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Forgotten Discovery with Promising Perspective: Huslianka, a Unique Traditional Carpathian Fermented Milk Product

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Abstract

Huslianka is a unique traditional naturally fermented milk product historically produced by Hutsuls, an ethnic group of Ukrainians inhabiting the Carpathian Mountains in Western Ukraine. Its distinctive characteristics were first investigated in 1912 by the Ukrainian researcher Volodymyr Kindraczuk, who isolated and described a lactic acid-producing bacterium designated by him as *Bacillus carpathicus*. Historical experiments demonstrated its considerable acidification capacity, distinctive fermentation characteristics, and inhibitory activity against selected microorganisms. Despite these early observations, the taxonomic identity of *B. carpathicus* remains unresolved, and the microbial composition of huslianka has not been adequately characterized using modern molecular approaches. This article revisits Kindraczuk's original findings, examines the historical development of research on huslianka, and compares its reported microbiological and biochemical characteristics with those of conventional yogurt. Particular attention is given to lactic acid production, temperature-dependent fermentation, microbial interactions, and the traditional preservation of this product. The historical evidence highlights the scientific interest of huslianka while emphasizing the need for comprehensive microbiological, genomic, biochemical, and food safety investigations. Such research may provide a foundation for preserving this traditional Carpathian food and exploring its potential applications in contemporary dairy biotechnology. Originally described by Dr. Volodymyr Kindraczuk in 1912, huslianka exhibits exceptional preservation characteristics and a potent microbiological profile attributed to the dominance of a novel bacterium, *Bacillus carpathicus*. This article revives the legacy of Kindraczuk's work, detailing the historical context, microbiological findings, and health implications of huslianka. Through comparative analysis with yogurt and other fermented milk products, we underscore the distinctiveness of huslianka and its potential as a natural, probiotic-rich food with significant health benefits. Given the growing

interest in traditional and sustainable foods, huslianka warrants comprehensive scientific investigation and broader recognition as a heritage food with promising applications in modern diets.

Keywords: huslianka; *Bacillus carpathicus*; fermented milk; Carpathian Mountains; traditional food; probiotics; Ukrainian cuisine

1. Description of the huslianka from Dr. Kindraczuk

114 years ago, Volodymyr Kindraczuk (b. 1882 in Horodenka, Austro-Hungarian Empire, now Ivano-Frankivsk region, Ukraine, d. 1969 in Hamilton, Canada), published the first paper about huslianka, fermented milk produced by Ukrainians inhabiting the Ukrainian part of the Carpathian mountains in Western Ukraine (Kindraczuk 2013). Historically, at those places lived a group of Ukrainians called hutsuly, and now, they are distributed in mountain parts of Ivano-Frankivsk (Halychyna), Chernivtsi (Bukovyna) and Zacarpatskyj (Zacarpattya) regions of Ukraine. In the Austro-Hungarian Empire, Ukrainians were called Ruthenians. The latter referred to the medieval land of Ruthenia, which was the Latin term for what is now known as Kyivan Rus, a medieval East Slavic state with the capital in Kyiv.

Huslianka attracted attention of Dr. Kindraczuk, probably because of "its long shelf life: commonly it can be stored for 1-2 years without going bad" (Kindraczuk 2013). In fact, from our experience, we can confirm that it maintains its properties for at least 12 years at storage in closed glass jars in a refrigerator (JV, VL – unpublished data). It was assumed that such a long shelf-life was due to the high amount of lactic acid, which ranged from 2 to 2.5%. The latter was suggested to be produced by some bacteria (Kindraczuk 2013).

Living in close proximity to Hutsul-inhabited areas, Dr. Kindraczuk collected huslianka samples and, with the support of Professor Winkler (Vienna, Austria), investigated properties of the product in his bacteriological laboratory. The key microbiological question focused on identifying the organism capable of producing such high concentrations of lactic acid.

