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Exploring the Gut-Brain Axis in Alcohol Use Disorders - *Ayurvedic* Insights and Therapeutic Strategies

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Abstract

Background: *Ayurveda* recognises a profound intrinsic link between the digestive system and the brain, conceptualised through *Agni* (digestive fire), *Ama* (toxins), and the *Pittadhara-Majjadhara Kala* (physiological pathways). In modern science, this connection is identified as the Gut-Brain Axis. Alcohol Use Disorder, correlated with *Madatyaya*, significantly disrupts this axis, leading to both systemic physiological damage and mental health deterioration. **Aim:** This article aims to explore the *Ayurvedic* perspective on the Gut-Brain Axis in the context of AUD and investigate how alcohol consumption impacts core principles such as *Agni*, *Kalas*, and *Ojas*. **Methods:** This systematic review was conducted in accordance with PRISMA guidelines, integrating evidence from contemporary scientific research and classical *Ayurvedic* literature. A comprehensive search of PubMed, Scopus, Google Scholar, and the AYUSH Research Portal was performed up to April 2023 using predefined keywords. Studies published within the last two decades, including clinical trials, systematic reviews, and meta-analyses, were included. **Results:** Chronic alcohol consumption disrupts the Gut–Brain Axis primarily through vitiation of *Pittadhara Kala,* leading to impaired *Agni, Ama* accumulation, and gut dysbiosis. This disturbance extends to *Majjadhara Kala*, resulting in neuroinflammation, cognitive impairment, and psychological dysfunction. These findings establish a clear *Ayurvedic* correlate of Gut–Brain Axis disruption, highlighting the interdependence of gastrointestinal and neurological pathways. Accordingly, a multidimensional therapeutic approach is advocated, including *Nidana Parivarjana* (avoidance of causative factors), *Panchakarma* (detoxification), *Sattvavajaya* (psychotherapy), and *Achara Rasayana* (behavioural therapy). **Conclusion:** Integrating *Ayurvedic* tenets with modern psychiatry offers a holistic model for treating AUD. Targeting the Gut-Brain Axis through diet, herbal therapy, *yoga*, and meditation supports comprehensive physical and mental recovery.

Major Findings: Alcohol-induced disruption of the *Pittadhara–Majjadhara Kala* axis reflects Gut-Brain Axis dysfunction, effectively managed through integrative *Ayurvedic* therapies.

Keywords: Alcohol Use Disorder, *Ayurveda*, Gut-Brain Axis, *Madatyaya, Majjadhara Kala, Pittadhara*

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1. Introduction

1.1 Gut-Brain Axis

The Gut-Brain Axis is a remarkable two-way communication channel that connects our brain to our digestive system. Originally introduced by the visionary thinkers William James and Carl Lange back in the 1880s as a way to understand how our emotions could be influenced by our bodily state, the concept has evolved through years of research. Modern studies using germ-free mice have brought to light how an imbalance in gut bacteria can significantly affect important chemicals in the brain, such as serotonin and brain-derived neurotrophic factor. These insights reveal that the Gut-Brain Axis functions through a synergy of quick neural reactions and more gradual

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immune responses, creating a delicate balance between our cognitive and digestive systems.

1.2 Overview of Alcohol Use Disorder and its Impact on Gut-Brain Axis

Alcohol misuse is a serious global issue with wide-ranging consequences, claiming over 3.3 million lives every year, as reported by the World Health Organization[1]. Beyond its grave physical health implications, alcohol abuse also has profound psychological effects, often causing depression, anxiety, emotional instability, and a slew of other mental health disturbances.

Moreover, alcohol consumption can lead to significant social challenges, including work-related problems, strained relationships, financial troubles, and incidents of violence. These issues underscore the pressing need for understanding and addressing the complex consequences of alcohol abuse. Crucially, alcohol has been shown to disrupt the gut microbiota, the vast and diverse community of microbes that reside in our bodies, outnumbering our own cells. The human body hosts approximately 10^{13} to 10^{14} bacteria[2]. As the most dominant members of this microbiota, *Bacteroidetes* and *Firmicutes* play critical roles in our well-being[3]. Recent insights reveal the extensive damage alcohol can inflict on the gut-brain axis by causing dysbiosis or an imbalance in our gut microbiome[4]. This disturbance is not a mere footnote in the narrative of alcohol's impact; it is central to the understanding of how alcohol can affect our brain's health and functioning. A wealth of studies identify multiple pathways through which the gut microbiota influences processes affected by alcohol. These include neural pathways like the Vagus nerve[5], Immune system responses[6], the Neuroendocrine system involving the HPA axis[7], metabolic pathways[8], and inflammatory pathways. This multifaceted web of interactions highlights the profound ways in which alcohol reshapes the delicate interplay between our gut and brain, further emphasising the importance of protecting and nurturing this axis for overall health and well-being.

