in quantity of 0.06 %), that were homogenized at 70 °C and 7.5 MPa pressure (5.0 and 2.5 MPa at the first and second homogenization stage, accordingly). The milk normalized according to the fat mass fraction was mixed and divided into four parts. No addition was made to sample 1; for making sample 2 the prepared milk base was enriched with FT 041081EU vitamin complex in quantity of 10 mg/100 g; for sample 3 – FT 042836EU mineral complex in quantity 10 mg/100 g was added; and for preparing sample 4 – FT 041081EU vitamin complex in quantity 10 mg/100 g and FT 042836EU mineral complex in quantity 10 mg/100 g were added [19].

The so prepared samples 1-4 were mixed, heated to 95 °C and held at the indicated temperature for 10 min in the container wherein, later, the samples were cooled to the fermenting temperature (37±1) °C, started, ripened and cooled. Starter *FD DVS La-5* of «Chr. Hansen» (Denmark) was introduced in the cooled to (37±1) °C samples 1-4 in quantity 1 g per 1,000 kg of the mixture (output concentration of lactobacilli equaled 1·10⁵ CFU/cm³ EMB) and adapted to MC milk *B. bifidum*, MK *B. longum*, MK *B. infantis* in quantities that ensured the output concentration of said MC BB 1·10⁵, 1·10⁵ and 1·10⁶ CFU/cm³, accordingly. The started samples 1-4 have been mixed for 20 min and ripened at said temperature mixed until the isoelectric condition (pH = 4.6) was achieved in the course of 9.5 hours [9,10,21].

The ripened test samples 1-4 were divided into two portions: the first portion of samples was cooled to 20 °C, mixed for 15 min, added with lactulose in quantity of 0.5 % of the product mass, mixed for 15 min and packed in sealed-off containers (150 cm³ twist-off sterile jars); the other samples were cooled to 20 °C, mixed for 15 min and packed in similar sealed-off jars. The samples packed in sealed-off containers were additionally cooled to 4 °C and directed for storage at the indicated temperature for a period of 28 days. The control sample was prepared out of cow milk with fat mass fraction of 3.2 % that was started at (37±1) °C with the use of *FD DVS La-5* starter, packed in a sealed-off container and additionally cooled to 4 °C.

It is expedient to keep the sour-milk infant drinks, including «Biolakt» at (4±2) °C because, if the temperature increases to 8 – 10 °C, the starter composition microorganisms may continue to develop therein [2,7,13-16] which facilitates deterioration of consumptive qualities and medical and biological characteristics of the product. It is inadmissible to apply the temperature lower than 0 °C in SMID-making technol-

ogies as at their freezing the structural characteristics of proteins and fats are changed which leads to deterioration of quality indicators of the drink, in particular, of organoleptic and rheologic indicators [2,7]. Therefore, the aseptically packed samples of SMID «Biolakt» were stored in sealed-off containers at 4 °C for 28 days.

During the 28 days storage the following indicators were determined with the interval of 4 days:

- physical and chemical indicators – storage temperature – according to GOST 25754-85; titrated acidity – was measured by titration method according to GOST 3624-92 (Fig. 1 a, b); active acidity – measured by potentiometer method according to GOST 26781-85 (Fig. 1 b,d); moisture retention (MR) – measured by centrifugal method according to [22] (Fig. 2, a,b);

- biochemical indicators – antioxidative activity – measured by a method based on the catalysis of the electron transfer in the «renewed nikotinamidadeninucleotid – potassium ferrocyanide» system [23] (Fig. 3 a,c); the maximum possible content of malondialdehyde in the product at complete oxidation was measured by colorimetric method according to [24] (Fig. 3 b,d);

- microbiological indicators – number of living cells of MixC bifidus bacteria in 1 cm³ of the product – by inoculating in tubes with high column of the thio-glycollate medium and thermostating at 37 °C under anaerobic conditions during 48 – 72 hours according to DSTU 7355:2013 (Fig. 4 a,c); the most probable number of MC living cells *L. acidophilus La-5* in 1 cm³ of the product – by inoculating in tubes with high column of the sterilized skimmed milk and thermostating during 72 hours according to GOST 10444.11-89 (Fig. 4 b,d) (determined in the control sample were the most probable number of MC living cells *L. acidophilus La-5* only); presence of colibacilli in 0.3 cm³ – by inoculating on Kessler's medium according to DSTU IDF 73A:2003; *Salmonella* was determined by inoculating Ploskirev's medium according to DSTU IDF 93A:2003;

- organoleptic indicators (taste and odour, colour, consistency and appearance) – by organoleptic method according to GOST 13264-88 (Tables 1 and 2).