The author focused exclusively on lactic acid bacteria, thereby excluding yeasts and molds from consideration. However, yeasts appear to be integral components of the specific huslianka ecosystem, whereas molds were never observed in our samples (VL, unpublished data). This absence of mold contamination is significant and may contribute to the characteristically long shelf-life of huslianka.

Individual bacteria (pure cultures) isolated from huslianka via plate cultures with selective media for lactobacteria by Dr. Kindraczuk were designated him as *Bacillus carpathicus* (Kindraczuk 1912, 2013). This isolated pure culture fermented sterilized milk without gas production over a temperature range of 30–50°C. When Kindraczuk investigated the temperature dependence of milk fermentation by *B. carpathicus*, the highest recorded titratable acidity (20.2 °SH) and the shortest milk coagulation time (2 h 50 min) were observed at 44°C (Figure 1A, B). These findings demonstrate a pronounced temperature dependence of acidification and milk coagulation by this microorganism, aligning with its reported optimal fermentation temperature range of 44–46°C and exhibiting characteristics similar to those of *Bacillus bulgaricus*.

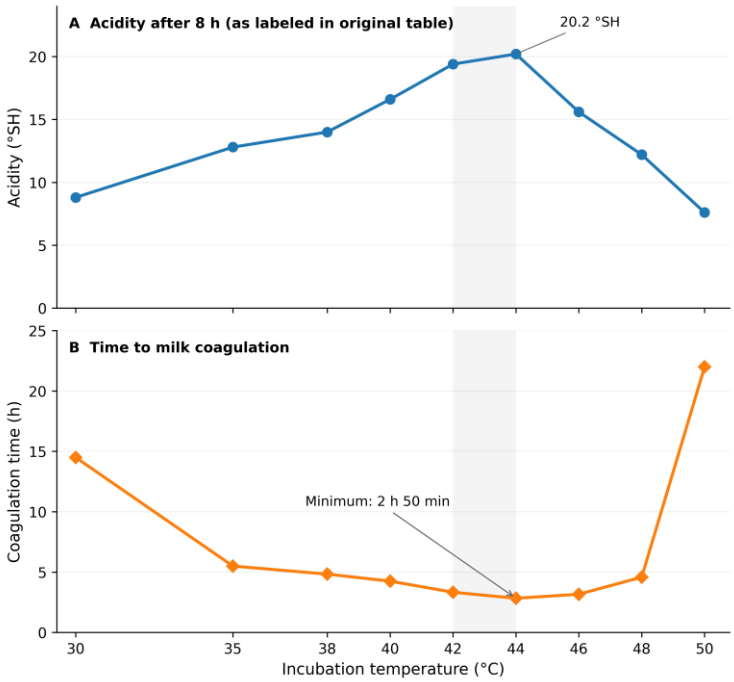


Figure 1. Temperature-dependent acidification and milk coagulation by *Bacillus carpathicus*. (**A**) Titratable acidity of fermented milk (°SH – Soxhlet-Henkel units) at different incubation temperatures. (**B**) Time required for milk coagulation (h). The highest titratable acidity and the shortest coagulation time were recorded at 44°C. Data are reconstructed from the historical experimental results of Kindraczuk (1912). The original table indicates an 8-h incubation period for acidity measurements, whereas the accompanying text refers to 3 h. This discrepancy remains unresolved. Error bars are not shown because the original publication did not report measures of variability.

When cultured on agar plates, *B. carpathicus* was described by Kindraczuk as a rod-shaped bacterium composed of straight rods measuring approximately 0.5–0.7 μm in width and 4–8 μm in length. The cells were predominantly straight and frequently observed occurring in pairs. Phenotypically, the bacterium was characterized as Gram-positive, nonmotile, non-spore-forming, and facultatively anaerobic. This process produced 2 to 2.5% left-rotating lactic acid. The literature data indicate that *B. bulgaricus* produces from 1 to 1.5% lactic acid in yogurt. These properties of fermented milk products were confirmed by W. Kindraczuk: if 1.273% lactic acid was found in milk fermented by *B. bulgaricus* in cultures, the same process with *B. carpathicus* resulted in the production of 2.421% lactic acid (Kindraczuk 2013).