1.3 Introduction to *Ayurveda* and Its Holistic Approach to Health

Ayurveda is an ancient system of medicine that originated in India. While many medical practices focus on treating illness, *Ayurveda*'s primary goal is to preserve the health of individuals who are already healthy and to restore health in those who are unwell. In *Ayurveda*, health encompasses the proper functioning of the mind, body, and soul. According to *Acharya Sushrut*, health is defined as a state of balanced *doshas*, tissues, and proper elimination of wastes. This balanced state results in peace of mind, senses, and soul. At the core of *Ayurveda*'s approach to Alcohol Use Disorders is the concept of *dosha* balance and *dhatu Shodhana* (purification of tissues). Each person has a unique constitution, or *prakriti*, determined by the predominance of *Vata, Pitta,* and *Kapha Doshas*, as well as *Raja* and *Tamas doshas*. An imbalance in these *doshas* can lead to physical, mental, and emotional disturbances, including addictive behaviours. *Ayurvedic* therapies for Alcohol Use Disorders focus on restoring *dosha* balance and addressing the underlying causes of addiction. This holistic approach recognises that addiction involves not only physical dependence on alcohol but also psychological, social, and spiritual aspects. *Ayurveda* emphasises restoring balance, promoting self-awareness, and fostering resilience, aligning with the journey of recovery and empowering individuals to lead fulfilling, substance-free lives.

2. Materials and Methods

This study follows a systematic review methodology, synthesising modern scientific research and conducted in accordance with PRISMA guidelines, synthesizing modern scientific research and classical *Ayurvedic* literature to provide a comprehensive understanding of Alcohol Use Disorder. A comprehensive electronic literature search was conducted from inception to April 2023 using databases such as PubMed, Scopus, Google Scholar, and the AYUSH Research Portal. Key search terms included "gut-brain axis", "alcohol use disorder", "gut microbiota", "neuroinflammation", "*Ayurveda* and alcohol", and "*Panchakarma* in addiction". The review focused on studies published within the last two decades, prioritising clinical trials, meta-analyses, and systematic reviews. Selected articles were critically evaluated based on their methodological rigour, relevance to AUD pathophysiology, and implications for treatment. Classical *Ayurvedic* texts, including *Charaka Samhita*, *Sushruta Samhita*,

*Ashtanga Hridaya***,** and *Bhavaprakasha***,** were examined to extract concepts related to *Madatyaya* (alcohol-related disorders), *Pittadhara Kala*, and *Majjadhara Kala*. *Ayurvedic* pathophysiological interpretations involving dosha imbalances**,** *dhatu* involvement, and *srotas* (microchannel) impairments were systematically analysed. Commentaries from *Ayurvedic* scholars and pharmacological texts (*Nighantu*) were reviewed to identify herbal formulations relevant to AUD. Articles meeting the inclusion criteria were categorised based on pathophysiology, gut microbiome alterations, neuroinflammatory mechanisms, and *Ayurvedic* interventions. Cross-disciplinary parallels were identified, particularly in relation to *Ama* (toxic metabolites), inflammatory pathways, gut barrier integrity, and neurotransmitter modulation. Integrative therapeutic strategies were synthesised to provide a holistic treatment framework. *Ayurvedic* interventions, including *Shodhana* (detoxification), *Shamana* (palliative care), *Rasayana* (rejuvenation), and *Ahara-Vihara* (diet and lifestyle modifications), were systematically reviewed for their effects on gut-brain health. Neuroprotective and gut-restorative *Ayurvedic* formulations such as *Brahmi (Bacopa monnieri), Ashwagandha (Withania somnifera), Guduchi (Tinospora cordifolia), Shankhpushpi (Convolvulus pluricaulis),* and *Takra* (medicated buttermilk) were assessed. *Panchakarma* therapies like *Virechana* (purgation) and *Basti* (medicated enema) were evaluated for their detoxifying and microbiota-modulating benefits.

2.1 Inclusion Criteria

The inclusion criteria comprised peer-reviewed publications published within the past 20 years, including original research articles, clinical trials, systematic reviews, and meta-analyses. Studies focusing on the gut-brain axis, gut microbiota, neuroinflammation, and Alcohol Use Disorder were considered. Additionally, research exploring *Ayurvedic* principles such as *Madatyaya*, *Agni*, *Ama*, and *Panchakarma* therapies was included to provide a comprehensive and integrative perspective.

2.2 Exclusion Criteria

Non-peer-reviewed materials such as editorials, commentaries, opinion pieces, and conference abstracts lacking full text were excluded. Studies unrelated to Alcohol Use Disorder or the gut-brain axis were not considered. Additionally, standalone pharmacological research without connections to the gut-brain axis or *Ayurvedic* viewpoints was excluded.

3. Results

3.1 Understanding the Gut-Brain Axis in Alcohol Use Disorders

3.1.1 The Role of the Gut Microbiota in Alcohol Use Disorders

The gut microbiota plays a pivotal role in the context of Alcohol Use Disorders, influencing a wide array of physiological processes. Here's an elaboration on the key points outlining the function of gut microbiota in AUD:

3.1.1.1 Bacterial Metabolites

The gut microbiota generates important metabolites such as Short-chain fatty acids and Tryptophan Metabolites. SCFAs, particularly butyrate, are primarily produced through the fermentation of dietary fibre by colonic microbes. These metabolites not only serve as a vital energy source for colonocytes but also reach the brain, where they can influence neuronal and glial function, thereby affecting behaviour and exerting potential antidepressant effects. dTryptophan, an amino acid from dietary proteins, is metabolised by gut bacteria along several pathways that affect the availability of tryptophan and its metabolites. These metabolites play critical roles in maintaining immune balance and influencing inflammatory reactions within both the gut and brain. The alteration of these processes can shed light on the role of gut microbiota in behavioural changes linked to Alcohol Use Disorders.