Substantiation of Storage Parameters of Infant Sour-Milk Drinks «Biolakt»

Characterized by High Probiotic and Immunomodulatory Properties and Low Allergic Impact and Produced According to the Improved Technology

In the course of 28 day storage the test and control samples of SMID «Biolakt» achieve the higher level of titrated acidity and lower level of active acidity which is explained by fermentation of a part of lactose (in test samples 2-1 – 2-4 and the control sample) or a part of lactose and lactulose (in test samples 1-1 – 1-4) contained therein into acetic and lactic acids as the lac-

tobacilli and bifidus bacteria cultures develop, in the process of living, the intercellular β -galactosidase. In the control sample of SMID «Biolakt» the titrated acidity increases and the active acidity decreases much faster than in the test samples (Fig. 1). Thus, during 16 days of storage, the active acidity of the control sample was reduced by 0.22...0.23 pH units, while in the test samples of the first and second groups – by 0.09 – 0.10 and 0.11 – 0.12 pH units, accordingly (Fig. 1 b, d).

During the first 8 and 16 days of storage the titrated acidity of SMID «Biolakt» of the first group that have been enriched with lactulose increases by 2.5 – 3.0 and 7.5 – 9.0 °T, accordingly, and on the 16th day of storage equals 78.5 – 89.0 °T; with SMID «Biolakt» of the second group (without adding lactulose) the acidity increases, during the indicated period, by 2.5 – 4.0 and 9.0 – 11.5 °T, accordingly, and equals, on the 16th day of storage, 81.0 – 92.0 °T; with the control sample the increase comprises 3.5 – 4.5 and 11.0 – 11.5 °T, accordingly, and equals 111.0 – 112.0 °T after 16 days of storage (Fig. 1 a, c). This is due to active development of bifidus bacteria in the test samples of SMID «Biolakt» which takes place due to presence of bifidogenic factors (lactulose, vitamins and mineral substances) while in the control sample of the drink lactobacilli develop actively (Fig. 1 b, d) and accumulate the lactic acid only which facilitates a faster growth of the titrated acidity and reduction of the active acidity. During next 12 days of storage a further increase of the titrated acidity is recorded (by 16.5 – 18.0 and 17.5 – 19.0 °T with the test samples of the first and second groups, accordingly, and by 19.0...20.0 °T with the control sample) which leads to occurrence of the pronounced sour-milk taste and odour with the test samples on the 24th...28th day of storage in the control sample it occurs already on the 12th day of storage, which is inadmissible for infant products [2,7]. The test samples of SMID «Biolakt», that are enriched with lactulose, polyunsaturated fatty acids omega-3, vitamins and/or mineral substances, are characterized by higher values of the titrated acidity and lower level of the active acidity as compared with the content of PUFA that were enriched just with lactulose and PUFA omega-3 complex, which is due to the lower concentration of the living cells of bifidus bacteria and lactobacilli in the latter case (Fig. 4). It takes place due to stimulating action of the microflora development in starter compositions of vitamins and/or mineral substances added to the MixC in the course of storage [12-15]. The above preconditions a pure sour-milk taste and odour of «Biolakt» drinks 1-2 – 1-4 during 16 – 20 days of storage, and less pronounced sour-milk taste and odour (so-called «curdled taste») of «Biolakt» drinks 1-1 during the first 8 – 12 days of storage.

Comparison of values of the titrated and active acidity of SMID «Biolakt» of the first and second groups (Fig. 1, a, c) indicates that introduction of lactulose in the test samples facilitates reduction of the titrated acidity levels in the first group drinks by 2.5 –

4.0 °T as compared with the second group drinks which is due to the higher concentration of the living cells of bifidus bacteria in the first group SMIDs during the entire storage period (Fig. 4 a,c). This is a still another proof that introduction of prebiotics in the fermented

bifidus-containing milk products promotes «preservation» of bifidobacterium flora in the course of storage – it preconditions higher probiotic and antagonistic properties of the symbiotic bifidus-containing milk products as compared with the probiotic products.

