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Anuarbekova S.*[1], Dusenova G.[2], Sabyrkhan A.[3], Ermakhanova A.[4], Atabaeva B.[5]

[1-5] Astana branch of the Kazakh Research Institute of Food and Processing Industry, c.Nur-Sultan, Kazakhstan

* Correspodning author (asel_08_11[at]mail.ru)

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BASES FOR THE DEVELOPMENT OF LACTOSE FREE DAIRY PRODUCTS

Research article

Abstract

As a result of the work, a collection of 259 lactic acid bacteria and yeast was created, having a viability index of more than 107 and possessing lactose-sensitizing activity. To determine the amount of lactose in milk, we used the cyanide method. In the cow's milk, which we are researching, lactose contains 3.3%. All cultures have the ability to ferment lactose. The active cultures of the yeast C164, C190, C196, C198, in which the complete utilization of lactose was carried out, gas evolution, organoleptic smell of alcohol and fresh koumiss was observed. When assessing the acid-forming activity, it was found that all cultures gave indicators of more than 40 ºT.

C164, C190, C196, C198 cultures as a result of screening for lactose-utilizing activity and cultures with high rates of acid production of C147, C158, C124, C133, C145, L111, L44, L90, L12 will be considered as will be considered as applicants for ferments for the production of fermented milk food.

Keywords: lactose, lactose insufficiency, disposal of lactose, strain, lactic acid bacteria, yeast crops, leaven.

Ануарбекова С.*[1], Дюсенова Г.[2], Сабырхан А.[3], Ермаханова А.[4], Атабаева Б.[5]

[1-5] Астанинский филиал Казахского научно-исследовательского института пищевой и перерабатывающей промышленности, г. Нур-Султан, Казахстан

* Корреспондирующий автора (asel_08_11[at]mail.ru)

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ОСНОВЫ РАЗРАБОТКИ БЕЗЛАКТОЗНЫХ КИСЛОМОЛОЧНЫХ ПРОДУКТОВ

Научная статья

Аннотация

В результате работы создана коллекция из 259 молочнокислых бактерий и дрожжей, имеющих показатель жизнеспособности более 10^7 и обладающих лактозоутилизирующей активностью. Для определения количества лактозы в молоке нами использован цианидный метод. Все культуры имеют способность сбраживать лактозу. У активных культур дрожжей, у которых прошла полная утилизация лактозы, наблюдалось выделение газа, органолептически запах спирта и свежего кумыса. При оценке кислотообразующей активности установлено, что все культуры дали показатели более 40 ºТ.

Культуры С164, С190, С196, С198 в результате скрининга лактозоутилизирующей активности и культуры с высокими показателями кислотообразования С147, С158, С124, С133, С145, L111, L44, L90, L12 будут рассмотрены как претенденты на закваски для производства кисломолочных продуктов питания.

Ключевые слова: лактоза, лактазная недостаточность, утилизация лактозы, штамм, молочнокислые бактерии, дрожжевые культуры, закваска.

1. Introduction

One of the most valuable foods is milk, which contains proteins, lipids and carbohydrates. The main carbohydrate found in milk is lactose (milk sugar), which is necessary for a person throughout life. Today, many people suffer from its intolerance and can not use products containing milk [1-5]. So, according to the Kazakh Academy of Nutrition, up to 40% of people in Kazakhstan suffer from lactose intolerance [6]. Such food is also relevant for patients with celiac disease due to the fact that, against the background of enterocyte damage, the development of secondary lactase deficiency (LD) is possible, since the enzyme lactase is located in the apical part of enterocytes [7]. Such dairy products are also of great importance for patients with

diabetes mellitus, for whom additional intake of sugar, even milk, is undesirable. In Kazakhstan, more than 320 thousand patients with diabetes mellitus are officially registered [8, 9].

Lactose (milk sugar) - a substance that enters the body mainly with dairy foods. In the small intestine, lactose is broken down by glucose and galactose under the influence of the enzyme [10]. Lactose intolerance (or hypolactasia) is a term for describing pathological conditions caused by a decrease in the level or activity of lactase, the enzyme responsible for the breakdown of lactose in the intestine [11].

Decreased lactase activity can be complete (alactasia) or partial (hypolactasia). By origin, primary lactose intolerance (LD) (decrease in enzyme activity in morphologically unchanged enterocyte) and secondary (decrease in enzyme activity, directly associated with damage to the enterocyte) are isolated. [11-21]. Lactose intolerance also increases with age [22, 23].

Substitutes for regular milk and dairy products are low- or lactose-free cow's milk, soybean and coconut milk, and lactic acid products on soybean milk.

Upon receipt of lactose-free dairy products, various methods of filtration [24-26], fermentation of milk [27, 28], immobilization [29, 30], in total [31, 32], and the use of cultures of microorganisms [33] are used.

It is known that the method of fermentation of lactose by lactic acid bacteria (LAB) can maximize utilize up to 20% of lactose (up to 4% of residual lactose), which, from the point of view of LD, is ineffective [34].