3.1.1.2 Neurotransmitter Production

The gut microbiota not only synthesises important neuroactive compounds such as dopamine, serotonin, and gamma-aminobutyric acid but also responds to them[9,10]. These neurotransmitters travel through the bloodstream to the brain and can impact mood regulation, reward circuits, and the stress response, all of which have implications for addiction and substance use behaviours. For instance, *Bacillus* species in the gut have been found to produce dopamine, and the levels

of this neurotransmitter and its turnover outside the CNS are affected by the presence of gut microbiota, highlighting a connection between gut health and brain function[10]. Gut microbiota have the amazing ability to transform glutamate, a type of amino acid, into GABA, a substance that our brain uses to regulate mood, find pleasure, and manage stress. Specific bacteria like *Bacteroides, Lactobacillus,* and *Bifidobacterium* are the key producers of GABA[11,12]. This GABA can then travel to our central nervous system, where it plays a big part in controlling behaviours linked to addiction and substance use, thanks to special transporters that help it cross into the brain.

3.1.1.3 Microbiota Composition

Alcohol consumption has a direct and damaging effect on the intestinal microbiota. Clinical research indicates that alcohol can significantly alter the diversity and makeup of the gut microbiome, in turn resulting in intestinal mucosal damage and increased permeability. This condition allows bacteria and their metabolites, including neurotransmitters, to leak into the bloodstream, potentially impacting overall health and well-being. One particular clinical study discerned a marked difference in the gut microbiomes of alcoholic patients compared to healthy controls, including decreased populations of beneficial bacteria like *Bifidobacteria, Lactobacilli,* and *Enterococci*[13] and a unique microbial pattern in those with AUD, featuring a reduction in *Akkermansia* and an increase in *Bacteroides*, with an accuracy rate of 93.4%[14].

3.1.1.4 Craving

Cravings in people with Alcohol Use Disorders might be more complex than just a need or desire for alcohol; they could be influenced by the gut microbiota's composition and functions. Specific bacteria and their metabolic processes in the gut are showing connections to the cravings experienced by individuals with AUDs. For example, there is a particular association between the craving for alcohol and a reduction in a type of bacteria known as *Ruthenibacterium lactatiformans*[15]. The way our gut microbiome influences cravings is linked to how it synthesises and breaks down certain substances. When there's a craving, there seems to be a decrease in the production of butyrate and inositol, while substances like acetate, glutamate, and tryptophan are increasingly synthesized[16]. Various changes in the gut are noted to go hand-in-hand with cravings. There's a decrease in the breakdown of acetate coupled with an increase in its creation. The production of butyrate, which plays a significant role in gut health, is lessened. The degradation of specific amino acids like valine and cysteine slows down, which is also related to intensified cravings. There's an increase in the conversion of acetyl-CoA to acetate and alcohol, which might be associated with the urge to drink. In sum, the emerging data suggest that cravings may be partly driven by the biochemical activities carried out by our intestinal microbes, adding another layer of complexity to understanding and treating AUDs.

3.2 Impact of Alcohol Use Disorder on Gut Health

Alcohol Use Disorder can have detrimental effects on gut health through a couple of major pathways: dysbiosis, increased intestinal permeability, nutritional dysfunction, inflammation and gastrointestinal disorders.

3.2.1 Dysbiosis

Chronic alcohol abuse can lead to dysbiosis, which is characterised by an imbalance between beneficial and harmful bacteria in the gut. This disturbance can decrease populations of good bacteria and increase harmful microbes, potentially causing gastrointestinal issues and inflammation. Studies have shown that alcohol consumption can alter the relative abundance of certain bacterial families and genera. For example, in alcohol-preferring rats, there is an increase in the genera *Ruminococcus* and *Coprococcus*[17]. In patients with Alcohol-Related Liver Disease, there's a higher relative abundance of *Proteobacteria, Lactococcus* and *Clostridium*, and lower *Firmicutes* and *Bacteroidetes*, among others. The increase in Gram-negative bacteria, like *Proteobacteria, Enterobacteriaceae,* and *Fusobacteria*, heightens the risk of inflammation due to lipopolysaccharides(LPS)[18], which are components of the bacterial cell wall known to stimulate strong immune responses.

3.2.2 Intestinal Permeability

Alcohol abuse can damage the intestinal barrier, resulting in increased permeability, often termed

"leaky gut". This condition allows toxins and microbial byproducts to leak into the bloodstream, which can prompt immune reactions and contribute to gut inflammation. Proteins such as Zonula Occludens-1 and occludin are critical for the tight junctions that preserve the integrity of the intestinal wall[19]. Alcohol can affect the expression of these proteins, altering tight junction structure and function[20-22]. Acetaldehyde, a by-product of ethanol metabolism, further impairs intestinal tight junctions by misplacing and reducing ZO-1 and occludin within cells[23]. This leads to fewer tight junctions[24], compromised intestinal barrier function, and can exacerbate the effects of dysbiosis.