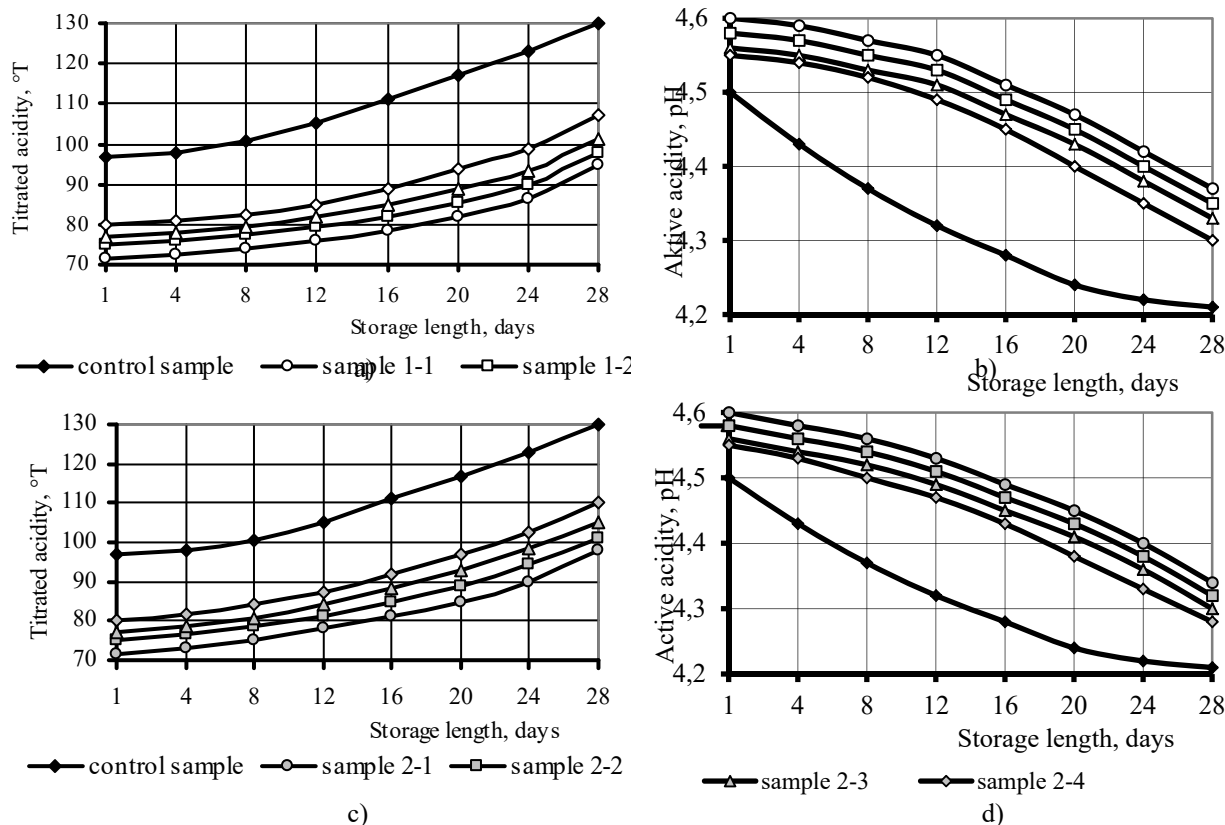


Fig. 1. Dynamics of the titrated (a, c) and active (b, d) acidity in stored infant sour-milk drinks «Biolakt» at 4 °C in sealed-off containers

The moisture retention capacity (MRC) of the test samples 1-1 – 1-3 and 2-1 – 2-3 of SMID «Biolakt» is lower than that one of the control sample: during 28 days of storage the MRC of samples 1-1 – 1-3 is within 75.0 – 88.5 %, of samples 2-1 – 2-3 – 75.0 – 87.0 %, and the MRC of the control sample equals 80 – 94 % (Fig. 2 a,b). The higher MRC values in the control sample are due to the higher content of the living cells of lactobacilli which produce exogenous polysaccharides – the latter, together with the MixC proteins are involved in formation of the spatial network of the product. Test samples 1-4 and 2-4 are characterized by the higher MRC values as compared with the control sample which is due to a minor difference in the number of MC living cells of *L. acidophilus La-5* in these samples and in the control sample (Fig. 4 c,d) and presence (besides lactobacilli) of still higher concentration of bifidus bacteria living cells in the test samples (Fig. 4 a,c).

Comparison of the MRC in samples of the first and second groups indicates a minor difference between these indicators: the MRC of the second group

samples is higher by 1.8 – 2.5 % than the MRC of the first group samples which is due to the higher concentration of MC *L. acidophilus La-5* in these group samples. The high moisture retention capacity of the test samples outstrips the syneresis in the course of storage, therefore ensuring good consistency and appearance of SMID «Biolakt» for a long period. Advantage should stay with the test samples that possess the highest MRC values, i.e., those drinks that have been enriched with lactulose, PUFA, vitamins and/or mineral substances.

Study of the biochemical indicators (Fig. 3) also proves good prospects for production of SMID «Biolakt» enriched with lactulose, PUFA omega-3, vitamin complexes and/or mineral substances because they are characterized by the highest antioxidative activity (AA) – 365 – 433 activity units in the fresh samples (Fig. 3 a,b) and the low content of the maximum possible malondialdehyde concentration (MD content) – 148 – 159 mg/100 g of the product in fresh samples (Fig. 3 c,d).

