JBCR Journal of Biomedical & Clinical Research
Journal of Medical University of Pleven

Journal of Biomedical and Clinical Research 18: 129–136 (2025)
DOI: 10.3897/jbcr.e143051

Research Article

Antarctica and psychobiotic effects of *Lactobacillus bulgaricus* under stress

Evgeniya Byrzashka[1], Boyan Mednikarov[2], Mariya Peneva[3], Teodora Valova[1], Georgi Alexandrov[4], Rositsa Nedeva[2]

1 *Medical Uiversity – Pleven, Pleven, Bulgaria*
2 *Nikola Vaptsarov Naval Academy, Varna, Bulgaria*
3 *Health Management Department, MC Evrozdrave-Bulgaria Ltd, Sofia, Bulgaria, Sofia, Bulgaria*
4 *Military Medical Academy, Sofia, Bulgaria*

Corresponding author: Evgeniya Byrzashka (byrzashka@abv.bg)

Summary

The maritime profession is an extreme test of the crew's mental health. Psychobiotics are live bacteria that improve the gut microbiome and benefit the host's mental health. The study aims to establish the effect of a probiotic containing *Lactobacillus bulgaricus* DWT1 on the mental resilience of the crew of the St. St. Cyril and Methodius research ship during the First Bulgarian Military Antarctic Expedition during the 127-day journey to Antarctica. The crew was divided into two groups: the first took the probiotic, and the second did not. Zung questionnaires were used to test anxiety and depression levels in everyone before departure and after return. We used the Wilcoxon test to analyze data from sleep quality assessments. The individuals taking the probiotic showed no statistically significant differences in anxiety and depression levels before and after the journey and maintained sleep quality under the expedition's extreme conditions. The ones not taking the probiotic had a significant increase in anxiety and depression levels, which correlatively worsened physiological sleep. The journey of the military ship crew to Antarctica is a model for studying the effects of probiotics containing *Lactobacillus bulgaricus* DWT1 on the mental health of people subjected to extreme stress. The probiotic's formula is psychobiotic, maintains the gut-brain axis, protects against depression and anxiety and improves physiological sleep under stress.

Key words: Antarctica, depression, *Lactobacillus bulgaricus*, Naval Academy, probiotic

Academic editor: Pencho Tonchev
Received: 29 November 2024
Accepted: 3 February 2025
Published: 9 April 2025

Citation: Byrzashka E, Mednikarov B, Peneva M, Valova T, Alexandrov G, Nedeva R (2025) Antarctica and psychobiotic effects of *Lactobacillus bulgaricus* under stress. Journal of Biomedical and Clinical Research 18: 129–136. https://doi.org/10.3897/jbcr.e143051

Introduction

Probiotics play an important role in maintaining human health (Guha et al. 2019). Ongoing experimental and clinical studies of the effects of probiotics necessitated the appearance of new terms such as psychobiotic (Shopova et al. 2023). Psychobiotics are live bacteria that can provide mental health benefits by improving the host's gut microbiome. Even 2,000 years ago, Hippocrates stated that all diseases start from the gut. Dr. William Beaumont, a US Army surgeon known as the Father of Gastric Physiology, conducted experiments

to determine the relationship between the bowel state and the emotions and anger of patients. In 2024, scientists from the University of Virginia School of Medicine and the University of Florida published data from an experimental study on mice, which proved that the good Bulgarian bacterium *Lactobacillus bulgaricus* prevents the onset of mental disorders such as depression and anxiety (Merchak et al. 2024). Dr Bankole Johnson summarized that this study highlighted the role of the gut microbiome in regulating stress and anxiety and shows how nutrition affects our mental well-being.

The maritime profession puts the health of every crew member to the test (Nedeva et al. 2023a). The influence of climatic conditions, crossing different time and climatic zones, social isolation, sensory deprivation, and many other physiological and psychological factors have a significant impact on the health of the ship's crew (Nedeva et al. 2023b).