3.2.3 Nutritional Dysfunction

Vitamin deficiencies can occur as a result of alcohol consumption, which can damage the intestinal barrier and hinder the absorption capabilities of the small intestine. This can, in turn, lead to malnutrition, including in the brain, where various vitamins play critical roles. Vitamin B1 (thiamine) is necessary for the Krebs cycle, which is pivotal for energy production in brain cells. A deficiency in vitamin B1 can lead to a decrease in energy production, potentially resulting in cell death and brain dysfunction[25]. Vitamin C is essential for various functions in the central nervous system, including neural development, neurotransmitter regulation, and antioxidant protection. A deficit in vitamin C can impair these functions, potentially contributing to neurodegenerative diseases[26]. A lack of vitamin D has been linked to an increased risk of several central nervous system diseases, highlighting the significance of proper vitamin nutrition for maintaining brain health[27].

3.2.4 Inflammation and Gastrointestinal Disorders

Alcohol consumption can activate Kupffer cells in the liver, increasing the production of inflammation markers like interleukin-1, interleukin-6, and tumour necrosis factor-alpha[28]. These inflammatory mediators can worsen gut permeability, allowing them to spread systemically and affect multiple organs. This inflammatory response may lead to gastrointestinal disorders, which can be exacerbated by alcohol use, and increase the severity of conditions like Irritable Bowel Syndrome[29]. Substance use, and particularly alcohol abuse, can thus create a feedback loop where gut health is impaired, leading to nutritional deficiencies and systemic inflammation that can have widespread impacts on bodily systems, including the brain and gastrointestinal system.

4. *Ayurvedic* Insights on the Gut-Brain Axis

The Gut-Brain Axis holds significant importance in *Ayurveda*, highlighting the link between the gastrointestinal system and psychological well-being. According to *Ayurvedic* principles, a strong digestive system is crucial for overall health as it is considered responsible for digestion, absorption, and metabolism. Just as modern science illustrates numerous connections between the gut and brain, *Ayurveda* also provides its own insights into their interplay. These ancient routes of understanding shine a light on the delicate balance between our digestive system and mental state.

4.1 *Agni* (Digestive Fire)and Mental Clarity

Ancient *Ayurvedic* texts like the *Charaka Samhita* and *Sushruta Samhita* offer detailed explanations about maintaining a balanced digestive system to promote mental and emotional equilibrium. In *Ayurveda*, *Agni* or "digestive fire" is recognised as a key element in the Gut-Brain Axis. In *Ayurvedic* belief, *Pitta Dosha* is often associated with *Agni* or Digestive fire[30,31]. The understanding of digestion and metabolism in *Ayurveda* is firmly based on the concept of *Pitta*. According to this philosophy, *Pitta dosha* roles cover physical, psychological, and emotional aspects both in its normal state and when imbalanced. Normal functions include facilitating digestion, enhancing visual perception, regulating body heat production, maintaining normal complexion, promoting courage and cheerfulness, supporting clarity of mind, intellectual function, knowledge acquisition, and boosting memory, as well as intellect. *Pitta* imbalance can lead to effects such as fear-complex, anger, and confusion[30]. This demonstrates how *Pitta* affects both the physical and mental functions of an individual.

4.2 *Pittadhara-Majjadhara Kala-Ayurvedic* Framework for Gut-Brain Axis

In *Ayurveda*, the human body is governed by three fundamental elements known as *Dosha*, *Dhatu* and