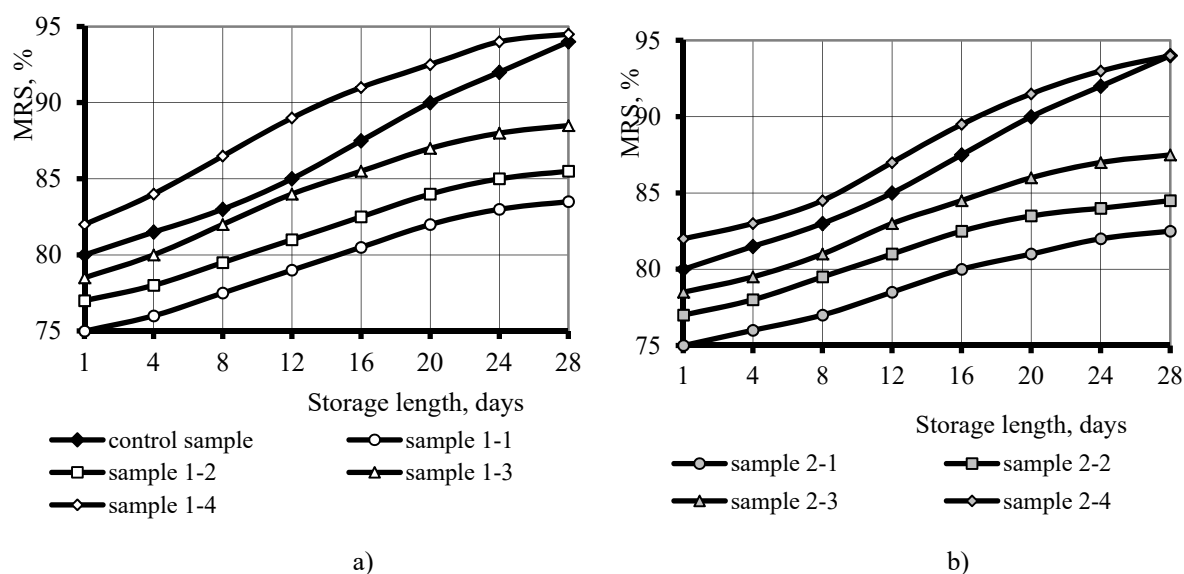


Fig. 2. Variation of the moisture retention capacity (a, b) during storage of sour-milk infant drinks «Biolakt» at 4 °C in sealed-off containers

In storage of samples 1-2 – 1-4 and 2-2 – 2-4 during 12 days AA increases by 7.2 – 8.2 % and, on the 12th day, reaches 405 – 472 and 395 – 464 activity units, accordingly (Fig. 3 a,c), which is also due to the increase of bifidobacterium flora in these samples in the course of 12 days storage period (Fig. 3 a,c). During next 4 days the AA in said samples does not, practically, change, and after 16 days of storage it begins to decrease so that on the 28th days AA comprises 312 – 402 and 301 – 391 activity units, accordingly. Samples 1-1 and 2-1 have the lowest AA among all test samples (102 and 101 activity units in fresh samples and 117 and 110 activity units on the 16th day of storage) as they are not enriched with water soluble antioxidants that are used in this method.

The maximum possible MD concentration in SMID «Biolakt» samples 1-2 – 1-4 and 2-2 – 2-4 during 16 days of storage increases 1.10 – 1.12 times which indicates minor reduction of the resistance to oxidation; in the period from the 16th day of storage and until the 28th days the MD content in these samples increases by 34.5 – 35.2 % (Fig. 3 b,d) which can cause oxidation of the unsaturated and saturated fatty acids in the products [25]. Test samples 1-1 and 2-1 are most susceptible to oxidation as they have the highest MD values (254 and 257 mg/100 g of the product, accordingly) – that is due to presence of high PUFA content and absence of antioxidants in the formula.

The control sample of SMID «Biolakt» has a low-level AA – 90 – 91 activity units; AA increases by 5 – 6 activity units in the course of 8 days of storage and afterwards it begins to decrease so that on the 28th day AA comprises 49 – 51 activity units (Fig. 3 a,c). The control sample of SMID «Biolakt» is more susceptible to oxidation both at once after the end of processing and during the entire storage period as com-

pared with samples 1-2 – 1-4 and 2-2 – 2-4 because under favourable conditions for oxidation a greater quantity of MD is produced in the control sample than in the test samples (Fig. 3 c,d). It also proves the necessity to enrich SMID «Biolakt» with vitamin complexes and/or mineral substances.