Purpose

The present study aimed to determine the effect of a probiotic formula containing *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4 on the mental resilience (anxiety, depression, professional burnout) of the crew of the St. St. Cyril and Methodius Research Vessel 421 during the First Bulgarian Military Antarctic Expedition. It is included in project No. 21-00038 (Study of the immunostimulating and protective effect of probiotic food by monitoring the change of the physiological and biochemical parameters and behavioural responses in extreme stress situations). The project was carried out by Nikola Vaptsarov Naval Academy in collaboration with Prof. Dr Paraskev Stoyanov Medical University – Varna and St. Kliment Ohridski Sofia University. The following tasks were set:

- Examination of the psychological state of the crew members before departure;
- Examination of the psychological state of the crew members after return;
- The results of the individuals taking probiotic formula containing *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4 were compared with those not taking this probiotic.

Materials and methods

We studied 23 sailors from the 25-member crew of the first Bulgarian military St. St. Cyril and Methodius research vessel (RV) 421. All were men at an average age of 36, all in service at Nikola Vaptsarov Naval Academy. Seven of them were army officers. All participants in the study were informed in detail about the aims, objectives and method of conducting the study. They signed written informed consent and privacy forms. All the tests were made by the cabin company officers from the Nikola Vaptsarov Naval Academy – specialists in psychology and the ship's physician from the Military Medical Academy Sofia. The research sessions were six. Voluntarily, the study participants were divided into two groups. The first group, hereinafter referred to as A, included 10 individuals (43.5%). They took a probiotic formula containing *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4 at a daily dose of 10 g. The second group, referred to as B, included 13 individuals (56.5%) who did not take

the probiotic. There were six officers in Group A and one officer in Group B. The first Bulgarian Military Antarctic Expedition took place in the period December 2022 – April 2023, including the sailing of the St. St. Cyril and Methodius Bulgarian RV421 from the port of Varna, Bulgaria, to the Bulgarian Research Base St. Kliment Ohridski on Livingston Island, Antarctica, stay there and sailing back to the Motherland. The duration of the expedition was 127 days (departure on 27.12.2022, return on 02.05.2023).

The probiotic formula, taken by the sailors in group A, is a Bulgarian product of scientific work, subject to patent protection in USA Patent No. US 9,131,708 B2/ Sep. 15, 2015 (Petrova and Alexandrov 2015), and in Bulgaria Patent №4294 U1/15.08.2022 (Peneva et al. 2022). The strains *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4 the product contains are original strains registered in the Czech Collection of Microorganisms at Masaryk University under the Budapest Treaty. These strains are the first in the world isolated from pure spring water in the Balkan Mountains, Bulgaria (Petrov et al. 2014).

The following methods were used to study the mental resilience of the crew:

- Zung psychological questionnaires for measuring the level of anxiety and depression (Kokoshkarova 1984);
- Beverly Potter's Methodology (Leadership Case Studies, Volume 4) is used to assess professional burnout;
- A questionnaire, part of the Neo-Pi-R, is used to assess the level of Extroversion of the personality and its facets – E1 Warmth; E2 Sociability; E3 Assertiveness; E4 Activity; E5 Thrill seeking; E6 Positive emotions;
- A questionnaire, part of Neo-Pi-R, is used to assess personality for „Openness to new experience" and the corresponding facets: O1 Fantasy; O2 Aesthetics; O3 Feelings; O4 Actions; O5 Ideas; O6 Values. Questionnaires, part of the Neo-Pi-R, use the Likert assessment scale. The questionnaires, part of the Neo-Pi-R, are standardized for a military environment;
- Sleep Quality Assessment (PSQI) methodology was used to study sleep. Data analysis was obtained from the sleep quality assessment using the Wilcoxon test. The survey questions aimed at self-assessment of sleep quality;
- Data were processed with the SPSS 19 statistical program. Spearman non-parametric correlation analysis and Wilcoxon test were performed;
- The indicator results from the individual research sessions are digitized and plotted in tables and figures. They are presented personally for the tested individuals in an SPSS, version 19, statistical data processing program.

Results and discussion

All methods were used to examine participants in the study before departure. Tables 1, 2 present the pre-departure examination results of the study participants in groups A (taking the probiotic) and B (not taking the probiotic).

