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Dietary Correction of Stress- and Trauma-related Mental Disorders: Kefir as a Psychobiotic Agent

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Abstract

Dietary correction of psychological disorders is an extensively developing area. Kefir is a popular dairy product that attracts attention due to its capability to correct mental disorders related to trauma and chronic stress, such as post-traumatic stress disorder and generalized anxiety disorder. This work aims to systematically analyze the neurobiological and molecular mechanisms, which the gut microbiota, in conjunction with metabolites from fermented foods such as kefir, modulates emotional and cognitive parameters. The authors' analysis shows that stress-induced dysregulation of the hypothalamic-pituitary-adrenal axis compromises the intestinal barrier, leading to systemic neuroinflammation. Kefir counteracts this process by strengthening tight junctions, reducing the translocation of pro-inflammatory lipopolysaccharides and food particles from the intestinal lumen into the bloodstream, particularly by producing short-chain fatty acids such as acetate, propionate, and butyrate. The paper demonstrates a direct link between kefir consumption and increased expression of brain-derived neurotrophic factor via short-chain fatty acids mediated epigenetic modulation and the production of the inhibitory neurotransmitter gamma-aminobutyric acid. We propose here the evidence-based recommendations for clinical practice, that a minimum kefir intervention duration of eight weeks is required for sustainable therapeutic effects. Due to its general psychobiotic properties realized through antiintflammatory, antioxidant, and neutropic effects, kefir may be a promising, safe, accessible, and inexpensive adjunct therapy to traditional psychotropic medications, calling for further large-scale randomized controlled trials.

Keywords: Kefir, PTSD, psychobiotics, gut-brain axis, neuroinflammation, short-chain fatty acids

1. INTRODUCTION

The global prevalence of post-traumatic stress disorder (PTSD) and generalized anxiety disorder (GAD), particularly related to the Russian war against Ukraine (Lushchak et al., 2023), underscores the need for effective, safe, and accessible adjuvant therapeutic strategies. Traditional pharmacological interventions are not often very effective and face challenges related to side effects and patient adherence. Recent advancements in neuroscience and microbiology have highlighted the crucial, bidirectional communication between the gut microbiota and the central nervous system (CNS) via the gut–brain axis (GBA). This review focuses on the potential of kefir, a traditional fermented milk beverage, as a functional food and psychobiotic agent for the dietary correction of these stress- and trauma-related disorders (Rosa et al., 2017). The work aims to analyse the current literature on the pathogenesis of these disorders, the molecular mechanisms of the GBA operation, and the specific role of kefir components, thereby justifying its clinical application as an integrative therapeutic tool.

2. PATHOGENESIS OF TRAUMATIC AND STRESS DISORDERS

2.1 Post-traumatic stress disorder

Post-traumatic stress disorder is a pathological condition that can occur in individuals who have experienced an event that involved a threat of death or serious injury, accompanied by intense fear. Patients with this problem repeatedly relive the traumatic event in the form of nightmares, intrusive memories, flashbacks, as well as physiological arousal and stress in response to reminders of the trauma.

The pathogenetic mechanism of PTSD is usually attributed to an imbalance between hypersensitive (Amygdala, Dorsal Anterior Cingulate Cortex (dACC), Insular Cortex) fear structures and hyposensitive (Medial Prefrontal Cortex (mPFC), Ventromedial Prefrontal Cortex (vmPFC), Hippocampus) regulatory structures in the brain (Shin & Liberzon, 2010).

Amygdala: In PTSD patients, the amygdala is generally considered hyperresponsive (hyperactivated). This heightened responsiveness may explain exaggerated fear responses and the persistence of traumatic memories. Functional neuroimaging studies support increased amygdala activation in response to trauma-related cues, fear expressions, and emotional stimuli (Rabinak et al., 2011).

Medial Prefronal Cortex: vmPFC, including the Rostral Anterior Cingulate Cortex (rACC), is typically found to be hyporesponsive (e.g.,dysfunctional). It is thought to be unable to adequately inhibit the amygdala. The imbalance between a hyperactive amygdala and a hypoactive mPFC may lead to deficits in fear extinction, emotion regulation, attention, and contextual processing (Hayes et al., 2012).

Hippocampus: Abnormal hippocampal function is observed, which may contribute to deficits in contextual processing. The hippocampus is crucial for distinguishing between threatening and safe contexts. Furthermore, most studies demonstrate a reduced hippocampal volume in patients with PTSD (Hayes et al., 2012). Other Structures: Emerging evidence suggests that the Dorsal Anterior Cingulate Cortex (dACC) and the Insular Cortex may also be hyperresponsive in PTSD, though Insular Cortex hyperresponsivity is not unique to PTSD (Shin & Liberzon, 2010).