Only a few representatives of the yeast flora have the ability to ferment lactose to form alcohol and carbon dioxide. Representatives of the genera *Lactobacillus, Candida* and *Kluyveromyces*, among them *C. kefir, C. sphaerica, K. marxianus var.*, are most frequently mentioned among the representatives of yeast microflora capable of fermenting lactose. *marxianus and K. marxianus var. lactis*. In the literature there are many other types of yeast, fermenting lactose, however, the vast majority of them are only synonyms mentioned [35].

The leader in the production of lactose free products is Finland. Perhaps this is due to the fact that in Finland every 35th congenital LD is.

Production has been established in the USA, Japan, the Netherlands, Holland, Italy, and the UK [24]. In Russia, there is lactose free milk of Finnish production on the market. Most countries have established the supply and production of these products. There are no such industries in Kazakhstan, which makes it necessary to conduct research on the development of technologies for the production of lactose free products.

2. Material and research methods

The objects of research were:

85 homemade lactic acid products (50) and factory cooking (35), 12 human biotopes. A total of 97. And cultures of microorganisms, isolated from the data of ecological niches, in the amount of 289: 150 LAB cultures and 139 yeast cultures;

Isolation of pure culture is carried out by generally accepted methods [36, 37]. The determination of the lactose content was carried out by the cyanide method [38], based on the ability of reducing sugars to reduce the red blood salt K3 [Fe (CN) 6] to yellow K4 [Fe (CN) 6] in an alkaline solution when heated. The acid-forming activity of the cultures was determined by the Turner method [39].

3 Research results

Among food products that are of particular importance for maintaining human health and its adaptation to adverse environmental conditions, an important role belongs to milk and dairy products.

Currently, one of the promising and sought-after areas of microbiology is the search for new strains of LAB and yeast to create probiotic preparations and starter cultures with probitically specified properties as functional food products.

The LAB and yeast were isolated from lactic acid products of factory (35) and homemade (50), also human biotopes (12 samples). Total 97. Dairy products are presented: koumiss - 8, cottage cheese - 13, kefir - 5, yogurt - 5, sour milk - 16, kvass - 1, butter - 7, kurt - 7, sour cream - 12, colostrum - 1, shubat - 4, cheese - 6 samples. Human biotopes: excretion of children as urine and feces.

Isolation of these bioobjects was carried out by sowing liquid Saburo and MRS in the thickness of the liquid during incubation at 30 and 37 ° C for 3-4 days. Then, the microbial suspension or accumulative culture was subcultured by the Gould method on solid nutrient media during incubation for 30 and 37 ° C for 2 days. A complex of morphological and cultural properties was studied from isolated isolates of microorganisms in order to determine the genus affiliation. Some LABs are characterized by growth on MRS-agar in the form of superficial round colonies with clear edges, white in color, shiny, sizes vary from small to large, the surface and edges are smooth - S-shape. Others formed a colony with jagged edges, pale gray in color, often with a thickened center. With the growth of bacteria in MRS broth (Figure 1), in some cases there is a uniform slight turbidity, in others flakes are formed, the medium remains clear. In all cases, a precipitate of greater or lesser intensity, friable, white in color, finely porous consistency.

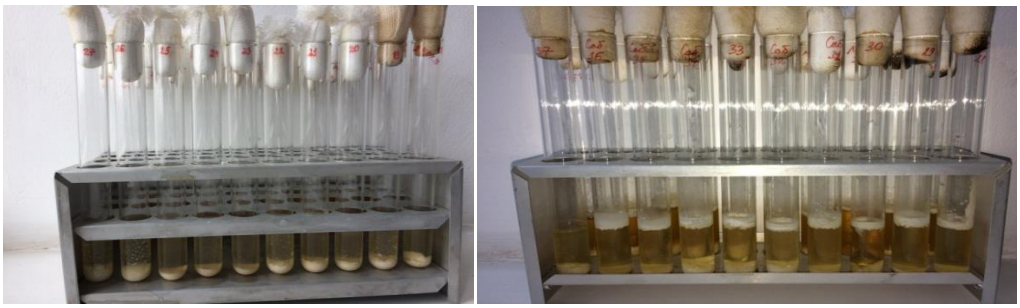
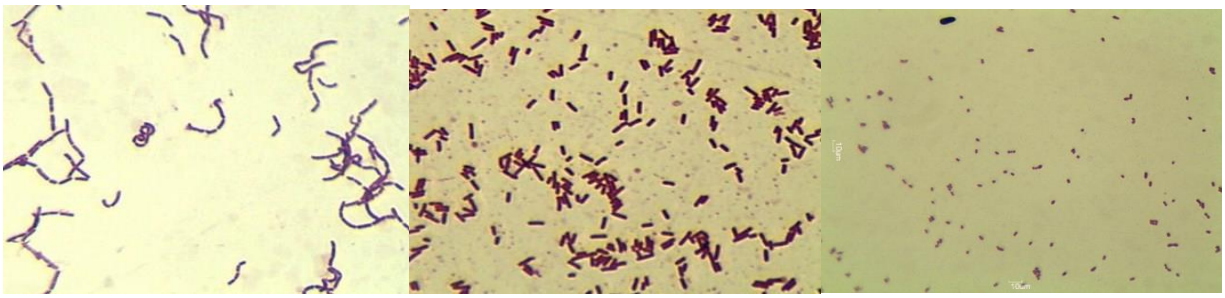