The following methods were used to examine the study participants after return: „Openness to new experience", Zung for assessing the level of anxiety, Zung for assessing the level of depression, Questionnaire to assess sleep quality and level of professional stress (Burnout). Table 4 presents the test results of the study participants from groups A and B (taking and not taking the probiotic) after return.

Table 1. Descriptive statistics of Neo Pi R questionnaire, facet "Extroversion", values measured before departure.

		Warmth	Sociability	Assertiveness	Activity	Thrill-seeking	Positive emotions	Total score on the "Extroversion" scale
N	Valid	22	22	22	22	22	22	22
	Missing	1	1	1	1	1	1	1
Mean		24.54	19.95	18.95	19.04	19.22	20.72	123.18
Median		25.00	20.00	19.00	18.50	20.00	23.00	124.00
Mode		22.00[a]	20.00[a]	19.00	15.00[a]	23.00	14.00[a]	105.00[a]
Std. Deviation		3.73	3.20	4.12	3.56	5.14	6.54	16.31
Skewness		-0.11	0.42	0.09	0.47	0.15	-1.22	0.66
Std. Error of Skewness		0.49	0.49	0.49	0.49	0.49	0.49	0.49
Kurtosis		0.45	0.42	0.34	-0.14	-0.19	1.76	0.98
Std. Error of Kurtosis		0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table 2. Descriptive statistics of Neo Pi R questionnaire, facet „Openness to new experience", values measured before departure.

	Fantasy	Aesthetics	Feelings	Actions	Ideas	Values	Total score on "openness to new experience" scale
Mean	16.68	16.90	19.27	14.50	16.95	17.95	103.81
Median	17.00	17.00	20.00	15.50	16.50	17.50	100.50
Mode	17.00[a]	16.00	17.00	16.00[a]	15.00	17.00[a]	95.00[a]
Std. Deviation	5.07	5.05	4.45	3.15	3.42	2.73	19.54
Skewness	-0.71	-0.76	-0.48	-0.68	0.35	0.01	1.11
Std. Error of Skewness	0.49	0.49	0.49	0.49	0.49	0.49	0.49
Kurtosis	0.99	0.44	-0.67	-0.65	-0.66	0.03	3.73
Std. Error of Kurtosis	0.95	0.95	0.95	0.95	0.95	0.95	0.95

Table 3. Descriptive statistics of Zung questionnaires for anxiety, depression and burnout, values measured before departure.

	Level of anxiety	Level of depression	Burnout
Mean	27.81	29.13	8.86
Median	26.00	29.00	4.00
Mode	23.00	26.00	1.00
Std. Deviation	7.04	5.93	12.73
Skewness	1.11	0.34	2.98
Std. Error of Skewness	0.49	0.49	0.48
Kurtosis	0.73	-0.28	10.20
Std. Error of Kurtosis	0.95	0.95	0.94

*Multiple modes exist. The smallest value is shown.

More methods were used to test the study participants before departure to determine their personality qualities more accurately. The psychological selection of job candidates is crucial for risky professions such as policemen, soldiers, firefighters, and sailors. Personality qualities that support adaptation and coping in extreme situations can help employers select specialists suitable for a particular activity. The personality assessment aims to determine which personality qualities are relevant to successful adaptation to changes and can serve as a buffer in stressful situations.

Table 4. Post-return results on „Openness to new experience" facet.

	Fantasy	Aesthetics	Feelings	Actions	Ideas	Values	Total score on "openness to new experience" facet
Mean	17	17.56	20.52	15.21	16.82	18	105.04
Median	17	17	19	16	16	18	100
Mode	12.00[a]	16.00	18.00	16.00	15.00	18.00	100.00[a]
Std. Deviation	4.31	4.74	4.46	3.04	3.92	1.93	15.97
Skewness	-0.06	-0.35	0.90	-0.30	0.09	0.71	0.32
Std. Error of Skewness	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Kurtosis	-0.52	2.94	0.57	0.35	-0.50	-0.06	-0.80
Std. Error of Kurtosis	0.94	0.94	0.94	0.94	0.94	0.94	0.94

Table 5. Results obtained on the Zung questionnaires for determining the level of anxiety, depression and professional burnout, measured after return.