The historical experimental data also demonstrate differences in the dynamics of lactic acid accumulation between the two bacterial cultures (Figure 2). Throughout the six-day observation period, *B. carpathicus* exhibited consistently higher lactic acid concentrations than *B. bulgaricus*. Both cultures approached their maximum reported acid concentrations early in the observation period, with relatively little subsequent change. These results highlight the greater acidification capacity of *B. carpathicus* under the experimental conditions described by Kindraczuk.

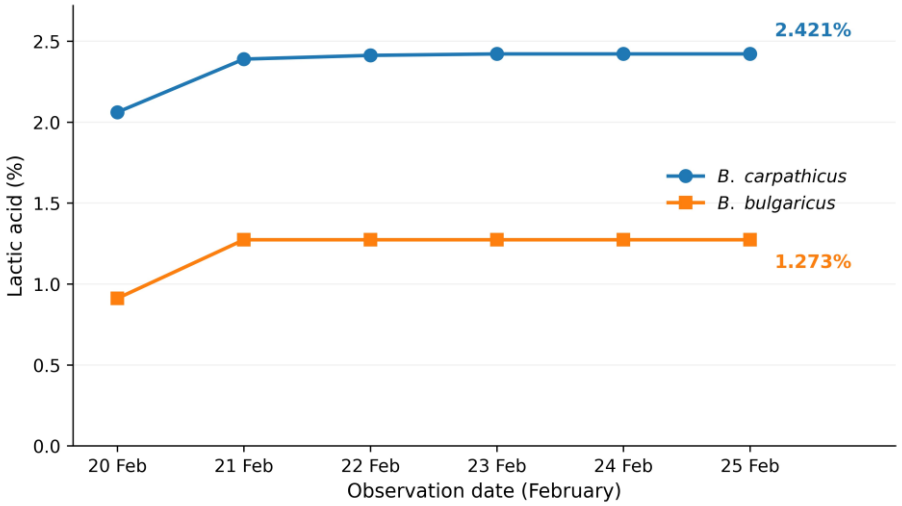


Figure 2. Comparative lactic acid production by *Bacillus carpathicus* and *Bacillus bulgaricus* during milk fermentation. Changes in lactic acid concentration (%) over six consecutive observation days (February 20–25), reconstructed from the experimental data reported by Kindraczuk (1912). The final reported lactic acid concentrations were 2.421% for *B. carpathicus* and 1.273% for *B. bulgaricus*. Points represent historical measurements; error bars and statistical comparisons are not provided because the original study did not report replicate variability.

Interestingly, at joint growth with the intestinal bacterium *Bacillus coli* (now probably known as *Escherichia coli*) and the putrefactive bacterium *Proteus vulgaris*, *B. carpathicus* suppressed their growth more efficiently than *B. bulgaricus*. These effects could be related to higher production of lactic acid by *B. carpathicus*. Similarly, *B. carpathicus* could suppress the lactic acid *Streptococcus* in huslainka because *B. carpathicus* clearly dominated in older cultures. Competition with other intestinal microorganisms was not tested, but on the basis of the data received, Dr. Kindraczuk suggested that "because of its great ability to produce acid, *B. carpathicus* should not take a second place to *Bacillus bulgaricus* and may even surpass it in many cases".

Taken together, the historical observations of Kindraczuk indicate that *B. carpathicus* differed from *B. bulgaricus* in several microbiological and physiological characteristics, particularly in its capacity for lactic acid production and inhibition of selected bacterial species. The major characteristics of these microorganisms, as documented in the original study, are summarized in Table 1. Although these findings suggest distinctive properties of *B. carpathicus*, its taxonomic identity and physiological characteristics require reassessment using modern microbiological and molecular biology approaches.