2.2 Generalized Anxiety Disorder

Generalized Anxiety Disorder patients complain of constant and severe attacks of anxiety and worry. Amygdala and Medial Prefrontal Cortex (mPFC): While research on GAD is less extensive and results are often inconsistent, some studies also implicate the amygdala and medial prefrontal cortex. For instance, activation of the amygdala and the ventrolateral prefrontal cortex was observed in children and adolescents with GAD in response to masked angry faces (Etkin et al., 2010).

3. THE INTERPLAY BETWEEN STRESS AND THE GUT–BRAIN AXIS

3.1. Impact of Stress on the Gut and Microbiota

Chronic stress is one of the most powerful triggers contributing to the development of systemic inflammation and GBA dysfunction. Its effect is mediated through the activation of the Hypothalamic–Pituitary–Adrenal (HPA) axis, which is the central link in the body's stress response. Activation of the HPA axis leads to the increased release of cortisol (in humans) or corticosterone (in rodents), the primary glucocorticoid. Elevated concentrations of these hormones have a direct impact on the intestine, causing a disruption in the structure and function of the epithelial barrier (Zheng et al., 2017). This compromise of integrity, known as increased intestinal permeability or the "leaky gut" phenomenon, occurs due to the breakdown of tight junctions between the intestinal epithelial cells (Dmytriv et al., 2024). The resultant increase in permeability allows bacterial components, notably lipopolysaccharides (LPS) (endotoxins from Gram-negative bacteria), to translocate from the gut lumen into the systemic circulation. This translocation is a key driver for the escalation of low-grade systemic inflammation or metabolic endotoxemia (Reyes-Martínez et al., 2023).

Stress not only compromises the physical barrier but also profoundly alters the composition of the gut microbiota, a process known as dysbiosis. Stress hormones can directly influence the growth, motility, and virulence of specific bacterial species (Cryan et al., 2019). Significantly, stress is associated with a reduction amount of beneficial bacteria that produce SCFA, such as acetic, propionic, and butyric ones. These acids serve as the primary energy source for colonocytes, maintain the integrity of the protective mucosal layer, and regulate gut immune responses (Koh & Bäckhed, 2020).

3.2. Mechanisms of gut–brain axis communication

Communication along the GBA occurs through several integrated pathways (Fig. 1) that combine rapid neural signaling via the vagus nerve with immune-mediated modulation and metabolic regulation. This system involves the regulation of inflammatory processes and intestinal barrier integrity, together with the actions of microbial metabolites such as short-chain fatty acids SCFAs that collectively maintain functional communication between the gut and the brain.