Mala. *Doshas* physiologically influence the *Seven Dhatus* (tissues), which are essential for the formation and maintenance of the body's physical structure. During this process, a major byproduct is formed, referred to as *Mala* (waste product). All these functions are made possible by digestive fire, specifically *Jatharagni* (type of digestive fire)[32], which is primarily associated with *Pitta Dosha*[30]. Digestive fire, as discussed, resides in the region between the stomach and intestines. This concept is elaborated by *Acharaya Sushruta* and *Vagabhata*, who describe the significance of *Kala* (lining of visceral organs), particularly *Pittadhara Kala*. This *Kala* is where digestive fire is situated and plays a crucial role in digestion and nutrient absorption. *Sushruta* explains the sixth *Kala*, located between the intestines and stomach, as *Pittadhara Kala* or *Grahani* (small intestine)[33]. He emphasises that the proper functioning of *Grahani* depends on the integrity of digestive fire within it. Any disruption in digestive fire affects *Grahani's* function and vice versa[34]. *Charaka's* perspective adds that *Grahani*, named so because it receives and retains food during digestion, fully digested food is distributed throughout the body via *Dhamanies* (channels)[35]. *Pittadhara Kala*, responsible for producing digestive juices collectively forming *Pachkagani* or *Jatharagni* (types of digestive fire), aids in food digestion and separation of nutrient fraction and indigestible residue (*Sara-Kitta Vibhajana*)[36]. Furthermore, *Pittadhara Kala* is crucial for producing *Pachaka Pitta* (a type of *pitta dosha*), supporting absorption, digestion, differentiation, and elimination processes with *Saman Vayu*[37]. *Pittadhara Kala* can be correlated with the lining membrane of the small intestine, vital for digestion and nutrient absorption. According to *Acharya Indu's* commentary on *Ashthang Sangraha*, *Medo* (fat) *dhatu* transforms into *Mastulunga* and *Majjadhatu* (Bone marrow), both having a solid *ghrit*-like appearance. *Mastulunga* is found inside flat bones of the skull, while *Majjadhatu* is the marrow inside bones (*asthi*) like the skull and vertebral column, integral parts of the central nervous system, and hence *majja dhatu* is related to the nervous system, and *Majjadhara Kala* is associated with the nervous system[38]. Depletion of *Majjadhatu* can lead to mental instability[39]. There's a potential bidirectional relation between *Pittadhara* and *Majjadhara*[40], as explained in the context of *Vishaveg lakshan* (Symptoms of Poison)[41]. Regulation of *Majjadhara kala* by *Pittadhara kala* can be observed, such as stress-induced *Jatharagni* depletion leading to *Rasa Dhatu Kshaya*[42] and poor food quality causing *Unmaad* and *Apasmaar*[43]. Research has shown correlations of *Virechan* with *Terminalia chebula* conditions like Parkinson's disease and Alzheimer's[44]. *Virechan,* which acts on *Pittadhara kala*, has been effective in treating *Pitta*-related disorders while also impacting distant *Rakta* and *Majjadhatu* related conditions[45,46] like patients of *Pakshaghata*. In *Ayurveda*, the interplay between *Pittadhara Kala* and *Majjadhara Kala* suggests a close relationship between *Pitta* and the Nervous system. *Pitta*, as represented by *Pittadhara Kala*, plays a vital role in the digestion and absorption of nutrients necessary for the formation and nourishment of *Majjadhatu*, which is associated with the nervous system and bone marrow. This shows the link between mind and body in *Ayurveda*, highlighting the interconnectedness of mental and physical well-being in *Ayurveda*.

4.3 *Ama* and Gut-Brain

When the digestive fire (*agni*) weakens or fails to maintain its equilibrium due to various reasons, the proper digestion of food does not occur, leading to the formation of undigested food, known as *ama*. The inability of *agni* to function properly results in *ajeerna* (indigestion), which *Ayurveda* identifies as a major cause of various diseases. This state of *ajeerna* progresses further to form *ama.* As we know, *agni* plays a key role in metabolic processes at different *dhatu* levels[47]. The formation of *ama* primarily occurs at the level of the digestive tract, but as it gets absorbed and leaks into the bodily tissues, it transforms into *amavisha.* This disruption in tissues leads to chronic inflammation and disease. Compromised mucosal integrity contributes to dysbiosis, leading to the formation of *ama*[48]. Similarly, the mind, akin to the body, possesses its own digestive power or "digestive fire" (*Agni*), which manifests as intelligence (*buddhi*)[49]. *Ama* can clog the physical channels in the body; it can also obstruct the mental channels (*Mannovaha strotas*), leading to clouded thinking and emotional disturbances. When *ama* accumulates, it can block the flow of *Prana* (life energy), which is crucial for mental clarity and equilibrium. The purpose of the mind is to provide experiences and liberation for the

soul. Experiences that we have properly digested or understood bring freedom and facilitate the expansion of awareness, much like well-digested food, releasing energy for physical activities and bringing physical happiness. Conversely, undigested experiences lead to disease, just as poorly digested experiences result in symptoms such as anxiety, irritability, and depression. Thus, managing *Ama* is considered essential not just for physical health, but also for maintaining mental and emotional well-being.

4.4 The Gut-Brain Axis and *Ojas*

In *Ayurveda*, the gut plays a crucial role in immunity, with a focus on Ojas as the essence of the seven *dhatus*. *Ojas* is instrumental in bolstering the immune system and confers numerous beneficial effects on both the mind and body. In modern science, the communication between the gut and the brain occurs via nerves or through hormones and chemical messengers. This axis encompasses gut bacteria, the Enteroendocrine system (EEC), and the Enteric nervous system (ENS), all of which produce various chemicals. The ENS is particularly noteworthy for generating over 30 neurotransmitters, including serotonin and dopamine. Serotonin, a vital regulator of mood, sleep, appetite, and other brain functions, is predominantly produced by gut cells, contributing to 90% of its production in the body. Similarly, about 50% of dopamine originates from the gut[50-52]. Several factors may contribute to *Ojas*, one of which is serotonin. Serotonin, circulating in the body through the bloodstream, influences not only mood and brain functions but also plays a role in strengthening the immune system and other physiological functions[53]. The essential amino acid tryptophan serves as a key precursor of serotonin, obtained through dietary sources. In summary, *Ojas* plays a pivotal role in enhancing the immune system and exerting beneficial effects on both mental and physical well-being, with serotonin and other factors contributing significantly to its functions. In *Ayurveda*, a clear distinction is made between descriptions of mental and physical diseases, highlighting a psychosomatic approach that intricately links the interaction between mind and body. This approach is not purely parallel but rather resembles interactionism, as the *doshas* affect both the body and mind mutually. *Ayurveda* consistently emphasises a psychosomatic approach in disease treatment, giving equal importance to psychological and physical aspects.