Figure 1 – Growth in MRS-broth and Saburo-broth

Figure 2 presents variants of a microscopic picture of lactobacilli (a, b) on solid nutrient media. The cultures studied are sticks represented by rods, differing in length, thickness, and nature of their location; rods often wrapped in rings are often found. In Figure 2a, the sticks are arranged in short and long chains, rings from bacteria are also observed; in Figure 2b - the sticks are arranged one by one, two by one, in clusters, in bundles. Also, there are long thick sticks arranged singly, in places with short chains. Among the bacteria were coccus (Figure 2 c).



a b c

Figure 2 – Variants of the microscopic picture of bacteria

Yeast micromorphology was studied in young cultures (2-3 day old) on Saburo liquid medium. With growth on Saburo-broth, a thin white film is observed in 90% of cases, which sometimes crawls onto the wall of the tube. In all cases, an abundant white fine precipitate is formed. The medium remains transparent (Figure 3).

The cultural characteristics of the yeast are presented in Figure 3.

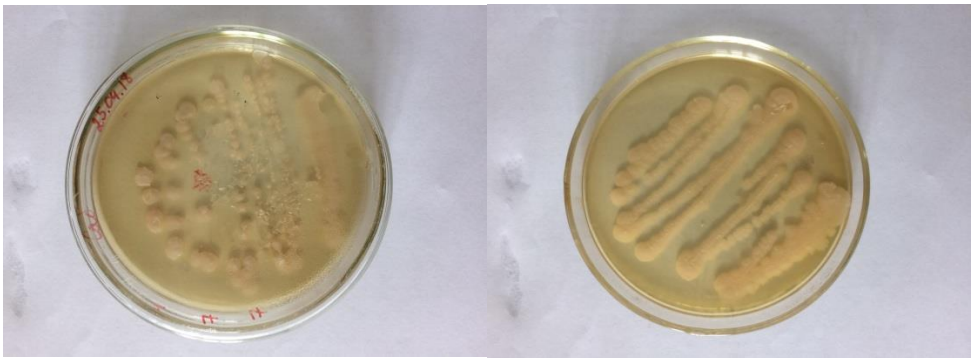


Figure 3 – Growth of colonies of isolated yeast on Saburo agar medium

Figure 4 presents options for a microscopic picture of yeast on solid nutrient media. Yeast is round, oval, rectangular, ellipsoidal, rod-shaped, bean-shaped. Different in size, length, thickness and nature of the location. budding is observed.

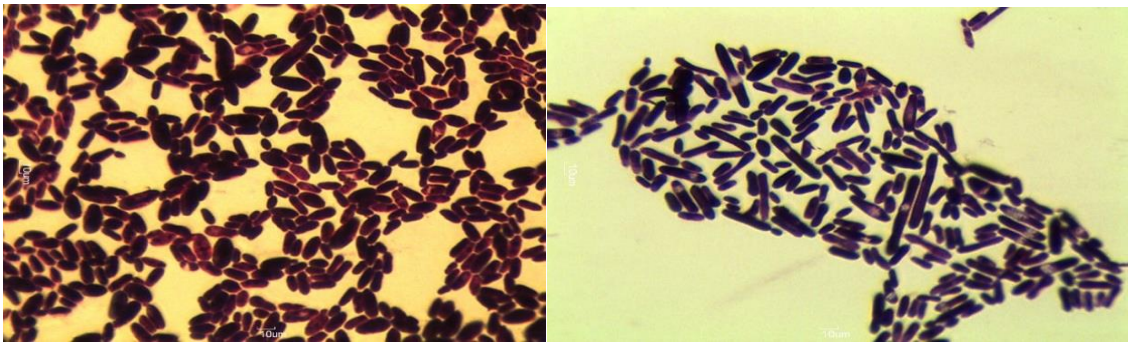


Figure 4 – Microscopic picture of yeast

Pure cultures were attributed to bacteria of the genus Lactobacillus according to the following characteristics [40-42]: non-spore-forming, regular shape, long or short, straight or curved, sometimes like coccus, gram-positive, immobile, catalo-negative sticks; located alone or in chains; not giving growth on dry nutrient agar; having characteristic colonies on MPC-agar. With age or with increasing acidity can be gram-negative.

Non-porous, gram-positive, immobile, catalase-negative, giving growth on dry nutrient agar, not giving growth in nutrient media with a pH of 9.6 and 6.5% NaCl coccus were attributed to bacteria of the genus Streptococcus [40-42].

Bacteria of the genus Lactococcus are gram-positive fixed coccus [40-42].

Yeast [42, 43] - large, yeast cells, polymorphic: round, oval, in the form of beans, rectangular, etc. When stained by the Gram - positive. A total of 289 isolates were isolated: 150 LAB isolates and 139 yeast isolates.