Table 1. Comparative microbiological and physiological characteristics of *Bacillus carpathicus* and *Bacillus bulgaricus* based on historical observations and subsequent microbiological studies

Characteristic	***B. carpathicus***	***B. bulgaricus***
Traditional fermented milk source	Huslianka (Ukrainian Carpathians)	Bulgarian yogurt (Ayivi & Ibrahim, 2022)
Cell morphology	Rod-shaped cells, 0.5–0.7 µm wide and 4–8 µm long, commonly occurring in pairs	Rod-shaped cells, approximately 0.5–0.8 µm wide and 2–9 µm long; occurring singly or in chains (Joint Genome Institute, n.d.)
Gram staining and motility	Gram-positive, nonmotile	Gram-positive, nonmotile (Joint Genome Institute, n.d.)
Spore formation	Non-spore-forming	Non-spore-forming (Joint Genome Institute, n.d.)

Optimal fermentation temperature	44–46 °C	Approximately 43–46 °C, depending on strain and culture conditions (Ayivi & Ibrahim, 2022)
Gas production during milk fermentation	Not observed	Generally not characteristic of homolactic fermentation under standard conditions (Rhee & Pack, 1980; Ayivi & Ibrahim, 2022)
Lactic acid concentration (%)	2.421	1.273 (Kindraczuk, 1912)
Inhibitory activity against *Bacillus coli* (historical name for *Escherichia coli*)	Stronger inhibition	Weaker inhibition in the historical comparison (Kindraczuk, 1912)
Inhibitory activity against *Proteus vulgaris*	Stronger inhibition	Weaker inhibition in the historical comparison (Kindraczuk, 1912)
Taxonomic status	Historical designation; modern taxonomic identity remains unresolved	Historical designation corresponding to *Lactobacillus delbrueckii* subsp. *bulgaricus* (Weiss et al., 1983)

Note. *The characteristics of B. carpathicus and the comparative data on lactic acid production and antimicrobial activity are derived from the historical experiments of Kindraczuk (1912). Additional morphological, physiological, and taxonomic information on B. bulgaricus was obtained from subsequent microbiological studies and descriptions of its currently recognized taxonomic equivalent, Lactobacillus delbrueckii subsp. bulgaricus. These supplementary characteristics represent established properties of the modern taxon rather than direct measurements from the original historical study. Differences in lactic acid production and antimicrobial activity reflect the specific experimental conditions reported by Kindraczuk and should not be interpreted as universal species-level differences.*

In conclusion, it was stated that "huslanka is a yogurt which is peculiar to certain regions of the Carpathian Mountains and is not a transplantation of Balkan yogurt. A glance at the photographs also shows the differences between *B. bulgaricus* and *B. carpathicus*, so that the latter cannot be regarded as a mere variety of the former" (Kindraczuk 2013).

Finally, Dr. Kindraczuk noted that huslianka was prepared by fermentation of cooled boiled skimmed milk. We used to ferment successfully, not skimmed boiled milk either, and obtained a good-quality product (not published). The milk is fermented in a warm place for several days in glass jars covered with thick cloth, and after coagulation, it is stored in a cool location with tightly closed lids for up to 10 years. It can be eaten directly or diluted with water and consumed with either polenta or potato, or used as a sauce for vegetables and salads. We personally used to eat huslianka in different combinations and found a number of them to be very palatable specific foods or additives.

According to Bahry (2018), the original Kindraczuk's paper was cited in German, Western European and American medical periodicals from the first half of the twentieth to the last mention of "the *Bacillus carpathicus* in the 1966 English–language index of bacteria classification, Index Bergeyana: An Annotated Alphabetic Listing of Names of the Taxa of the Bacteria, a Companion Volume to Bergey's Manual of Determinative Bacteriology, edited by Robert E. Buchanan, Professor of Bacteriology at Iowa State University".

In 1932, J. Rosell analyzed the available literature on the fermented milk products kefir and yogurt and noted that these products are used "not only because of their palatability but also because of their digestibility, which permits the consumption of large quantities without disturbance. In addition to their advantages in this particular must be placed their valuable therapeutical properties". Among the different names of listed milk products, he mentioned "huslanka" of the Carpathian mountains and Bukovyna" (Rosell 1932). Interestingly, Rossel noted that some fermented milk products, such as the "kefir" from the Caucasus, were gaseous milk containing some alcohol. A similar milk product called "kumys", containing some alcohol, was provided to me in 1981 in Mongolia by local shepherds.