5. *Ayurvedic* Insights of Alcohol Use Disorder

Alcohol is a psychoactive drug that individuals often consume to cope with stress, anxiety, or other emotional issues. When someone engages in alcohol use, it not only affects their health but also has mental and social impacts. Alcoholism is a term used broadly to describe a range of problems related to alcohol consumption, including alcohol abuse and alcohol dependence. This behaviour often harms the drinker's health, personal relationships, and social status. In psychiatry, terms like "alcohol abuse" and "alcohol dependence" are used, each with slightly different definitions. In *Ayurveda*, the term "*Madatyaya*" refers to a condition that closely relates to what modern medicine describes as Alcohol Use Disorder or alcoholism. The term is derived from two Sanskrit words: "*mada*", meaning intoxication or alcohol, and "*atyaya*", meaning excess or transgression. Thus, *Madatyaya* can be interpreted as a state resulting from the excessive consumption of alcohol, leading to physical, mental, and social disturbances. After alcohol consumption, the absorption process begins in the digestive system, primarily in the stomach and small intestines, resembling the *Pittadhara Kala* concept in *Ayurveda*. Alcohol's inherent qualities, such as being light (*laghu*), easily digestible, and having a penetrating (*vyavayi*) nature, facilitate its rapid spread throughout the body. Its penetrating (*tikshna*) quality allows it to penetrate body tissues effortlessly. All ten properties of alcohol, namely easily digestable (*laghu*), heat producing (*ushna*), penetrating the tissue (*tikshna*), capacity to enter into minute pores (*sukshma*), sour (*amla*), spreading all over the body quickly (*vyavayi*), causing dryness (*ruksha*), producing loosening of joints (*vikashi*), non-slimy (*vishada*), and quick acting (*ashukara*), affect the heart by counteracting the *Ojas* (the vital essence of the body) and its ten qualities with the ten qualities of alcohol itself[54]. This leads to agitation of mental strength that is dependent on *Oja* and results in perplexity. The heart is the site for the channels of the *Rasa dhatu* (the nutritional fluid produced immediately after digestion), *Vata*, and others, including *Satva* (mental strength), intellect (*Buddhi*), senses (*Indriya*),

self (*Aatman*), and primary *Ojas* (vital essence). As alcohol traverses the body via the bloodstream, it impacts the *Dhatus* (body tissues), *Agni* (digestive fire), and *doshas*, disrupting their equilibrium. For instance, disturbances in the *Rasa dhatu* can lead to dehydration, attributed to alcohol's heating (*ushna*) property. Similarly, disruptions in the *Mamsadhatu* manifest as muscle weakness, reduced coordination, and tremors. Such disturbances may involve the *Majjadhara Kala* through the disturbance of the *Majja Dhatu*, potentially causing nervous system disorders, indicating brain involvement. Alcohol induces profound agitation of the mind, akin to how a storm affects a tree. An uninformed individual, influenced by the qualities of passion (*Rajas*) and ignorance (*Tamas*), becomes fascinated by alcohol addiction, willingly embracing major flaws and diseases. Under the influence of alcohol, which impairs righteous (*Sattvik*) qualities, one becomes blind to the ravages of alcoholism, losing credibility and surrendering to addiction. Alcohol leads to confusion, fear, sorrow, anger, and even death, accompanied by mental disorders, intoxication, unconsciousness, epilepsy, and muscular spasms. Excessive alcohol consumption disrupts *dosha* balance, notably *Pitta* and *Kapha*, resulting in mental restlessness, impaired decision-making, emotional instability, and heightened susceptibility to psychological disorders.

6. Treatment of Alcohol Use Disorder

In *Ayurveda*, true health is the harmony of the mind, body, and spirit. This ancient system recognises that our mental and physical well-being are deeply connected, focusing on how they influence each other, an approach that sees the interplay between our thoughts and our physical health. This isn't just about treating symptoms; it's about looking at the whole picture. For instance, when dealing with Alcohol Use Disorder, which *Ayurveda* compares to facing a *Mada* (alcohol) that's not as immediately deadly as poison but just as harmful over time, the treatment is comprehensive. The first and foremost step in any treatment is identifying and avoiding the cause, and in the case of alcohol addiction, often it's an error in judgment or wisdom known as '*Pragya aparadha*', which can lead to Alcohol Use Disorder over time. The second key step is embracing '*Sadvritta*' in *Ayurveda*, which involves adhering to simple moral principles and good conduct[55]. Prevention of addiction can be enhanced by practising *'Achara Rasayana*' - where '*Achara*' stands for behaviour and '*Rasayana*' for rejuvenation, together promoting the revitalisation of both body and mind[56]. These practices are essential when treating Alcohol Use Disorder. The treatment includes '*Satvavajaya Chikitsa*', a mental restraint therapy, '*Padanshika krama*', a step-by-step approach, alongside medications, detoxifying '*Panchkarma*' therapies, and the holistic benefits of *yoga* and meditation combined with the healing power of *mantra* therapy. Each plays a valuable role in addressing the disorder while also considering the vital link between our gut health and brain function. It's not just about cleansing the body, but also nurturing the mind and nourishing the spirit, aiming to heal the person as a whole and restore balance to their life.