An assessment was made of the maximum viability for selection among the isolated isolates of viable cultures. The optimal numbers in the selection of cultures of microorganisms is the maximum indicator of viability - 107 or more. For further work, 259 cultures with a valid viability index were taken: 139 yeast and 150 ICD. In parallel, laid them in storage.

3.3 Search for cultures of microorganisms that have the property to reduce the content of lactose.

To determine the amount of lactose in milk, the cyanide method was used [81], which showed that 4.4, 4.1, and 4.7 ml were used to titrate a solution of red blood salt. The average is 4.4 ml. The working solution of lactose in this milk was 3.3%.

When determining lactose, the green solution is a matrix solution; the transition to yellow through violet indicates the presence of lactose (Figure 5).

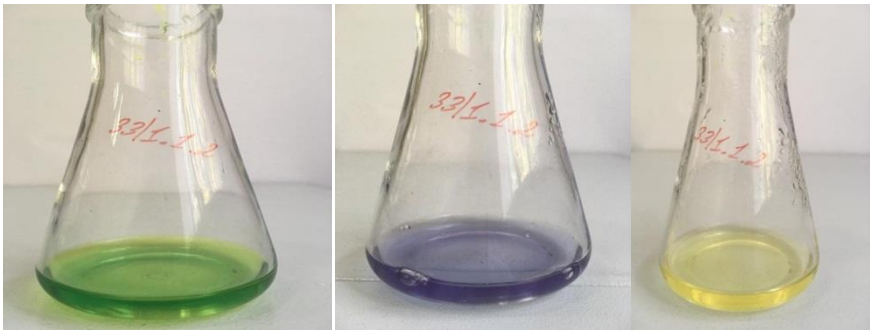


Figure 5 – Determination of lactose in milk with culture 33 / 1.1.2

For convenience, the lactose obtained in determining the amount was conventionally divided into levels (Table 3.1.1).

Table 1 – Title

Name of culture	Content, %	The number of microorganisms
Microorganisms from household products (total 228)		
LAB (108)	0,36-0,93	92
	1,02-1,68	12
	2,22-2,4	3
	3	1
Yeast (120)	0,43-0,9	78
	1-1,82	32
	2,12-2,7	6
	-	4
Microorganisms from factory products (total 28)		
LAB (18)	0,54-0,92	9
	1,08-1,87	6
	2,1-2,4	3
Yeast (10)	0,74-0,96	4
	1,2-1,65	3
	2,28	1
	3,6	1
	-	1
Microorganisms from human biotopes (12 in total)		
LAB (12)	0,42-0,9	12
Milk	3,3	3 repetition

Cultures of microorganisms gave indicators less than 3.3%, the bulk were microorganisms with an index from 0.36 to 0.93 - lactobacilli. The best indicators were microorganisms isolated from domestic dairy products, as they contain wild natural strains that are not subject to any effects, and lactobacilli from human biotopes, less - microorganisms from factory products, due to the fact that these are commercial strains that are subject to various changes . 5 yeast cultures did not detect lactose, of which 4 cultures isolated from home-made products, 1 - from factory production. At the same time, gas release, organoleptic smell of alcohol and fresh koumiss was observed. All these cultures can be used to obtain the leaven after studying the leaven properties.

The main potential of the culture is C164, C190, C196, C198. These strains will be major in the development of a consortium for leaven of lactic acid products after studying the leaven properties.

During the work, the leaven characteristics of yeast and LAB cultures, acid-forming activity, and clot formation time were studied. Acid-forming activity was studied at 24 hours of growth, it is expressed in ° T. Indicators were conventionally divided into groups: up to 20 ºT, from 20 to 40 ºT, 41 ºT and more. Of the studied 122 cultures of microorganisms, all have acid-forming activity, of which 68 are cultures of LAB and 54 cultures of yeast. Yeast up to 20 ºT - 1 culture, with parameters 20-40 ºT - 34 cultures, 41 ºT and more - 19 cultures, the indicator of acid production was from 60 ºT. The most active cultures are C147 - 98, C158 - 90, C124 - 93, C133 - 90, C145 - 104 ºT. At LAB up to 20 ºT - 1 culture, with parameters 20-40 ºT - 23 cultures, 41 ºT and more - 43 cultures. The most active cultures are L111 - 80, L44 - 85, L90 - 89, L12 - 84. At the same time, it was observed that the lactose-sensitizing activity of crops with a higher rate of acid production, has a different indicator of lactose utilization. For example, in culture C217, the utilization of lactose corresponds to 2.12%; at C164, C190, C196, C198 - recycling is completely; for L79 and C211, when acidification is 16 ° T, utilization is 0.69 and 2.12%. This suggests that these indicators do not affect each other. Clot formation time was observed at 17, 18, 19, 22, 23 and 24 hours of cultivation, in one culture - at 14 hours. Cultures with high rates of acid formation will be considered as applicants for creating a consortium - these are cultures of C147, C158, C124, C133, C145, L111, L44, L90, L12.