Jose M. Rosell reported that some fermented milk products contain gases, whereas others do not (Rosell 1932). It seems that the gas produced in these cases is the carbon dioxide (CO_2) formed during the decarboxylation of pyruvate during ethanol production via heterofermentation. That is possible that because at huslianka production gas was not produced (Kindraczuk 2013), which we also received in our preliminary experiments, homofermentation of milk takes place in this case.

It looks strange that in the paper of Supińska and Pijanowski published in 1937, the authors noted that "in the dairy literature we did not find any data on the quality or composition of the huslanka (Supińska and Pijanowski 1937). In the description of various drinks obtained by the natural fermentation of milk in different countries, Fleischmann-Weigmann is limited to briefly mentioning that húslanka is a type of persistent sour milk produced in the Carpathians by the Hutsuls" (cited after Bahry (2018)). Therefore, the authors either did not know about the paper of Dr. Kindraczuk or ignored it for some reasons.

"Classic" yogurt is a product of milk fermentation by the association of two yogurt lactic acid bacteria, *Streptococcus thermophilus* (*S. thermophilus*) and *Lactobacillus delbrueckii* ssp. *bulgaricus* (*Lb. bulgaricus*) according to present via standard protocol (Rul 2017). In yogurt, the concentration of lactic acid is 0.7–1.0%, and the concentration of alcohol was 0.05–0.50%, depending on the incubation and storage conditions (Niamsiri and Batt 2009). This clearly shows that described by V. Kindraczuk *B. carpathicus*, which produced more than 2% lactic acid during milk fermentation, is different from *L. delbrueckii* ssp. *bulgaricus*. This peculiarity of the huslianka clearly highlights the need for future studies. The term yogurt was strictly defined by the FAO/WHO: "the coagulated milk product obtained by lactic acid fermentation through the action of *L. delbrueckii* ssp. *bulgaricus* (*Lb. bulgaricus*) and *S. thermophilus* from milk and milk products. The microorganisms in the final product must be viable and abundant" (Rul 2017). Other similar products containing other bacteria such as probiotics (e.g., *Bifidobacteria*, *Lactobacillus* spp.) have to be called "fermented milk" and cannot carry the "yogurt" label. According to the Codex Alimentarius for fermented milk products, yogurt should contain a minimum of 2.7% (m/m) milk proteins, a maximum of 15% milk fat, a minimum of 0.6% titratable acidity (expressed as a percentage of lactic acid), and a minimum of 10^7 CFU/g of microorganisms (total microorganisms in the starter culture) (Codex STAN 243-2003). Therefore, because we do not know the species that form the ecosystem of huslianka, it cannot be formally claimed as yogurt, as it was initially proposed by Dr. Kindraczuk, although it is so attractive and romantic to some extent that this milk-fermented product, huslianka, is called "Carpathian Yogurt".

2. Huslianka vs industrially produced fermented milk products

Microbial transglutaminase is used in certain food-processing applications to modify protein structure and improve technological properties. Although potential health concerns related to its use have been discussed, particularly regarding gluten modification and celiac disease, researchers have not conclusively established a direct causal relationship between dietary exposure to microbial transglutaminase and the development of these diseases (Amirdivani et al., 2018). Traditional fermented milk products such as huslianka may offer opportunities for development of fermented dairies based on microbial fermentation without the need for selected processing aids, provided their safety, quality, and shelf-life characteristics are adequately demonstrated.