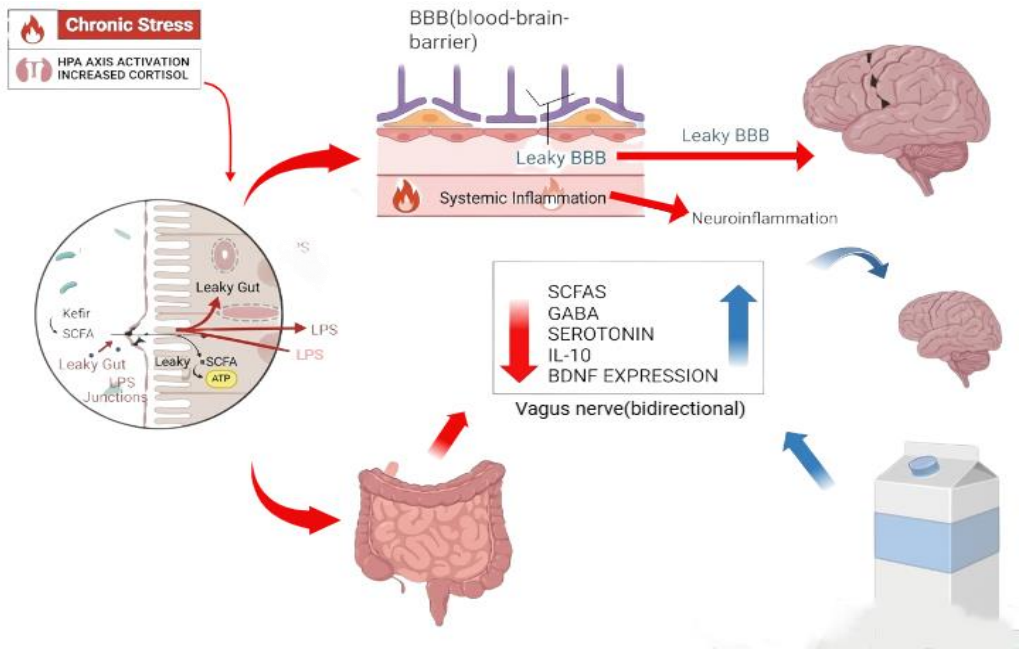

Figure 1. Communication Pathways of the Gut-Brain Axis (GBA) and their Modulation by Stress and Kefir. The diagram illustrates how chronic stress disrupts the GBA via LPS-induced systemic and neuroinflammation (through a leaky blood brain barrier (BBB)). Kefir restores communication by reinforcing the gut barrier and increasing the levels of

key metabolites (SCFAs, Gamma-aminobutyric acid (GABA)) and expression of brain-derived neurotrophic factor (BDNF), utilizing the vagus nerve (bidirectional signaling) as the principal neural link. Source: Adapted using BioRender.com

Neural pathway: The bidirectional communication within the GBA is facilitated by a multi-component neural network that integrates the CNS, the autonomic nervous system (ANS), and the enteric nervous system (ENS). The primary and fastest neural conduit is the vagus nerve, which provides immediate transmission of afferent signals from the gut lumen (including sensory information about microbial metabolites) to the brainstem, as well as efferent regulation of gut functions (Bonaz et al., 2018) . Furthermore, the ENS functions as a "second brain," autonomously controlling gastrointestinal motility and secretion while integrating local signals that are then relayed to the CNS via spinal and vagal pathways, underscoring the critical role of neuroanatomical routes in systemic homeostasis (Carabotti et al., 2015).

Immune Pathway: The immune pathway provides a crucial, non-neuronal route for communication within the GBA, primarily mediated by inflammatory signaling. A key mechanism involves increased intestinal permeability (often termed as a "leaky gut"), which allows bacterial products and other antigens to leak into systemic circulation, thereby initiating or exacerbating systemic inflammation. This peripheral inflammation, in turn, intensifies CNS pathology by compromising the integrity and function of the BBB. As systemic cytokines and other inflammatory mediators transit or signal across a compromised BBB, triggering neuroinflammation, linking peripheral gut health directly to central neurodegenerative and neuropsychiatric disorders (Varatharaj & Galea, 2017).

Metabolic pathway: Crucially, chronic stress is associated with a reduction in beneficial bacteria that produce SCFAs (Dalile et al., 2019). These acids are not only the primary energy source for colonocytes and critical for maintaining the protective mucosal layer, but they also serve as key mediators in the gut–brain axis communication. Gut microbiota bacteria produce SCFAs, which, upon entering the systemic bloodstream, can modulate brain function (O'Riordan et al., 2022). These metabolites influence the brain through several mechanisms: firstly, SCFAs can directly impact the integrity and function of the BBB, and secondly, they participate in the modulation of neurotransmitter synthesis in the brain. Thus, any disruption in SCFA production, caused, for example, by chronic stress, can have a direct effect on the neurobiological processes critical for emotional and cognitive regulation.

4. KEFIR AS A SOURCE OF PROBIOTICS AND BIOACTIVE COMPOUND

4.1. Definition and Chemical Composition of Kefir

Kefir is a fermented milk beverage characterized by natural carbonation and mild acidity. It is traditionally produced by fermenting milk with kefir grains, which comprise a complex symbiotic consortium of microorganisms. The metabolic activity of this microbial community results in a product rich in diverse chemical compounds that determine the functional properties of kefir. Key bioactive components include organic acids, bioactive peptides, exopolysaccharides, vitamins, minerals, and fermentation-derived metabolites (Divnych et al., 2025). Lactic and acetic acids are the predominant organic acids and are primarily responsible for kefir's acidity, flavor, and preservative properties. Proteolytic fermentation processes generate bioactive peptides with reported antihypertensive, antioxidant, and anti-inflammatory activities. Kefir also contains the exopolysaccharide kefiran, which has been associated with immunomodulatory effects and the maintenance of gut health. In addition, kefir provides B-group vitamins, particularly thiamine (B_1) and cobalamin (B_{12}), vitamin K_2, and essential minerals. Yeast activity during fermentation leads to the formation of small amounts of ethanol and carbon dioxide, imparting mild effervescence and a slightly alcoholic character to the beverage.