Thus, cultures of L111, L44, L90, L12, C164, C190, C196, C198, C147, C158, C124, C133, C145 as a result of the evaluation of lactose-sensitizing activity and acid formation can be possible applicants for ferments for the production of fermented milk food. According to the acid-forming activity and the time of clot formation, the numbers are low, it is necessary to strengthen them. To do this, it is necessary to add nutrient substrates to the medium, and when creating a consortium, there is an increase in activity by stimulating each other's crops, which will be carried out later.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

References

1. Права человека: изложение фактов. № 34. Управлением верховного комиссара по правам человека Организации Объединенных Наций: http://www.ohchr.org, 20.03.18.

2. Шаурина О.С., Горбатов А. В. Повышение качества продуктов питания отечественного производства как составляющая продовольственной безопасности России и ее регионов // Научный журнал Кубанского ГАУ. – 2016. - №119(05): http://ej.kubagro.ru/2016/05/pdf/75.pdf, 20.03.18.

3. Анацкая А.Г. Создание новых молочных продуктов // Молочная промышленность. - 2000. - № 2: интернет-ресурсы, 20.03.18.

4. Кайшев В.Г. Пищевая промышленность: итоги 2001 года // Пищевая промышленность. – 2002. - № 5. – С. 4.

5. Елен П., Голманн П., Кулбеэ Т. Технология сквашивания // Молочная промышленность. - 2005. - № 6. - С. 64-65.

6. http://lactel.kz/low_lactose_milk.php, 28.08.18.

7. Клинический протокол диагностики и лечения целиакия у детей: Утверждено МЗРК, протокол №10 от «04» июля 2014 г. – 19 с.

8. В Казахстане - более 300 тысяч больных сахарным диабетом: https://forbes.kz/news/2018/06/21/newsid_175541, 24.03.18.

9. 320 тысяч больных сахарным диабетом насчитали врачи в Казахстане, число быстро растёт: https://informburo.kz/novosti/320-tysyach-bolnyh-saharnym-diabetom-naschitali-vrachi-v-kazahstane-chislo-bystro-rastyot.html, 24.09.18.

10. Жизнь без лактозы: как выбрать продукты: https://medaboutme.ru/zdorove/publikacii/stati/lechebnoe_pitanie/zhizn_bez_laktozy_kak_vybirat_produkty/?utm_source=copypaste&utm_medium=referral&utm_campaign, 28.08.18.

11. Парфенов А.И. Энтерология: руководство для врачей. - 2-е изд. – М.:МИА, 2009. – С. 71-113.

12. Сорокина М. Лактазная недостаточность. – 2010: http://gvinfo.ru/ln_ms, 28.08.18.

13. Лифшиц Ф. Непереносимостъ углеводов у детей грудного возраста / под ред. Ф. Лифшиц. – М., 1984. – 90 с.

14. Бельмер С.В., Мухина Ю.Г., Чубарова А.И. и др. Непереносимость лактозы у детей и взрослых // Лечащий врач. - 2005. - №1. - С. 34-38.

15. Мухина Ю.Г., Шумилов П.В., Дубровская М.И. и др. Современные подходы к диагностике и терапии дисахаридазной недостаточности у детей // Трудн. пациент (Педиатрия). - 2006. - № 4 (9). - С. 12–16.

16. Звягинцева Т.Д. Синдром раздраженного кишечника: современные аспекты диагностики и лечения // Здоровье Украины. – 2007. - № 7/1. – С. 3-5.

17. Парфенов А.И., Ручкина И.Н., Постинфекционный синдром раздраженного кишечника или хронический колит? // Матер. V съезда гастроэнтерологов России и XXXII сессии ЦНИИГ. – М: Анахарсис, 2005. – С. 482-483.

18. Sahi T. Genetics and epidemiology of adult-type hypolactasia // Scand J Gastroenterol. – 1994. – Suppl. 29:202, P. 7-20.

19. Semrad C.E. Approach to the patient with diarrhea and mal-absorption // I. Goldman, A.L. Schafer, eds. Cecil Medicine – 24th ed. – Philadelphia, Pa: Saunders Elsevier, 2011. - Ch. 142.

20. Swagerty D.L., Walling A.D., Klein R.M. Lactose intolerance // Am Fam Physician. – 2002. – Vol. 65, P. 1845-1850.

21. Питание здорового и больного ребенка: Пособие для врачей / Под ред. Тутельяна В.А., Коня И.Я., Каганова Б.С. - М., 2009. - С. 96–101.

22. Пичугина Е. Молоко – это не модно / Газета «Московский комсомолец», №26822 от 30.05.15.: https://www.mk.ru/social/2015/05/29/neperenosimost-moloka-populyarnyy-diagnoz.html, 17.09.18.

23. Непереносимость молока — популярный диагноз: https://www.mke.ee/zdorovje/neperenosimost-moloka-populyarnyj-diagnoz, 19.08.18.

24. Доронин А.Ф., Шендеров Б.А. Функциональное питание. - М.: Грантъ, 2002. - 296 с.

25. Process for making lactose free dairy products / DMK Deutsches milchkontor GMBH [DE]. - Patent EP №3158871 от 04.26.2017.