Comparison of antioxidative properties and oxidation capacity of SMID «Biolakt» samples of the first and second groups prove that it is expedient to enrich the product with lactulose as it ensures more intensive growth of bifidus bacteria in the drinks at storage and, accordingly, the higher content of vitamins that are synthesized in their life cycle

Hence, as far as it is required to provide for high antioxidant status of SMID «Biolakt», the samples should be stored in sealed-off containers during not more than 16 days at temperature (4±2) °C. During this period the SMID test samples also possess high probiotic properties: concentrations of the bifidus bacteria living cells in the first and second group samples comprises (2.52 – 8.63)·10⁹ and (2.52 – 7.71)·10⁹ CFU/cm³, accordingly (Fig. 4 a,b), and concentrations of *L. acidophilus* La-5 living cells are (2.5 – 9.0)·10⁸ and (4.0 – 10.4)·10⁸ CFU/cm³, accordingly (Fig. 4 c, d). It should be noted that during the first 16 days of storage all test samples of the first group exhibit growth of bifidobacteria flora; on the 20th day their number decreases by 1.5 – 2.2 %; on the 28th day it further decreases by 10.4 – 10.7 % (Fig. 4a). The number of bifidus bacteria living cells in the test samples of the second group is 3.7 – 5.8 % lower than in the first group samples which also proves a necessity to enrich the drinks with lactulose. Growth of bifidobacteria flora in the 2nd group samples is recorded until the 12th day only, afterwards these bacteria begin to die (Fig. 4c) which is due to a fast growth of the MC

L. acidophilus La-5 (Fig. 4d). The highest probiotic properties are with SMIDs 1-2 – 1-4 that have been enriched with lactulose, PUFA, vitamin complex and/or mineral substances. It is explained by the fact that lac-

tulose «supports» survival of the bifidobacteria flora in sour-milk products at low active acidity values, and vitamins and mineral substances also manifest their bifidogenous properties [2,7,12-13].

