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Alcohol hangover treatment

Tratamento da ressaca por álcool

Tratamiento de la resaca alcohólica

Lucas Casagrande Passoni Lopes[1], José Henrique Pinheiro[1], Alexandra Rodrigues de Freitas[2], Júlio César Garcia Alencar[1].

ABSTRACT

Objective: To investigate and describe the standardized medicine to treat alcohol hangover that are presented by scientific literature. **Methods:** Were developed a systematic review which aims to answer the question: "Which standardized medicines are presented by the scientific literature to treat alcohol Hangover". This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and made a search in MEDLINE, Scielo, Web of Science, Latin American and Caribbean Health Sciences Literature with the descriptors “Alcohol hangover AND Treatment”. The PROSPERO number of this article is: CRD42024557119 **Results:** From the 425 found studies, two noted that Pyrithioxin and Propranolol did not reduce alcohol hangover symptoms. However, other four studies proposed that Chlormethiazole, Loxoprofen, SJP-001 and L-cysteine significantly reduced these symptoms effects of alcohol hangover. **Final considerations:** A wide range of treatment measures are presented in the literature, with few options appearing to have beneficial effects over alcohol hangover. Personal factors such as gender, age, ethnicity, and other conditions should be taken into consideration when evaluating the effects of a medication on alcohol hangover treatment.

Keyword: Alcohol, Hangover, Treatment.

RESUMO

Objetivo: Investigar e descrever os medicamentos padronizados para tratar a ressaca alcoólica apresentados pela literatura científica. **Métodos:** Desenvolveu-se uma revisão sistemática que visa a responder a pergunta: "Quais medicamentos padronizados são apresentados pela literatura científica para tratar a ressaca alcoólica". Este estudo seguiu as diretrizes do Preferred Reporting Items for Systematic Reviews and Meta-Analyses e fez uma busca no MEDLINE, Scielo, Web of Science, Literatura Latino-Americana e do Caribe em Ciências da Saúde com os descritores “Alcohol hangover AND Treatment”. O número PROSPERO deste artigo é: CRD42024557119. **Resultados:** Dos 425 estudos encontrados, dois observaram que Piritioxina e Propranolol não reduziram os sintomas da ressaca alcoólica. No entanto, outros quatro estudos propuseram que Clormetiazol, Loxoprofeno, SJP-001 e L-cisteína reduziram significativamente esses efeitos dos sintomas da ressaca alcoólica. **Considerações finais:** Uma ampla gama de medidas para tratar a ressaca por álcool é apresentada na literatura, com poucas opções parecendo ter efeitos benéficos sobre esta condição. Fatores pessoais como gênero, idade, etnia e outras condições devem ser considerados ao se avaliar os efeitos de um medicamento no tratamento da ressaca alcoólica.

Palavras-chave: Álcool, Ressaca, Tratamento.

RESUMEN

Objetivo: Investigar y describir medicamentos estandarizados para tratar la resaca presentados en la literatura científica. **Métodos:** Se desarrolló una revisión sistemática para responder a la pregunta: "¿Qué

[1] Universidade de São Paulo, Faculdade de Medicina de Bauru, Bauru – SP.
[2] Universidade Federal de Minas Gerais, Belo Horizonte - MG.

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medicamentos estandarizados se presentan en la literatura científica para tratar la resaca alcohólica?". Este estudio siguió las pautas de Elementos de informes preferidos para revisiones sistemáticas y metanálisis y realizó búsquedas en MEDLINE, Scielo, Web of Science, literatura latinoamericana y caribeña en ciencias de la salud con los descriptores “Resaca alcohólica Y tratamiento”. El número PROSPERO de este artículo es: CRD42024557119. **Resultados:** De los 425 estudios encontrados, dos observaron que la Piritioxina y el Propranolol no redujeron los síntomas de la resaca inteligente. Sin embargo, otros cuatro estudios han propuesto que el clormetiazol, el loxoprofeno, el SJP-001 y la L-cisteína reducen significativamente estos efectos de los síntomas de la resaca líquida. **Consideraciones finales:** En la literatura se presenta una amplia gama de medidas para tratar la resaca alcohólica, y pocas opciones parecen tener efectos beneficiosos sobre esta afección. Se deben considerar factores personales como el género, la edad, el origen étnico y otras condiciones al evaluar los efectos de un medicamento en el tratamiento de la resaca líquida.

Palabras clave: Alcohol, Resaca, Tratamiento.

INTRODUCTION

An alcohol hangover is broadly characterized by a range of adverse physical and mental symptoms that can arise after the consumption of a significant amount of alcohol in a single instance (VERSTER JC, et al., 2020). These symptoms can manifest in more than forty distinct physical complaints, with the most commonly reported being fatigue, headache, nausea, and general malaise (VERSTER JC, et al., 2020; PALMER E, et al., 2019). In addition to these physical discomforts, alcohol hangover significantly affects cognitive and psychological functioning.