4.2. Microbiological Composition

Unlike other fermented milk products (e.g., yogurt), the microbial composition of kefir grains is highly diverse (Prado et al., 2015). This symbiotic community is primarily composed of lactic acid bacteria, including the *Lactobacillus*, *Lactococcus*, *Leuconostoc*, and *Streptococcus genera*, as well as acetic acid bacteria, represented mainly by *Acetobacter* species. Furthermore, the yeast population further enriches this consortium, featuring both lactose-fermenting (*Kluyveromyces*) and non-lactose-fermenting (*Saccharomyces and Pichia*) species. These microorganisms are embedded in a unique extracellular polysaccharide matrix known as kefiran, which consists mainly of glucose and galactose.

4.3. Bioavailability, Metabolism, and Permeability

Kefir acts as a psychobiotic by influencing the brain primarily through SCFAs. These SCFAs (notably butyrate, acetate, and propionate) are key metabolites produced by the gut microbiota during the fermentation of indigestible carbohydrates (Cryan et al., 2019). These highly bioavailable metabolites affect the central nervous system in two major, interlinked ways. Of particular significance is their ability to regulate the function of the BBB. Reduction of BBB pepmeability by SCFAs is provided due to the influence on the tight junctions between endothelial cells. This defensive action is crucial for mitigating neuroinflammation and protecting the CNS. Furthermore, after entering the brain, SCFAs function as powerful epigenetic modulators. Specifically, they can inhibit the enzyme histone deacetylase (HDAC). This inhibition increases histone acetylation, leading to the transcriptional activation of beneficial genes, such as the gene encoding BDNF. Thus, SCFAs derived from kefir directly link the microbiome, epigenetics, and the brain's capacity for regeneration and neuroplasticity (Cryan et al., 2019).

5. MOLECULAR MECHANISMS OF PSYCHIATRIC DISORDER CORRECTION BY KEFIR

5.1. Neurotransmitter Modulation

Gamma-aminobutyric acid is the primary inhibitory neurotransmitter in CNS, responsible for dampening neural activity, inducing relaxation. Found in kefir *Lactobacillus* strains, utilizing glutamate as a substrate, can produce GABA due to the present enzyme glutamic acid decarboxylase (GAD). This direct metabolite production in the gut contributes to the anxiolytic (anti-anxiety) effect of kefir by acting on GABA receptors along the gut-brain axis and potentially exerting systemic effects (Grant et al., 2025).

Brain-derived neurotrophic factor is critical to support neuronal survival. It promotes neurogenesis, and is essential for neuroplasticity—the brain's ability to adapt and learn. Its levels are characteristically diminished in stress-related and depressive disorders. Probiotics found in kefir have been shown to stimulate the expression of BDNF in the hippocampus, a brain region vital for memory and emotional regulation. This mechanism is frequently mediated by SCFAs, which act as epigenetic modulators, ultimately enhancing the transcription of the BDNF-encoding gene (Mörkl et al., 2020).

5.2. Anti-inflammatory and antioxidant activity

Probiotic strains in kefir modulate the synthesis of key neurotransmitters and neurotrophic factors, thereby directly impacting the psycho-emotional state. The conceptual model (Fig. 2) demonstrates how kefir mitigates systemic inflammation, which often originates from increased intestinal permeability, so-called "leaky gut" (Dmytriv et al., 2024). Probiotic components and metabolites in kefir counteract translocation from the gut of LPS, a potent pro-inflammatory trigger. At the molecular level, kefir consumption reduces levels of pro-inflammatory cytokines (TNF-alpha, IL-6), an effect demonstrated in stress models (Balatskyi et al., 2025), by inhibiting the crucial

inflammatory signaling pathway, the Nuclear Factor-kappa B (NF-kB) pathway. This inactivation prevents the transcription of pro-inflammatory genes, thereby effectively counteracting neuroinflammation and its detrimental effects on brain function (Yang et al., 2021).

Kefir also exhibits significant antioxidant potential, which is critical for neuroprotection. During fermentation, numerous bioactive peptides are formed, which function as free radical scavengers. These peptides are capable of neutralizing reactive oxygen species (ROS) and reducing intensity of oxidative stress in neurons caused by chronic stress and inflammation. Elevated paraoxonase (PON) activity in the blood suggests reinforced protection against oxidative damage (Balatskyi et al., 2025). Analysis of the cerebral cortex revealed that kefir consumption increases the steady-state transcript levels of genes critical for neuroprotection and the oxidative stress response (e.g., UGDH, PPARGC1A) by modulating local oxidative pathways. Reducing oxidative damage supports the integrity of neuronal membranes and mitochondrial function, thus contributing to the overall neuroprotective effect of kefir (Cryan et al., 2019).