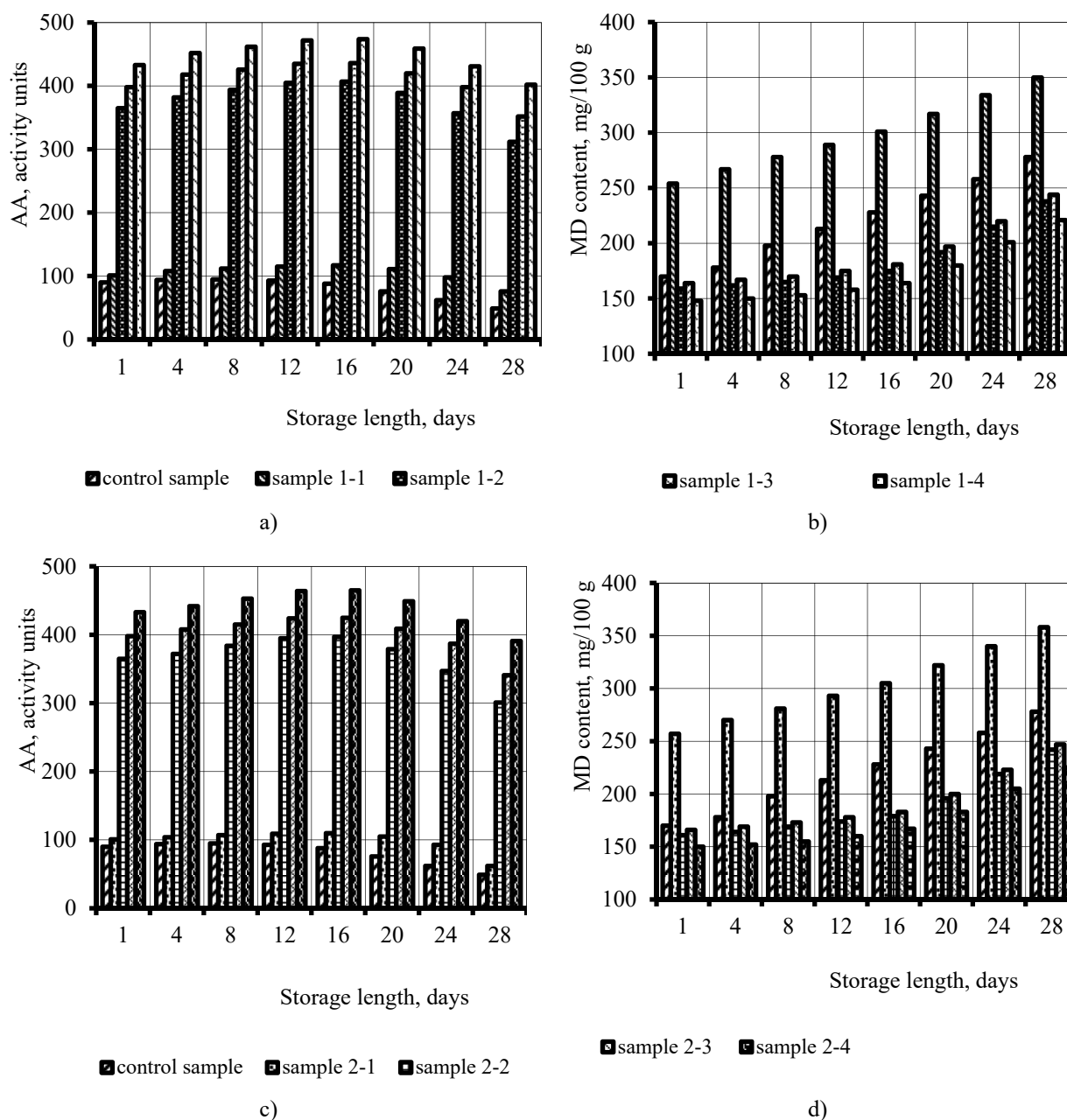


Fig. 3. Dynamics of AA (a, c) and MD content (b, d) in storage of sour-milk infant drinks «Biolakt» at 4 °C in sealed-off containers

The control sample of SMID «Biolakt» contains the highest number of living cells of *L. acidophilus La-5* and, as a result it has pronounced sour-milk taste already on the 9th day of storage (Tables 1,2) while the test samples have pure sour-milk taste and odour throughout all 20 days of storage showing no excessive acidity (for samples 1-1 and 2-1, during 8 and 4 days of storage, accordingly, there is a specific minor «cur-

dled milk» smack which is due to the lowest level of the titrated acidity in them). Samples 2-2 – 2-4 are characteristic of the pronounced sour-milk taste on the 21st day of storage (Table 2), and samples 1-2 – 1-4 – on the 25th day (Table 1). There is no syneresis in SMID «Biolakt» throughout the entire storage period which is due to a high MRC of curdles.