Important notes: There are at least two problems with currently industrially produced fermented milk products. They are as follows: 1) To increase shelf life, different preservatives are used, and 2) in many cases, for different purposes, many of these goods are produced with the use of transglutaminase. The latter has several health disadvantages, such as the induction of various diseases, such as celiac disease, Alzheimer's disease, autoimmune diseases, and digestive disorders (Amirdivani et al., 2018). These two and other problems can be eliminated with the production of huslianka. However, first, it should be investigated with the maximum arsenal of modern science

and food technologies. To the best of our knowledge, several companies claim to produce huslanka in Ukraine, but unfortunately, no information is available on the microbial species used.

3. Kindraczuk vs/with Metchnikov's works

In 1907, the Ukrainian biologist, a Nobel Laureate Ilya Metchnikov (Elie Metchnikoff), published a book titled 'The Prolongation of Life' (Metchnikoff 1907). He described the results of his observation that natural fermentation of food by lactic acid-producing bacteria prevented the growth of putrefactive organisms. He suggested that the activity of microbes in the intestine results in the production of toxic substances that damage the nervous and vascular systems, leading to human aging. This conclusion was drawn from the observation that Bulgarian peasants consumed large quantities of yogurt, which could increase their life expectancy. Therefore, he concluded that "as lactic fermentation serves so well to arrest putrefaction in general, why should it not be used for the same purpose within the digestive tube?". Current understanding of the role of *Lactobacillus* species in gastrointestinal health has recently been discussed (Dempsey and Corr 2022). Despite some details of Metchnikoff's theory not being supported later, it was absolutely right in the point that *lactobacilli* are important for gut health and, through this to the health of the whole organism.

In parallel with Illya Metchnilov, Dr. Kindraczuk disclosed that, like *L. delbrueckii* ssp. *bulgaricus*, *B. carpathicus* could be beneficial for human health because it not only produce lactic acid but also compete with harmful gut bacteria. These bacteria were defined as probiotics. I. Metchnikov also proposed that lactic acid bacteria could improve intestinal health by replacing harmful and toxic bacteria, which cause the aging process, in the intestines. Therefore, Dr. Metchnikov proposed that the consumption of milk fermented with *B. bulgaricus* could prolong life through the occupation of the intestine and the replacement of bad bacteria (Metchnikoff 1907).

According to Bahriy (2018), "Since there has been no taxonomic revision of the bacterium *B. carpathicus*, the subject of the microbiological composition of huslianka requires further research". I was also unable to find any further information on this topic, which was necessary to analyze the microbiological composition of the huslainka via modern technical approaches. We have introduced huslianka culture into our laboratory, where it was produced in limited amounts, and, in very preliminary experiments, we found that the structure, smell, taste, and pH are changed during milk fermentation, similar to the findings described by Dr. Kindraczuk. In this process, the number of microorganisms is clearly changed during such fermentation in a successive way, and as described by Dr. Kindraczuk, the long-maintained product presented is terminally fermented milk with stable microbiota of huslianka, where *B. carpathicus* could be the dominant species.

4. Conclusive remarks and perspectives

Fermented foods are recognized as important health-promoting components of traditional diets. Different types of fermented milk occupy this special position because for more than a century, fermented milk has been produced industrially. One such product, called huslianka, has been produced by Western Ukrainian people called hutsuls, who inhabit the Eastern part of the Carpathian Mountains. Local shepherds ferment skimmed milk to obtain huslianka, the product of which can be maintained in closed vessels for years without being bad. In 1912, Dr. V. Kindraczuk first described the characteristics of huslianka and identified new microorganisms termed by him *B. carpathicus* (Kindraczuk 2013). It differed from *B. bulgaricus, which was* described several years before in fermented milk by Bulgarian physician and microbiologist Stamen Grigoroff (1905). The paper of Dr. Kindraczuk was cited many times in different scientific publications, with the last available mention in 1962. Unfortunately, to date, the microorganism discovered by Dr. Kindraczuk has not been revised or placed in modern scientific classification. The taxonomic identity of *B. carpathicus*

remains unresolved, and its possible relationship to currently recognized lactic acid bacterial taxa requires investigation using genome-based methods.