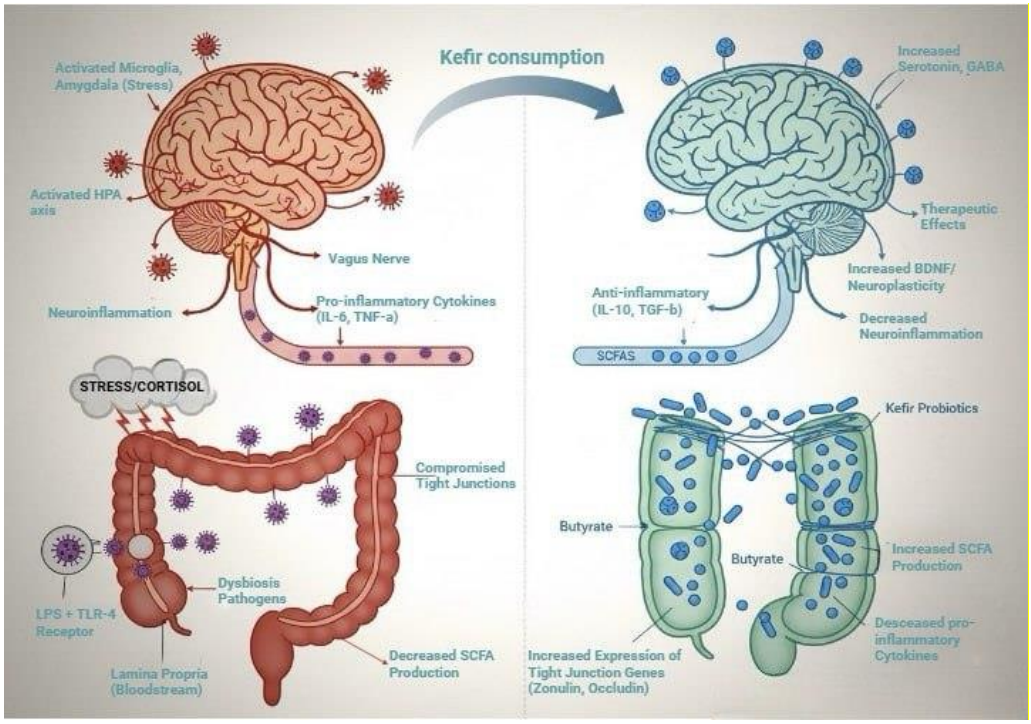

Figure 2. Bidirectional Modulation of the Gut–Brain Axis by Kefir: Mechanisms Countering Stress-Induced Neuroinflammation. Description: The picture illustrates the pathological (left) and corrective (right) pathways of interaction. (Left): Chronic stress activates the HPA axis, leading to increased cortisol levels, which compromises the integrity of tight junctions in the intestinal barrier. This causes the translocation of LPS, which activate TLR4 receptors and initiates systemic inflammation (via vagus nerve signaling and circulating cytokines) and microglial activation in the brain, resulting in neuroinflammation. (Right): Kefir consumption (psychobiotics) increases butyrate production. Short-chain fatty acids strengthen the barrier (by increasing expression of Zonulin-1 and Occludin), blocking LPS translocation. This leads to a reduction in pro-inflammatory cytokine levels, the enhancement of anti-inflammatory and therapeutic signaling to the brain, and the suppression of microglial activity. Source*:* Adapted using BioRender.com

5.3. Improvement of barrier function and hormonal modulation

Kefir-mediated correction of neuropsychiatric disorders encompasses both local effects within the gut and systemic endocrine modulation, highlighting the bidirectional nature of the gut-brain axis.

Probiotic strains present in kefir play a crucial role in strengthening the intestinal barrier, preventing the progression of "leaky gut". They enhance the expression and proper assembly of tight junctions, which seal the intestinal epithelial cells. These tight junctions contain key proteins such as zonulin-1 and occludin. Strengthening these junctions significantly reduces intestinal permeability, which, in turn, prevents the translocation of pro-inflammatory molecules (like LPS) into the bloodstream. This restoration of barrier integrity effectively decreases systemic inflammation, a primary driver of neuroinflammation (Dmytriv et al., 2024).