6.1 Physical and Psychological Detoxification Strategies

When treating alcohol-related disorders, there are two main methods of physical detoxification: firstly, *Shaman Chikitsa* (Pacification Therapy), and secondly, *Shodhana Chikitsa* (Purification Therapy). Within this detoxification process, there are also two types of treatment: the first focuses on managing withdrawal symptoms, while the second is rehabilitation. In *Ayurveda*, one of the treatment strategies for Alcohol Use Disorder involves a step-by-step tapering off called '*Padanshik krama*'[57]. This gentle approach aligns with the *Ayurvedic* principle of decreasing dependence without startling the body. By carefully and progressively lessening the amount of alcohol, ultimately leading to its cessation, this method aims to minimise withdrawal symptoms. Thus, the doses of alcohol are meticulously decreased over time to ensure a smooth transition towards recovery. As a substitute drug for alcohol, *Shreekhand asava* can be administered in decreasing amounts over a period of time. It exhibits hepatoprotective effects[58]. *Madatyaya* is a *Tridoshaja* disease, but initially, treatment should be based on the site of *Kapha dosha*. The process of detoxification aims to strengthen *Agni* (Digestive fire) to digest *ama* and restore balance; it is the primary step in the treatment of Alcohol Use Disorder[59]. *Acharaya Kashyapa* identifies *Madatyaya* as *Aamaja*, underscoring the importance of prioritising *Langhan* (fasting) and *Ama Pachana*

(digestion) at the onset of treatment for *Madatyaya*[60]. When the digestion of *ama* occurs, and the patient starts feeling hungry and thirsty, they should be given alcohol (*mada*) in a low dose to consume. However, consuming alcohol in excessive amounts or in the wrong manner and because of its sharp (*tikshna*), hot (*ushna*), acidic properties, results in it turning into an alkali (*kshara*) substance. This transformation can lead to symptoms like thirst, confusion, giddiness, and *Madatyaya.* Therefore, when alcohol, which is predominantly acidic in nature, comes into contact with alkali, it combines with it to neutralise the effects[61]. The drugs used during the detoxification process aim to minimise withdrawal effects. However, the psycho-somatic clinical manifestations observed during this time need to be managed through symptomatic treatment. Symptomatic treatment[62] is given in Table 1.

6.2 External Therapies in Alcohol Use Disorder

In addition to internal medication, external application of medicines and procedures plays a significant role in the treatment of Alcohol Use Disorders. *Abhyanga* (massage) is recommended for 20-30 minutes on the entire body. This helps pacify *Vata dosha*, nourishes the body, promotes relaxation and improves circulation[66], which can help reduce the physiological and psychological stress associated with Alcohol Use Disorders. *Shirodhara* is particularly effective for insomnia, a symptom frequently encountered during alcohol withdrawal. It is traditionally used to calm, vasodilate, tranquilizing effect due to an increase in brain circulation, cognition, improved memory and stabilise the mind[67], therefore well-suited to psychological aspects of Alcohol Use Disorder treatment.

6.3 *Ayurvedic* Purification Measures

For purification procedures, in conditions of *Kaphaja Madataya* and *Pittaja Madataya*, *Acharya Charaka* prescribed *Vamana* (emesis) *karma*[68]. Additionally, *Virechana* (laxative) can also be recommended to the patient. These procedures are carefully executed to realign the *doshas* and cleanse the body of toxic substances. *Virechana* therapy, a key component of *Ayurvedic panchakarma*, effectively addresses imbalances predominantly related to the *Pitta dosha*. Recognising that the channels responsible for *Pittadhara Kala* (Linning of the small intestine) and *Majjadhara Kala* (nervous system and bone marrow) share a common origin, *Virechana* serves as a powerful treatment for both digestive and neurological health[69]. This cleansing process is not only purgative but also

Table 1. Symptomatic treatment

Sr. No.	Clinical Feature	Management
1	Pain in the head, bones and joints	*Beejpuradi sanskarit mada*
2	Cough along with blood, feeling discomfort in the side torso and breast areas, enduring an intense thirst, sensations of internal burning, and imbalances in the doshas within the heart and chest area.	A herbal brew created from the plants *Guduchi* (*Tinospora cordifolia*), *Devdaru* (*Cyprus rotundus*), or *Patola* (*Trichosanthes dioica*), blended with powdered dry ginger, to be consumed before a meal that would typically be eaten by a partridge.
3	Indigestion and loss of appetite	A salad made with *Karavi* (*Strobilanthes callosa*) leaves, seasoned with vinegar and the solidified syrup of sugarcane, known as *matysyandika. -Ashtanga lavana -Sauvarchala, Jeeraka* (*Cuminum cyminum*), *Vrikshamla* (*Garcinia indica*), *Amlavetasa* (*Garcinia pedunculata*), each one part, *Twak* (*Cinnamomum zeylanicum*), *Ela* (*Elettaria cardamomum*), *Maricha* (*Piper nigrum*), each half part and sugar one part.
4	Pacifies thirst and fever.	Water boiled with *Duralabha* (*Fagonia cretica* L.), Musta (*Cyperus rotundus*) or Musta (*Cyperus rotundus*), Parpata (*Fumaria indica*) or only Musta (*Cyperus rotundus*)