Thousands of people in the Ukrainian Carpathian Mountains have traditionally consumed the palatable, health-promoting fermented milk huslianka for centuries. Unfortunately, only two studies on this daily food are available (Kindraczuk 2013; Supińska and Pijanowski 1937). We also introduced such cultures in our laboratory and, in preliminary experiments, confirmed most findings of Dr. Kindrazhuk (Kindraczuk 2013). Interestingly, if the milk obtained from the Carpathian Mountains huslianka or received by us in our laboratory culture is used in close proximity to the Carpathian Mountains plain (Western Ukraine, near Ivano-Frankivsk city), after two nonsterile passages, it is regular and common for this place to produce naturally fermented milk, called “sour milk”. The latter is principally different from huslianka. Considering the claimed health-promoting properties and high dietary value of this food, characterization of the components of the huslianka, including the microbiota, standardization, and introduction of this palatable food in practice, is needed. Moreover, it has a long shelf life without losing quality and without any preservatives. This is the modern trend of using local traditional foods for human benefit. Traditional fermented milk products, such as huslianka, closely align with Hippocrates' ancient aphorism: "All disease begins in the gut." Ultimately, the "secret" to human health lies within the gut/ to be more specific, in maintaining or restoring its structural integrity. This is where fermented dairy products like huslianka can be incredibly beneficial.

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Забуте відкриття з перспективами подальших досліджень: гуслянка – унікальний традиційний карпатський кисломолочний продукт

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Анотація

Гуслянка – унікальний традиційний кисломолочний продукт природного бродіння, який здавна виготовляли гуцули. Наукове дослідження особливостей цього продукту вперше здійснив у 1912 році український дослідник Володимир Кіндрачук, який виділив та описав молочнокислу бактерію, названу ним *Bacillus carpathicus*. Проведені на той час експерименти засвідчили високу здатність цього мікроорганізму до утворення молочної кислоти, своєрідний характер процесу ферментації та пригнічувальну дію щодо окремих видів мікроорганізмів. Попри ці ранні наукові спостереження,

таксономічне положення *B. carpathicus* досі залишається нез'ясованим, а мікробний склад гуслянки недостатньо досліджений із застосуванням сучасних молекулярно-біологічних методів. У статті проаналізовано результати оригінальних досліджень Володимира Кіндрачука, розглянуто історію наукового вивчення гуслянки та проведено порівняння її описаних мікробіологічних і біохімічних властивостей із характеристиками традиційного йогурту. Особливу увагу приділено утворенню молочної кислоти, залежності процесів ферментації від температури, взаємодії мікроорганізмів, а також особливостям зберігання гуслянки за традиційних умов. Історичні дослідження свідчать про значний науковий інтерес до гуслянки, зокрема завдяки її здатності до тривалого зберігання та своєрідним мікробіологічним властивостям, які Володимир Кіндрачук пов'язував із переважанням виділеної ним бактерії *B. carpathicus*. Водночас ці спостереження потребують перевірки із застосуванням сучасних мікробіологічних, геномних і біохімічних методів, а також комплексного оцінювання безпечності продукту. У статті також розглянуто можливе значення гуслянки для харчування людини та перспективи вивчення її потенційних пробіотичних властивостей. Порівняння з йогуртом та іншими ферментованими молочними продуктами дає підстави розглядати гуслянку як самобутній продукт із характерними особливостями мікробного складу й процесів ферментації, що заслуговують на подальше дослідження. З огляду на зростання інтересу до традиційних харчових продуктів, сталих технологій виробництва їжі та функціонального харчування, гуслянка становить інтерес не лише як складова культурної й гастрономічної спадщини Українських Карпат, але й як перспективний об'єкт сучасної харчової біотехнології. Комплексне дослідження її мікробіоти, біохімічного складу, функціональних властивостей і безпечності може створити наукове підґрунтя для збереження традиційної технології виготовлення гуслянки, стандартизації її виробництва та ширшого використання в сучасному харчуванні.

Ключові слова: гуслянка; *Bacillus carpathicus*; ферментоване молоко; Українські Карпати; традиційні харчові продукти; пробіотики; українська кухня.