Kefir consumption also modulates the hormonal stress response by acting on the HPA axis. This axis is the master regulator of the stress response, and its chronic dysregulation is central to the pathogenesis of many stress-induced disorders, including depression. Numerous studies indicate that the probiotics present in fermented dairy products can promote faster recovery of cortisol levels following acute stress, leading to a quicker return to physiological homeostasis. This modulation of HPA axis activity is a key aspect in the therapy of chronic stress-induced disorders (Bodur et al., 2025).

6. KEY STUDIES ON THE EFFECTS OF KEFIR AND SIMILAR PROBIOTICS

6.1. *In Vitro* and Animal Studies

The use of animal models has provided direct evidence on the psychobiotic mechanisms of kefir that are unattainable in *in vitro* settings. The most illustrative studies involve the chronic unpredictable stress (CUS) model, which mimics the chronic stress typical of depressive and anxiety disorder development in humans (Balatskyi et al., 2025). In rodents, *Lactobacillus plantarum* strains (similar to those found in kefir), significantly alleviated anxiety and depression, and these behavioral improvements correlated with distinct neurochemical changes (Chong et al., 2019).

Hypothalamic–pituitary–adrenal modulation: A decrease in corticosterone levels (the main stress hormone in rodents) was found, confirming successful modulation of the HPA axis and improved stress resilience (Balatskyi et al., 2025). This hormonal stabilization facilitates the restoration of the negative feedback loop within the HPA axis, preventing the deleterious effects of chronic glucocorticoid exposure on brain structures.

Catecholamine Modulation: The influence of kefir and similar psychobiotics extends to the rapid stress response system—the "fight-or-flight" mechanism. *Lactobacillus plantarum* strains studies demonstrated restoration of the normal levels of key monoamine neurotransmitters, specifically norepinephrine (NE) and epinephrine (EPI), which are depleted or imbalanced as a result of chronic stress (Liu et al., 2016). This normalization is crucial in critical brain regions, such as the hippocampus and hypothalamus, since the depletion of these "reserves" exacerbates symptoms of anxiety and depression, and restoring their balance contributes to better emotional regulation.

Neuroplasticity: There was also an observed increase in the expression of BDNF in the hippocampus—a brain region critical for emotion and memory. Stimulation of BDNF expression is a key to enhancing neuroplasticity and counteracting the neural atrophy induced by chronic stress (Sun et al., 2021). *In vivo* studies confirm that the active components of kefir have the capacity not only to alleviate symptoms but also to restore stress-disrupted neuroendocrine and neurotrophic signaling pathways (Huang et al., 2017).

6.2. Clinical and Population Studies

A recent cross-sectional studies, examined the relationship between fermented food consumption and social anxiety symptoms in young adults (N = 710) (Hilimire et al., 2015). Regression analysis revealed a significant interaction between fermented food consumption and neuroticism in predicting social phobia symptoms. Specifically, more frequent consumption of probiotic-rich foods (such as yogurt, kefir, and fermented vegetables) was associated with reduced

social anxiety, an effect most pronounced among participants with a high genetic predisposition to neuroticism. The authors concluded that such dietary interventions might serve as a protective factor for at-risk individuals, likely via gut-brain axis mechanisms (Hilimire et al., 2015).

6.3. Comparative Analysis

Recent randomized controlled trials (RCTs) have provided substantial evidence that probiotic interventions can act as modulators of the GBA. In a landmark study by (Tillisch et al., 2013), multi-strain probiotics, similar to those found in kefir, demonstrated a clear impact on the participants' psychoemotional state. Specifically, the intervention improved mood and a statistically significant reduction in the subjective perception of stress. Crucially, these behavioral changes were substantiated by objective neurobiological data. The use of functional magnetic resonance imaging (fMRI) recorded dynamic changes in the brain's response to emotional stimuli. This indicates that probiotics do not merely influence subjective feeling, but actively modulate emotional processing centers in the brain, altering patterns of neural activity. As such, probiotics should be considered as potential psychobiotics capable of influencing cognitive and affective processes via the gut microbiome (Crocetta et al., 2024).