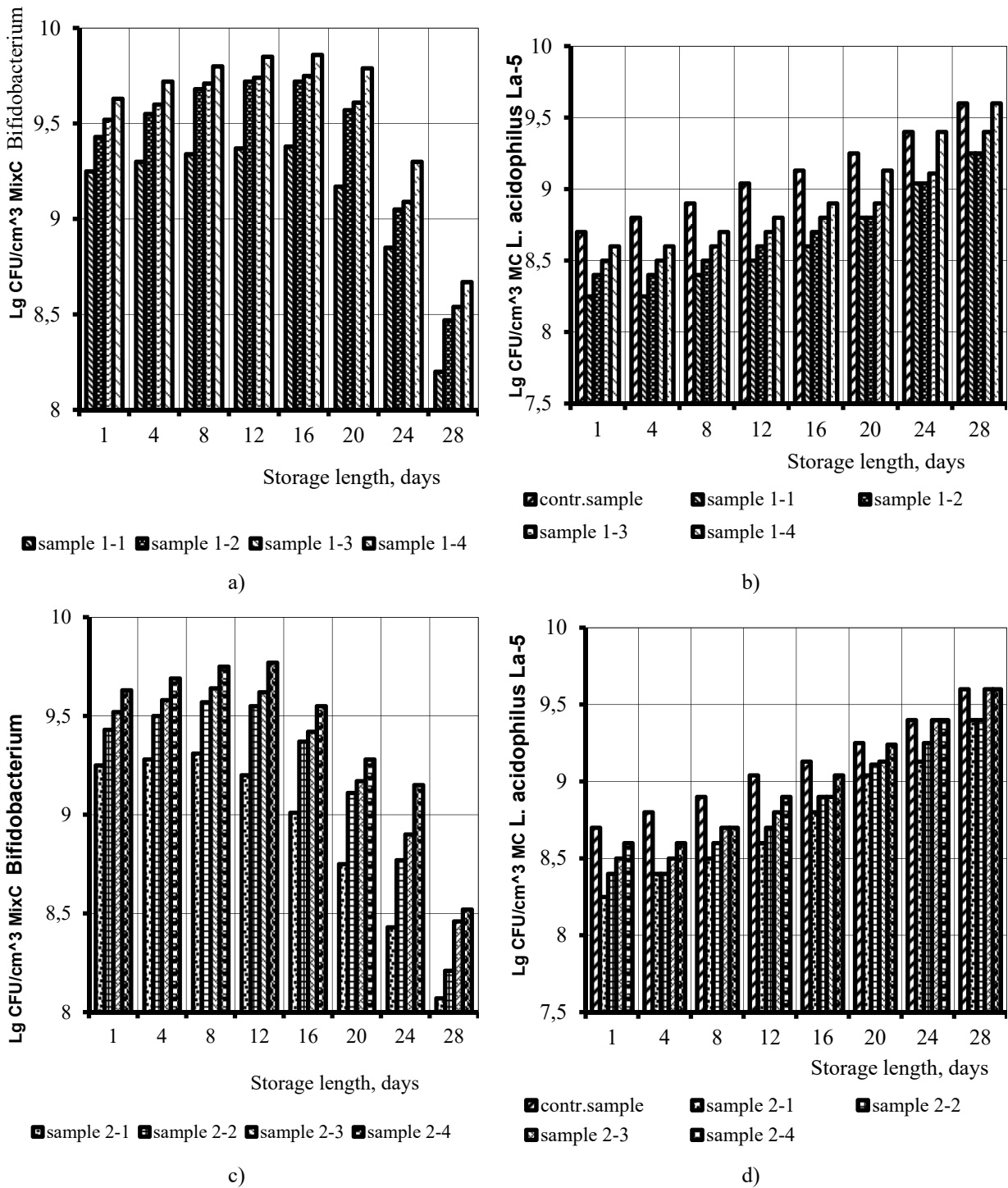


Fig. 4. Dynamics of the number of MixC *Bifidobacterium* living cells (a, c) and MC *L. acidophilus La-5* (c, d) in 1 cm³ of SMID «Biolakt» when stored in sealed-off containers at 4 °C

Analyses for presence of colibacillus bacteria proved that these were absent in 0.3 cm³ of the products during the entire period of research, pathogenic organisms, including *Salmonella*, were absent in 50 cm³ of all drinks which indicates correct selection of the production parameters.

Considering the presented data and taking into

account the requirements [26] which state that the safety margin in case of sour-milk infant products should equal 2, it is expedient to set the limit storage length period for SMID «Biolakt» enriched with lactulose, packed in sealed-off containers and kept at (4±2) °C at 12 days maximum.

Table 1. Dynamics of organoleptic indicators of test samples 1-1 – 1-4 and the control sample of sour-milk infant drinks «Biolakt» in storage (n=5)

Indicator	Length of sample storage, days	Indicator value for				
		control sample	test sample 1-1	test sample 1-2	test sample 1-3	test sample 1-4
Taste and odour	0 – 8	Pure sour-milk taste w/o foreign smack and odour	Pure sour-milk taste with slightly distinguished smack and odour introduced by PUFA, and a slight «curdled milk» smack	Pure sour-milk taste with slightly distinguished smack and odour introduced by additives		
	9 – 16	Sour-milk taste with sour smack and odour	Pure sour-milk taste with slightly distinguished smack and odour introduced by additives			
	17 – 20	Pronounced sour-milk taste				
	21 – 24	Pronounced sour-milk taste with excessive sourish odour	Sour-milk taste with sourish smack and odour and slight smack and odour introduced by additives			
	25 – 28		Sour-milk taste with sourish smack and odour and slight smack and odour introduced by PUFA	Pronounced sour-milk taste with sourish smack and odour and slightly perceptible smack and odour of the introduced additives		
Consistency and appearance	0 – 24	Homogenous and viscous, w/o whey creaming	Homogenous, viscous and sour cream-like, w/o whey creaming			
	25 – 28	Viscous, w/o whey creaming	Viscous and sour cream-like, w/o whey creaming			
Colour	0 – 28	Light crème-coloured and homogenous throughout the drink mass	Light crème-coloured with slight grayish tint which is due to the introduced introduced PUFA complex, homogenous throughout the drink mass			

Table 2. Dynamics of organoleptic indicators of test samples 2-1...2-4 of the sour-milk infant drinks «Biolakt» in the course of storage (n=5)

Indicator	Length of sample storage, days	Indicator value for			
		test sample 2-1	test sample 2-2	test sample 2-3	test sample 2-4
Taste and odour	0 – 4	Pure sour-milk taste with slightly distinguished smack and odour introduced by added complexes, and slight «curdled milk» smack	Pure sour-milk taste with slightly distinguished smack and odour introduced by added complexes		
	5 – 16	Pure sour-milk taste with slightly distinguished smack and odour introduced by added complexes			
	17 – 20	Sour-milk taste with sourish smack and odour and slightly perceptible smack and odour of the introduced additives			
	21 – 28	Sour-milk taste with sourish smack and odour and slightly perceptible smack and odour of the introduced additives	Pronounced sour-milk taste with sourish smack and odour and slightly perceptible smack and odour introduced by the added complexes		
Consistency and appearance	0 – 20	Homogenous, viscous and sour cream-like, w/o whey creaming			
	21 – 28	Viscous and sour cream-like, w/o whey creaming			
Colour	0 – 28	Light crème-coloured with slight grayish tint which is due to the introduced PUFA complex, homogenous throughout the drink mass			