26. Method for processing foodstuffs which are largely left in their natural state, where energy and nutrient contents can be adjusted and lactose intolerance prevented / Laufer Ingeborg [DE]. - Patent EP №1803359 от 07.04.2007.

27. Lactose-free milk productand processes for producing the same / Valio LTD [FI]. Patent US №20110059220 от 03.10.2011.

28. Method and system for lactose-free or lactose-reduced milk and associated products, production thereof, and associated processes / Univ Cornell [US]. - Patent US №20100196985 от 08.05.2010.

29. Process for making a lactose-free milk and milk so processed / Lange Michel, Agropur Cooperative [CA]. - Patent US №20030031754 от 02.13.2003.

30. Method of producing low-lactose and lactose-free sour milk products / Valio LTD [FI]; Silfverberg PetriI [FI]; Tossavainen Olli [FI] / Jonson Virpi [FI]. - Patent WO №2008000895 от 01.03.2008.

31. Process for producing lactose-free dairy products (II) / DMK Deutsches Milchkontor GMBH. - Patent CA №2936820 от 01.25.2017.

32. Горбатова К.К. Биохимия молока и молочных продуктов. – М.: Легкая и пищевая промышленность, 1984. - 344 с.

33. Арсеньева Т.П. Исследование и разработка низколактозных кисломолочных напитков лечебно-профилактического назначения // Здоровье семьи - 21 век. – 2010. - № 2. – С. 8.

34. Ed. Kreger van Rij N.J.W. The yeasts. Taxonomic study // Elsevier Sci. Publ. BV. - 1984. – P. 1082.

35. Kaizu H., Sasaki M., Nakajima H., Suzuki Y. Effect of antioxidative lactic acid bacteria on rats fed a diet deficient in vitamin // E. J. Dairy Sci. – 1993. – Vol. 76, P. 2493-2499.

36. Практикум по микробиологии: Учеб. пособие для студ. высш. учеб. заведений / А.И. Нетрусов, М.А. Егорова, Л.М. Захарчук и др.; Под ред. А.И. Нетрусова. – М.: Академия, 2005. – 608 с.

37. Руководство к практическим занятиям по микробиологии / Под ред. Н.С. Егорова. – М.: Издательство Московского университета, 1985. – 653 с.

38. Волков В.Н. Определение качества молока и молочных продуктов / В.Н. Волков, Н.И. Солодова, Л.А. Волкова // Химия в школе. – 2002. - № 1. – С. 57–63.

39. Банникова Л.А., Королева Н.С.. Семинихина В.Ф. Микробиологические основы молочного производства. – М.: Агропромиздат, 1987. – 400 с.

40. Характеристика молочнокислых бактерий: http://bio-x.ru/articles/harakteristika-molochnokislyh-bakteriy, 24.09.18.

41. Хоулт Дж. Определитель бактерий Берджи: в 2-х т., пер. с англ.; / под ред. Дж. Хоулта, Н. Крига, П. Снита и др. – М.: Мир, 1997. – 800 с.

42. Квасников Е.И., Нестеренко О.Л. Молочнокислые бактерии и пути их использования. - М.: Наука, 1975. - 389 с.

43. Квасников Е.И., Щелокова И.Ф. Дрожжи – Киев: Наук. думка, 1991. – 316 с.

44. Просеков А.Ю. Научные основы производства продуктов питания: Учебное пособие / Кемеровский технологический институт пищевой промышленности. – Кемерово, 2005. - 234 с.

References in English

1. Prava cheloveka: izlozhenie faktov. - № 34. Upravleniem verhovnogo komissara po pravam cheloveka OrganizatsiiOb'edinennyih Natsiy [Human Rights: Fact Sheet. No. 34. United Nations High Commissioner for Human Rights]: http://www.ohchr.org, 20.03.18. [in Russian]

2. Shaurina O.S., Gorbatov A. V. Povyishenie kachestva produktov pitaniya otechestvennogo proizvodstva kak sostavlyayuschaya prodovolstvennoy bezopasnosti Rossii i ee regionov [Improving the quality of domestic food as a component of food security in Russia and its regions] / O.S. Shaurina, A.V Gorbatov.// Scientific journal of the Kuban State Agrarian University, 2016. – № 119(05): http://ej.kubagro.ru/2016/05/pdf/75.pdf, 20.03.18. [in Russian].

3. Anatskaya A.G. Sozdanie novyih molochnyih produktov [Creating new dairy products]/ A.G.Anatskaya// Dairy industry. - 2000. - № 2: Internet resources, 03/20/18. [in Russian].

4. Kayshev V.G. Pischevaya promyishlennost: itogi 2001 goda. [Food industry: results of 2001] / V.G Kayshev// Food industry. - 2002. - № 5. - p. 4. [in Russian].

5. Elen P., Golmann P., Kulbee T. Tehnologiya skvashivaniya [Souring Technology]/ P. Elen, P.Golmann, T.Kulbee // Dairy Industry. - 2005. - № 6. - p. 64-65. [in Russian].

6. http://lactel.kz/low_lactose_milk.php, 28.08.18.