7. PRACTICAL ASPECTS AND FUTURE PERSPECTIVES

7.1. Recommendations for dosing and duration of kefir intake

In the context of psychobiotic correction, particularly for the adjuvant therapy of depressive disorders, clinical data from systematic reviews allow the development of some general recommendations regarding dosing and duration that can be extrapolated to the consumption of fermented products, such as kefir. The RCT meta-analysis is key in defining the minimum effective terms. The analysis showed that to achieve a statistically significant reduction in depression symptoms, the required duration of probiotic intervention is at least eight weeks (Huang et al., 2016). Shorter courses may be insufficient for inducing sustainable changes in the microbiota and functional modulation of the GBA. Some studies included in the analysis typically used probiotic concentrations in the range of 10^9 to 10^{10} CFU/day (colony-forming units). While kefir is not standardized by CFU like pharmaceutical supplements, the consumption of the recommended volume should ensure that this minimum threshold is met. Thus, to achieve a noticeable therapeutic effect in psychiatric diseases, the intervention must be not only regular but also sufficiently prolonged, with a minimum recommended term of eight weeks (Huang et al., 2016).

7.2. Combined Dietary Therapy

While kefir (as a source of probiotics) independently demonstrates pronounced anti-inflammatory and neuroprotective effects, the future of psychobiotic correction lies in the synergistic combination of nutrients. The systematic review affirms that the key mechanisms for CNS protection (specifically combating neuroinflammation and oxidative stress) can be enhanced when probiotic intervention is paired with other bioactive compounds (Socała et al., 2021).

Synergism with Omega-3 and Magnesium: The probiotic kefir action of reducing gut inflammation can be potentiated by Omega-3 Fatty Acids, such as eicosapentaenoic acid and docosahexaenoic acid, which are powerful systemic anti-inflammatory agents. Concurrently, magnesium, as a cofactor for hundreds of enzymatic reactions and a neuroregulatory mineral, can reinforce the function of neural pathways already modulated by microbiota metabolites such as SCFAs (Socała et al., 2021).

Creating Synbiotics: The effect of kefir is amplified when it is utilized as a synbiotic (kefir + prebiotics, e.g., dietary fibers). This combination is critical for maximizing SCFA production directly

in the colon, ensuring the necessary concentration of these neuroactive metabolites to impact the GBA. Specifically, studies combining *Lactobacillus* strains with fructooligosaccharides or galactooligosaccharides as prebiotics demonstrate a marked increase in butyrate concentration, which is critical for neuroprotection and the integrity of the BBB (Kezer et al., 2025). Thus, achieving the maximum neuroprotective effect requires clinical recommendations to favor comprehensive dietary strategies that leverage the synergy of multiple components.

7.3. Limitations and future directions in psychobiotic research

The main limitation in the field of psychobiotic research lies in the lack of large-scale RCTs, especially those focused on patients with clinically diagnosed stress disorders. Existing studies are often characterized by small sample sizes and short intervention durations, which significantly restricts the generalizability of results and the assessment of long-term therapeutic potential. Additional challenges include the high heterogeneity of the psychiatric disorders themselves and significant variability in the strains, formulations, and dosages of psychobiotics used , which complicates standardization and direct data comparison (Dziedziak et al., 2025).

Future research must address these limitations by focusing on personalized psychobiotic diets (individualized strategies), based on a detailed analysis of the patient's microbiota profile. This transition to precision psychobiotics requires the application of high-throughput sequencing, genomics, and artificial intelligence to accurately type the microbiota and predict treatment response. There is also a necessity for conducting long-term RCTs with larger sample sizes and further determining the optimal doses and precise molecular mechanisms of action of effective strains via the gut-microbiota-brain axis (Dziedziak et al., 2025).

7.4. Translational and Clinical Prospects

The research findings confirm the potential of kefir as a functional dietary intervention, which supports its clinical prospects as an adjuvant agent for improving long-term treatment outcomes for stress disorders. Reduction of anxiety and depression: studies in animal models, particularly mouse ones, have shown that long-term consumption of kefir or its peptides reduces anxiety- and depression-like behavior and mitigates symptoms similar to PTSD (Balatskyi et al., 2025). Regulating neurotransmitters (serotonin, dopamine), particularly through kefir peptides that can activate the BDNF/TrkB pathway associated with antidepressant activity (Cryan et al., 2019).

8. CONCLUSIONS

Kefir represents a potent psychobiotic tool capable of mitigating stress-related symptoms through multiple neurobiological pathways. Its consumption enhances neuroplasticity by increasing BDNF expression in the hippocampus and modulates the gut-brain axis by strengthening the intestinal barrier, thereby reducing neuroinflammation and systemic oxidative stress. Acting on the HPA axis, kefir promotes faster recovery of cortisol levels, while its microbial metabolites, such as GABA and short-chain fatty acids (SCFAs), directly contribute to its anxiolytic and antidepressant effects. To achieve sustainable therapeutic results, a minimum intervention period of eight weeks is recommended to induce functional modulation of the microbiota-gut-brain axis.