	Level of anxiety	Level of depression	Burnout
Mean	31.59	33.63	38.3
Median	32	32.5	34
Mode	26.00[a]	43.00	29.00
Std. Deviation	7.16	9.02	13.92
Skewness	0.38	0.49	0.77
Std. Error of Skewness	0.49	0.49	0.48
Kurtosis	0.29	-0.42	0.05
Std. Error of Kurtosis	0.95	0.95	0.94

Studies of the impact of maritime activity and long voyages on the psyche of ship crews focus on the manifestation of anxious and depressive symptoms among crew members due to the influence of the distance from family, the impossibility of separating work from rest, fatigue, emotional exhaustion, harsh conditions in a limited space, etc.

Regarding all participants (groups A and B as a total), statistically significant differences are observed in the level of anxiety (Z-2.228; $p < 0.0027$), in the level of depression (Z-2.260; $p < 0.0027$) and in the level of burnout (Z-3.119; $p < 0.005$), measured before departure and after return.

The study of the collective group shows an increase in the levels of anxiety, depression and burnout syndrome upon return from Antarctica at the expense of the individuals in group B who did not take the probiotic.

Data comparative analysis of the studies of the individuals from group A, taking the probiotic, and those from group B, not taking the probiotic, during the journey showed the following results:

- In the individuals from group A, there are no statistically significant differences in the levels of anxiety and depression measured twice before departure and after return (Z-1.415; $p = 0.157$; Z-2.202; $p = 0.0028$). There are statistically significant differences among them in the burnout level measured before departure and compared with the results after return (Z-4.170; $p < 0.005$);

- In the individuals from group B, statistically significant differences were found in the levels of depression and burnout measured before departure and in their comparison with the data obtained after return. (Z-2.202; $p < 0.005$; Z-3.119; $p < 0.005$).

The results showed that the group A individuals who took the probiotic formula during the journey had no increase in anxiety and depression manifestations after their return from the Antarctic. The individuals from group B who did not take the probiotic formula had a significant increase in the manifestations of anxiety and depression.

Sleep is an important factor that affects human well-being. Sleep is characterized by peculiar cycles raging from a nap to a deep sleep, with intervals of a unique type of sleep with vivid dreams. During sleep, the body recovers from physical activity during the day and organizes mental processes. The quality of sleep has a direct impact on fatigue accumulation. Fatigue accumulation and chronic lack of sleep can lead to increased anxiety, depressive states, accidents, and even trigger mental disorders. More and more shipping companies are surveying the sleep quality of their crews in order to prevent, analyze and control the factors on board the ship leading to sleep problems.

The sleep study results showed a correlation between the sleep status before the crew departure and the changes in the sleep quality after return. The quality of sleep and its dynamics directly interact with the level of accumulated fatigue and stress and their processing at a mental level. There are statistically significant correlations between the separate items in the study of sleep quality and the level of depression and anxiety.

We found statistically significant profound positive correlations between the assessment of item „How long (in minutes) did it take you to fall asleep at night?“, item „I cannot fall asleep within 30 min.“ and item “I wake up because I cough or snore loudly“ and the level of depression ($rs = 0.608$; $p = 0.003$; $rs = 0.433$; $p = 0.050$; $rs = 0.495$; $p = 0.023$).

Our results show that the study participants in group A, who took the probiotic, had no increase in the symptoms of anxiety and depression and maintained the quality of their sleep under the extreme conditions of sailing.

The study of the effects of the probiotic formula on the psyche continued during the journey of the military ship 421 to Antarctica and back on the second Bulgarian military Antarctic expedition, with a new crew, including women.

Conclusions

The journey of the crew of the St. St. Cyril and Methodius Bulgarian research ship 421 during the First Bulgarian Military Antarctic Expedition is a model for studying the effects of a probiotic formula containing *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4, on the mental health of people subjected to extreme stress and strain.