Evaluation of the Study Results

Improved technology of the sour-milk infant drink «Biolakt» was tested in industrial environment at

LLC «Molochna torгова kompaniya» (Ukraine). Samples of the product obtained in plant conditions met the requirements to the sour-milk infant drinks beginning

from 8 months according to their organoleptic, physical, chemical, microbiological, probiotic, sanitary and hygienic indicators. The conducted medical and biological studies proved expediency and good prospects for use of the developed sour-milk infant drinks «Biolakt» as the products that normalize intestine microflora, are characterized by probiotic, hepatoprotective and hypoallergic effects, high assimilability and biological efficiency [27].

Conclusions

1. Changes in the SMID «Biolakt» organoleptic, physical, chemical, microbiological and biochemical quality indicators characterized by high probiotic and immunomodulatory properties and low allergic effect made according to the improved technology and stored in sealed-off containers at temperature (4±2) °C were studied. It was shown that under stated conditions in the course of 24 days the studied target product sam-

ples possess high organoleptic properties standardized for sour-milk infant drinks, physical, chemical biochemical and microbiological properties and are, also, characterized by high content of probiotics: (0.43 – 8.60)·10⁹ and (0.25 – 1.10)·10⁹ CFU/cm³ of living cells of bifidus bacteria and lactobacilli, accordingly.

2. It has been established that the limit storage period of SMID «Biolakt» produced according to the improved technology and stored at temperature (4±2) °C should not exceed 12 days with due account of the safety margin for sour-milk infant drinks (provided they are kept in sealed-off containers).

3. It has been proved that the target product formulas should include lactulose, polyunsaturated fatty acids omega-3 FT EU of «Fortitech» company (Denmark), vitamin complex FT 041081EU of «Fortitech» company (Denmark) and/or complex of mineral substances FT 042836EU of «Fortitech» company (Denmark).

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ОБОСНОВАНИЕ ПАРАМЕТРОВ ХРАНЕНИЯ НАПИТКА КИСЛОМОЛОЧНОГО ДЕТСКОГО ПИТАНИЯ «БИОЛАКТ»

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Аннотация. Исследовано изменение показателей качества напитков кисломолочных детского питания «Биолакт» с повышенными пробиотическими и иммуномодулирующими свойствами и пониженным аллергенным эффектом, произведенных по усовершенствованной технологии, при хранении в герметичной таре при температуре $(4 \pm 2)^\circ\text{C}$ в течение 28 суток: органолептических – вкуса и запаха, цвета, консистенции и внешнего вида; физико-химических – титруемой кислотности, $^\circ\text{T}$, активной кислотности, ед. рН, влагоудерживающей способности, %; микробиологических – количества жизнеспособных клеток смешанных культур *B. bifidum 1* + *B. longum Я3* + *B. infantis 512*, КОЕ/см³; наиболее вероятное число жизнеспособных клеток монокультур *L. acidophilus La-5*, КОЕ/см³; наличие бактерий группы кишечных палочек в 0,3 см³; наличие *Salmonella* в 50 см³; биохимических – антиоксидантной активности, ед. акт.; максимально возможного содержания малонового диальдегида при полном окислении ингредиентов продукта, мг/100 г. Показано, что при указанных условиях в течение 24 суток исследованные образцы целевых продуктов имеют высокие органолептические, нормированные для кисломолочных напитков детского питания физико-химические, биохимические и микробиологические, показатели, а также характеризуются высоким содержанием пробиотиков: $(0,43 \dots 8,60) \cdot 10^9$ и $(0,25 \dots 1,10) \cdot 10^9$ КОЕ/см³ жизнеспособных клеток бифидобактерий и лактобацилл, соответственно.

Установлено, что предельный срок хранения напитков кисломолочных детского питания «Биолакт», произведенных по усовершенствованной технологии, при температуре $(4 \pm 2)^\circ\text{C}$ не должен превышать 12 суток с учетом коэффициента запаса для кисломолочных продуктов детского питания (при условии хранения в герметичной таре). Доказано, что рецептура целевых продуктов должны включать лактулозу, полиненасыщенные жирные кислоты омега-3 FT EU фирмы «Fortitech» (Дания), комплекс витаминов FT 041081EU фирмы «Fortitech» (Дания) и/или комплекс минеральных веществ FT 042836EU фирмы «Fortitech» (Дания).

Ключевые слова: детское питание, напиток кисломолочный «Биолакт», хранение, органолептические характеристики, кислотность, биохимические показатели, лактулоза, пробиотические свойства.

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