As an accessible and safe dietary intervention, kefir serves as a promising adjunct to traditional psychotropic medications, potentially improving long-term treatment adherence. Future clinical prospects lie in the development of synergistic combinations, such as synbiotics, to maximize the production of neuroactive metabolites. However, the transition to personalized psychobiotic therapy requires large-scale randomized controlled trials and the utilization of high-throughput sequencing to accurately predict treatment responses. Addressing current limitations like strain

heterogeneity will be crucial for establishing kefir as a standard element of clinical dietary correction for stress and trauma-related disorders.

List of Abbreviations:
ANS – Autonomic Nervous System
BBB – Blood-Brain Barrier
BDNF – Brain-Derived Neurotrophic Factor
CFU – Colony-Forming Units
CNS – Central Nervous System
CUS – Chronic Unpredictable Stress
dACC – Dorsal Anterior Cingulate Cortex
ENS – Enteric Nervous System
EPI – Epinephrine
GABA – Gamma-Aminobutyric Acid
GAD – Generalized Anxiety Disorder
GBA – Gut–Brain Axis
HDAC – Histone Deacetylase
HPA axis – Hypothalamic–Pituitary–Adrenal axis
LAB – Lactic Acid Bacteria
LPS – Lipopolysaccharides
mPFC – Medial Prefrontal Cortex
NE – Norepinephrine
NF-kB – Nuclear Factor-kappa B
PTSD – Post-Traumatic Stress Disorder
rACC – Rostral Anterior Cingulate Cortex
RCTs – Randomized Controlled Trials
ROS – Reactive Oxygen Species
SCFAs – Short-Chain Fatty Acids
TrkB – Tropomyosin Receptor Kinase B
vmPFC – Ventromedial Prefrontal Cortex

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Declarations
Conflict of interest. The authors have no competing interests to declare relevant to this article's content.
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Плитус Святослав, Лущак Володимир. Корекція психічних розладів пов’язаних із травмами та стресом: Кефір як психобіотичний агент. Журнал Прикарпатського національного університету імені Василя Стефаника. Біологія 12:168-180.

Дієтична корекція психічних розладів є широко розвиненим та перспективним напрямом сучасної нейропсихіатрії. Кефір — ферментований молочний продукт, дослідження якого привертає значну наукову увагу, завдяки своїй потенційній здатності модулювати психічні розлади, асоційовані з травмою та хронічним стресом, зокрема посттравматичний стресовий розлад і генералізований тривожний розлад. Метою цієї роботи є аналіз нейробіологічних і молекулярних механізмів, за допомогою яких, кишкова мікробіота у взаємодії з метаболітами ферментованих продуктів, таких як кефір, впливає на емоційні та когнітивні параметри. Проведений аналіз свідчить, що індукована стресом дисрегуляція гіпоталамо-гіпофізарно-надниркової осі призводить до порушення цілісності кишкового бар’єра, що, своєю чергою, сприяє розвитку системного запалення та нейрозапальних процесів. Кефір може протидіяти цим змінам шляхом зміцнення міжклітинних щільних контактів епітелію кишківника, зменшуючи транслокацію прозапальних ліпополісахаридів із кишкового просвіту в системний кровотік. Зазначений ефект реалізується, зокрема, через стимуляцію продукції коротколанцюгових жирних кислот, таких як ацетат, пропіонат і бутират. У статті також продемонстровано зв’язок між споживанням кефіру та підвищенням експресії мозкового нейротрофічного фактора, що опосередковується епігенетичною модуляцією, залежною від коротколанцюгових жирних кислот, зокрема інгібуванням гістондеацетилази, а також продукцією інгібуючого нейромедіатора γ-аміномасляної кислоти. На основі наявних експериментальних і клінічних даних запропоновано практичні рекомендації для клінічного застосування: мінімальна тривалість втручання з використанням кефіру становить вісім тижнів і є необхідною для досягнення стійких терапевтичних ефектів. Завдяки своїм психобіотичним властивостям, які реалізуються через протизапальні, антиоксидантні та нейротрофічні механізми, кефір може розглядатися як перспективна, безпечна, доступна та економічно ефективна ад'ювантна терапія на додаток до стандартних психофармакологічних підходів. Водночас доцільність його широкого клінічного впровадження потребує підтвердження в межах великомасштабних рандомізованих контрольованих досліджень.

Ключові слова: кефір, ПТСР, психобіотики, вісь кишечник-мозок, нейрозапалення, коротколанцюгові жирні кислоти.