The probiotic formula protects against the emergence of depression and anxiety and improves physiological sleep under stressful conditions.

The probiotic formula with *Lactobacillus bulgaricus* DWT1 and *Streptococcus thermophilus* DWT4 supports the gut-brain axis, acts as a psychobiotic, and maintains mental health.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statements

The authors declared that no clinical trials were used in the present study.

The authors declared that no experiments on humans or human tissues were performed for the present study.

The authors declared that no informed consent was obtained from the humans, donors or donors' representatives participating in the study.

The authors declared that no experiments on animals were performed for the present study.

The authors declared that no commercially available immortalised human and animal cell lines were used in the present study.

Funding

No funding was reported.

Author contributions

All authors have contributed equally.

Author ORCIDs

Evgeniya Byrzashka https://orcid.org/0000-0001-7770-1751
Boyan Mednikarov https://orcid.org/0000-0003-4247-897X
Mariya Peneva https://orcid.org/0000-0002-4500-0122
Teodora Valova https://orcid.org/0000-0002-2987-3089
Georgi Alexandrov https://orcid.org/0000-0002-3811-0120
Rositsa Nedeva https://orcid.org/0000-0002-0543-1331

Data availability

All of the data that support the findings of this study are available in the main text.

References

Guha D, Banerjee A, Mukherjee R, Pradhan B, Peneva M, Alexandrov G, Suklabaidya S, Senapati S, Aich P (2019) A probiotic formulation, containing *Lactobacillus bulgaricus* DWT1, inhibits tumor growth by activating pro-inflammatory responses in macrophages. Journal of Functional Foods 56: 232–245. https://doi.org/10.1016/j.jff.2019.03.030

Merchak A, Wachamo S, Brown LC, Thakur A, Moreau B, Brown RM, Rivet-Noor CR, Raghavan T, Gaultier A (2024) *Lactobacillus* from the Altered Schaedler Flora maintain IFNγ homeostasis to promote behavioral stress resilience. Brain, Behavior and Immunity 115: 458–469. https://doi.org/10.1016/j.bbi.2023.11.001

Nedeva R, Velikova S, Stoyanov V (2023a) Psychological assurance of ship crews: following the example of the Bulgarian Navy. X Jubilee International Congress of Psychology – the Challenges to Modern Psychology, Sofia (Bulgaria). http://psychology-bg.org/wp-content/uploads/Program-X-congres-Final-18.10.2023.pdf

Nedeva R, Stavrev D, Mednikarov B, Doncheva D, Georgieva M, Vladimirova N (2023b) The maritime profession and the physical and mental health of the crew: a study of anthropometrical and psychological alterations after the first transatlantic voyage to the Antarctic. 13-th South-East European Conference on Chemotherapy and Infection, Belgrade (Serbia), October 2023. Journal of International Medical Assembly Bulgaria – Annual Proceeding (Scientific Papers), 2023, vol. 29. Publisher: Peytchinski Publishing Ltd., Pleven, Bulgaria, 6–8. [ISSN: 1312 773X, SUPPLEMENT] https://www.journal-imab-bg.org/issues-2023/Supplement/2023v29Supplement1Medicine.pdf

Peneva M, Alexandrov G, Petrova D, Alexandrov N (2022) Biologically active product. The Patent Office of the Republic of Bulgaria, Utility model registration certificate, Reg. № 4294 U1, 1–13.

Petrova D, Alexandrov N (2015) Probiotics for Dietary Dairy Product. United States Patent and Trademark Office, United States Patent No. US 9,131,708 B2, 1–24.

Petrov N, Alexandrov G, Peneva M (2014) Newly found origin of probiotics in the Balkans. IPA World Congress, Athens, Greece, Beneficial Microbes, ISSN 1876-2883, 5: 14. https://doi.org/10.3920/BM2014.S1

Shopova I, Bogueva D, Yotova M, Danova S (2023) Can Bulgarian yogurt enhance astronauts' performance during the Mars missions? Journal of Ethnic Food 10: 1–16. https://doi.org/10.1186/s42779-023-00211-5