7. Klinicheskiy protokol diagnostiki i lecheniya tseliakiya u detey: Utverzhdeno MZRK, protokol - №10 ot «04» iyulya 2014 g. – 19 s. [Clinical protocol for the diagnosis and treatment of celiac disease in children] Approved by the Ministry of Health and Social Development, Protocol No. 10 dated July 04, 2014 - 19 p. [in Russian].

8. V Kazahstane - bolee 300 tyisyach bolnyih saharnyim diabetom [In Kazakhstan - more than 300 thousand patients with diabetes]: https://forbes.kz/news/2018/06/21/newsid_175541, 24.03.18. [in Russian].

9. 320 tyisyach bolnyih saharnyim diabetom naschitali vrachi v Kazahstane, chislo byistro rastYot [320 thousand patients with diabetes were counted by doctors in Kazakhstan, the number is growing rapidly] https://informburo.kz/novosti/320-tysyach-bolnyh-saharnym-diabetom-naschitali-vrachi-v-kazahstane-chislo-bystro-rastyot.html, 24.09.18. [in Russian].

10. Zhizn bez laktozyi: kak vyibrat produktyi [Lactose-free life: how to choose products] https://medaboutme.ru/zdorove/publikacii/stati/lechebnoe_pitanie/zhizn_bez_laktozy_kak_vybirat_produkty/?utm_source=copypaste&utm_medium=referral&utm_campaign, 28.08.18. [in Russian].

11. Parfenov A.I. Enterologiya: rukovodstvo dlya vrachey [Enterology: a guide for doctors] / A.I. Parfenov - 2nd ed. - M.: MIA, 2009. - p. 71-113. [in Russian].

12. Sorokina M. Laktaznaya nedostatochnost. [Lactase deficiency] / M.Sorokina, – 2010: http://gvinfo.ru/ln_ms, 28.08.18. [in Russian].

13. Lifshits F. Neperenosimost' uglevodov u detey grudnogo vozrasta [Carbohydrate intolerance in infants] / F. Lifshits. - M., 1984. - 90 p. [in Russian].

14. Belmer S.V., Muhina Yu.G., Chubarova A.I. i dr. Neperenosimost laktozyi u detey i vzroslyih [Lactose intolerance in children and adults] / S.V.Belmer, Yu.G.Muhina, A.I. Chubarova // The attending physician. - 2005. - №1. - p. 34-38. [in Russian].

15. Muhina Yu.G., Shumilov P.V., Dubrovskaya M.I. i dr. Sovremennyie podhodyi k diagnostike i terapii disaharidaznoy nedostatochnosti u detey. [Modern approaches to the diagnosis and treatment of disaccharidase deficiency in children]/ Yu.G. Muhina, P.V.Shumilov, M.I. Dubrovskaya // Difficult patient (Pediatrics). - 2006. - № 4 (9). - pp. 12–16. [in Russian].

16. Zvyagintseva T.D. Sindrom razdrazhennogo kishechnika: sovremennyie aspektyi diagnostiki i lecheniya [Irritable bowel syndrome: modern aspects of diagnosis and treatment] T.D.Zvyagintseva // // Health of Ukraine. - 2007. - № 7/1. - pp. 3-5. [in Russian].

17. Parfenov A.I., Ruchkina I.N., Postinfektsionnyiy sindrom razdrazhennogo kishechnika ili hronicheskiy kolit [Post-infectious irritable bowel syndrome or chronic colitis] / A.I. Parfenov, I.N. Ruchkina, // Proceedings of the 5th Congress of Russian Gastroenterologists and the XXXII Session of the Central Research Institute of Gastroenterology. - M: Anaharsis, 2005. - p. 482-483. [in Russian].

18. Sahi T. Genetics and epidemiology of adult-type hypolactasia // Scand J Gastroenterol. – 1994. – Suppl. 29:202, R. 7-20.

19. Semrad C.E. Approach to the patient with diarrhea and mal-absorption // I. Goldman, A.L. Schafer, eds. Cecil Medicine – 24th ed. – Philadelphia, Pa: Saunders Elsevier, 2011. - Ch. 142.

20. Swagerty D.L., Walling A.D., Klein R.M. Lactose intolerance // Am Fam Physician. – 2002. – Vol. 65, P. 1845-1850.

21. Pitanie zdorovogo i bolnogo rebenka: Posobie dlya vrachey / Pod red. Tutelyana V.A., Konya I.Ya., Kaganova B.S. [Eating a Healthy and Sick Child: A Manual for Doctors] / Ed. V.A. Tutelyana V.A, I.Ya.Konya, B.S. Kaganova - M., 2009. - P. 96–101. [in Russian].

22. Pichugina E. Moloko – eto ne modno [Milk is not fashionable]/ E. Pichugina / Newspaper "Moskovsky Komsomolets", No. 26822 of 05/30/15.: Https://www.mk.ru/social/2015/05/29/neperenosimost-moloka-populyarnyy-diagnoz. html, 09/17/18. [in Russian].

23. Neperenosimost moloka — populyarnyiy diagnoz [Milk intolerance is a popular diagnosis] https://www.mke.ee/zdorovje/neperenosimost-moloka-populyarnyj-diagnoz, 08.19.18. [in Russian].