When managing Alcohol Use Disorder in *Ayurveda*, it's crucial to consider the liver, providing treatments that are soothing and beneficial for liver health (*'yakrit prasadan'*). For supporting liver function, substances like *Bhunimba (Andrographis paniculata)*[63] and *Kutaki (Picrorhizakurroa)*[64] are recommended due to their therapeutic effects on the liver. For mental health and cognitive support, *'Medhya Rasayana'*[65], which includes herbs that enhance mental function, is advisable. Herbs such as *Brahmi (Bacopa monnieri), Shankha pushpin (Convolvulus prostratus),* and *Guduchi (Tinospora cordifolia)* are often used for their properties that promote mental health and well-being.

bridges the gap between bodily detox and mental clarity, showcasing the holistic essence of *Ayurvedic* medicine. *Basti* therapy is a cornerstone in *Ayurvedic* treatment, much like how water nourishes a tree from its roots to its leaves, *Basti* can rejuvenate the body. According to the wisdom offered in the *'Charak Samhita'*, we can utilise *Yapana Basti* and *Anuvasana Basti* with *Bala Taila*, both of which cleanse and nourish simultaneously. These therapies are particularly beneficial in treating mental health conditions, such as *'Unmada'* and various other mind-related disorders, boosting overall vitality as excellent rejuvenators. *Basti* using *Bala Taila* is effective in calming an aggravated *Vata dosha*, enriching the *'Majja Dhatu'* (bone marrow and nervous tissue), and ensuring the nerves function smoothly. Moreover, *Matra Basti* helps balance the intestinal bacteria, which is crucial for the natural production of Vitamin B1[70]. Research has indicated that *Basti* reduces pyruvic acid levels, an element of keto acids, which in turn can raise Vitamin B1 in the body[71].

6.4 Non-pharmacological Interventions in Alcohol Use Disorder

After pharmacological treatment, non-pharmacological interventions play a crucial role in the rehabilitation of patients with Alcohol Use Disorder (AUD). This includes ongoing support that encapsulates Psychological counselling, Dietary Modifications and holistic practices such as *yoga* and meditation. Such interventions are continuous and unfold over extended periods, affirming their commitment to the rehabilitation process.

6.4.1 Dietary Recommendations and Mental Detoxification

Dietary Therapy in *Ayurveda* is not just about physical nourishment but also mental and spiritual nourishment. Emphasis on a *Sattvic* diet helps maintain mental equilibrium and inner peace, advocating for a largely vegetarian diet that aligns with this philosophy[72]. Just as the body requires detoxification, the mind also undergoes detoxification at different levels. The first level involves physical detoxification achieved through a wholesome diet, including periods of fasting if necessary. At a more subtle level, mental clarity is further achieved through *Pranayama*, which expels negative mental patterns. At the deepest level, causal detoxification, performed through *mantra* or sound therapy, addresses the transformation of the three mental qualities (*Manas Gunas*)[73]. Although these qualities are intrinsic to the elemental makeup of the mind and cannot be entirely eradicated from consciousness (*Chitta*), they can be refined. Utilising *sattvic mantras* like '*OM*' promotes the conversion of *Rajasic* (action-oriented) and *Tamasic* (inert) tendencies into a harmonious *Sattvic* state. *Mantras* are powerful tools that can cleanse our nervous system and the invisible pathways within us, known as *Nadis*. They assist in sharpening our focus and boosting our creativity. Acting as conduits, *mantras* can channel the universal energy into our healing practices, breathing life into them. This helps create a complete healing experience that engages our inner spirit[74].

7. Conclusion

Ayurveda sheds light on the Gut-Brain Axis, bringing forth a holistic approach to understanding how our digestion influences our mental health. It suggests that a well-functioning digestive system, maintained by a strong digestive fire known as *Agni*, is essential for mental clarity. When it comes to Alcohol Use Disorder, *Ayurveda* points out that excess alcohol can disturb the body's natural balance, leading to both physical and mental health issues. *Ayurvedic* practices, with their emphasis on detoxification and restoring inner peace, are aimed at bringing back the natural order of the body and mind. *Ayurveda*'s approach to AUD, with its unique focus on diet, cleansing procedures, and overall balance, offers a rich complement to today's treatment methods. By uniting traditional *Ayurvedic* knowledge with modern science, we gain a more profound appreciation of health as a whole, highlighting the need for a balanced digestive and mental state to achieve true wellness.

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Author Contribution

All authors made significant contributions to this manuscript. Dr. Neha Saini handled conceptualisation, literature review, data interpretation, and primary drafting; Dr. Digambar G. Dipankar provided supervision, critical review, and intellectual guidance; Dr. Bhavya Khurana assisted with literature search, data compilation, and manuscript organisation; Dr. Neha Suresh Dubal contributed to data analysis, editing, and proofreading. All authors have read and agreed to the published version of the manuscript.