24. Doronin A.F., Shenderov B.A. Funktsionalnoe pitanie. [Functional food]/ A.F. Doronin, B.A. Shenderov - M .: Grant, 2002. - 296 p. [in Russian].

25. Process for making lactose free dairy products / DMK Deutsches milchkontor GMBH [DE]. - Ratent EP #3158871 от 04.26.2017.

26. Method for processing foodstuffs which are largely left in their natural state, where energy and nutrient contents can be adjusted and lactose intolerance prevented / Laufer Ingeborg

27. Lactose-free milk productand processes for producing the same / Valio LTD [FI]. Patent US №20110059220 от 03.10.2011.

28. Method and system for lactose-free or lactose-reduced milk and associated products, production thereof, and associated processes / Univ Cornell [US]. - Patent US №20100196985 от 08.05.2010.

29. Process for making a lactose-free milk and milk so processed / Lange Michel, Agropur Cooperative [CA]. - Patent US №20030031754 от 02.13.2003.

30. Method of producing low-lactose and lactose-free sour milk products / Valio LTD [FI]; Silfverberg PetriI [FI]; Tossavainen Olli [FI] / Jonson Virpi [FI]. - Patent WO №2008000895 от 01.03.2008.

31. Process for producing lactose-free dairy products (II) / DMK Deutsches Milchkontor GMBH. - Patent CA №2936820 от 01.25.2017.

32. Gorbatova K.K. Biohimiya moloka i molochnyih produktov. [Biochemistry of milk and dairy products]/ K.K.Gorbatova – M .: Light and food industry, 1984. - 344 p. [in Russian].

33. Arseneva T.P. Issledovanie i razrabotka nizkolaktoznyih kislomolochnyih napitkov lechebno-profilakticheskogo naznacheniya [Research and development of low-lactose fermented milk drinks for therapeutic and prophylactic purposes]/ T.P. Arseneva // Family Health - 21st Century. - 2010. - № 2. - p. 8. [in Russian].

34. Ed. Kreger van Rij N.J.W. The yeasts. Taxonomic study // Elsevier Sci. Publ. BV. - 1984. – R. 1082.

35. Kaizu H., Sasaki M., Nakajima H., Suzuki Y. Effect of antioxidative lactic acid bacteria on rats fed a diet deficient in vitamin // E. J. Dairy Sci. – 1993. – Vol. 76, R. 2493-2499.

36. Praktikum po mikrobiologii: Ucheb. posobie dlya stud. vyissh. ucheb. zavedeniy / A.I. Netrusov, M.A. Egorova, L.M. Zaharchuk i dr.; Pod red. A.I. Netrusova.[

Workshop on Microbiology: A manual for students. higher studies. institutions] / A.I. Netrusov, M.A. Yegorova, L.M. Zakharchuk et al .; Ed. A.I. Netrusova. - M .: Academy, 2005. - 608 p. [in Russian]

37. Rukovodstvo k prakticheskim zanyatiyam po mikrobiologii / Pod red. N.S. Egorova. [Guide to practical classes in microbiology] / Ed. N.S. Yegorova. - M: Moscow University Press, 1985. - 653 p. [in Russian].

38. Volkov V.N. Opredelenie kachestva moloka i molochnyih produktov / [Determination of the quality of milk and dairy products] / V.N. Volkov, N.I. Solodova, L.A. Volkova // Chemistry at school. - 2002. - № 1. - p. 57–63. [in Russian].

39. Bannikova L.A., Koroleva N.S.. Seminihina V.F. Mikrobiologicheskie osnovyi molochnogo proizvodstva. [Microbiological basis of dairy production]. L.A.Bannikova, N.S.Koroleva, V.F.Seminihina.- M .: Agropromizdat, 1987. - 400 p. [in Russian].

40. Harakteristika molochnokislyih bakteriy [Characteristics of lactic acid bacteria]: http://bio-x.ru/articles/harakteristika-molochnokislyh-bakteriy, 09/24/18. [in Russian].

41. Hoult Dzh. Opredelitel bakteriy Berdzhi: v 2-h t., per. s angl.;[The determinant of bacteria Burgi: in 2 tons., Trans. from English] / ed. J. Hoult, N. Krieg, P. Snita, and others. - Moscow: Mir, 1997. - 800 p. [in Russian].

42. Kvasnikov E.I., Nesterenko O.L. Molochnokislyie bakterii i puti ih ispolzovaniya.[Lactic acid bacteria and their use.]/ E.I. Kvasnikov, O.L. Nesterenko. - M .: Science, 1975. - 389 p. [in Russian].

43. Kvasnikov E.I., Schelokova I.F. Drozhzhi [Yeast]/ E.I. Kvasnikov, I.F.Schelkova/ - Kiev: Science. Dumka, 1991. - 316 p. [in Russian].

44. Prosekov A.Yu. Nauchnyie osnovyi proizvodstva produktov pitaniya[The scientific basis of food production]: textbook / Kemerovo Technological Institute of Food Industry. - Kemerovo, 2005. - 234 p. [in Russian].