Individuals often experience a noticeable decline in attention, memory, and psychomotor skills, which can hinder daily activities and performance (VERSTER JC, et al., 2020; PALMER E, et al., 2019). The cumulative impact of these symptoms can severely disrupt both physical well-being and mental sharpness, leaving the individual unable to function at their usual capacity until the effects fully subside. (VERSTER JC, et al., 2020; PALMER E, et al., 2019)

In this context, it is evident that alcohol hangovers have far-reaching consequences on a global scale (ROCHE A, et al., 2015). The economic impact of this condition is staggering, with various studies highlighting the substantial financial losses attributed to hangover-related absenteeism.

For instance, research conducted by Roche A, et al. (2019) and Severeijns NR, et al. (2024) estimates an annual economic loss of nearly 300 million dollars in Australia and approximately 1 billion dollars in the Netherlands, respectively, due to missed workdays caused by alcohol hangovers (ROCHE A, et al., 2015; SEVEREIJNS NR, et al., 2024).

Similarly, a study by Sacks et al. projected that the United States incurs an astonishing 249 billion dollars annually in losses linked to reduced worker productivity as a direct result of alcohol hangovers (SACKS JJ, et al., 2015). Furthermore, a recent investigation carried out in several Latin American countries revealed that excessive alcohol consumption was already prevalent in the region prior to the COVID-19 pandemic (GARCÍA-CERDE R, et al., 2021). However, during the pandemic, a significant increase in the number of individuals engaging in risky drinking behavior was observed, exacerbating the potential for economic and social consequences tied to alcohol-related absenteeism (GARCÍA-CERDE R, et al., 2021).

These findings underscore the widespread and multifaceted impacts of alcohol hangovers, both in terms of individual health and broader economic ramifications (GARCÍA-CERDE R, et al., 2021). Given this widespread issue, numerous therapeutic measures have been developed with the aim of managing alcohol hangovers and mitigating their significant socioeconomic impacts (TELLEZ-MONNERY K, et al., 2021). Notably, the 12th Alcohol Hangover Research Group Meeting highlighted the ongoing debate within the scientific community regarding the efficacy of various treatments.

While some studies have introduced promising approaches for alleviating the symptoms of alcohol hangover, other research challenges these findings, asserting that no treatment has yet demonstrated the ability to consistently and effectively address all hangover symptoms on a scientifically reliable scale. This divergence of opinions underscores the complexity of the condition and the difficulty in developing a universal

remedy that is both scientifically validated and capable of providing comprehensive relief across the wide range of symptoms associated with alcohol hangovers (TELLEZ-MONNERY K, et al., 2021). Thus, this research was forged with the aim to investigate and describe the main standardized medicines to treat alcohol hangover that are presented by scientific literature.

METHODS

Study design

This was a systematic review which aims to answer the question: "Which standardized medicines are presented by the scientific literature to treat alcohol Hangover". This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PAGE, MJ., 2021). The PROSPERO number of this article is: CRD42024557119.

Eligibility criteria

The articles that fulfill the inclusion criteria, that is, were original in human qualitative, interventional and observational studies (cross-sectional, case-control, and cohort studies), or were literature reviews, and answer the guiding question, were included. Only the article that discuss standardized medicines, that is, medications that have followed rigorous development, manufacturing and quality control processes, ensuring consistency in composition, dosage, and efficacy were included.

The medications evaluated are approved for use by regulatory agencies, such as the North-American Food and Drug Administration, and are distributed for clinical use, not necessarily only for the possible treatment of alcohol hangovers. Therefore, naturally based compounds and medicine which commercialization has not yet been standardized were excluded from the selection. If an article did not meet the previously cited inclusion criteria, it was excluded too. There are no restrictions about language and time of publication.

Search strategy

The search strategy was performed by the use of descriptors with boolean operators as “Alcohol hangover AND Treatment”. The search was run on 21th February 2024 in MEDLINE, Scielo, Web of Science, Latin American and Caribbean Health Sciences Literature (LILACS) and Scopus databases. Reference lists of relevant papers and previous narrative reviews were manually searched in order to identify citations that did not appear in the main searches.

Study Selection

The entire process of selecting articles and extracting their data was performed manually by the authors of this research. The title, the abstract and the full text were evaluated in sequence to select only the articles that answered the guiding question. The investigators were not blinded to the authors, journals, or results of the studies. Any disagreement was resolved by consensus in a discussion between the authors. Rayyan® was used as a tool to facilitate and organize the review process (OUZZANI M, et al., 2016).

Data extraction

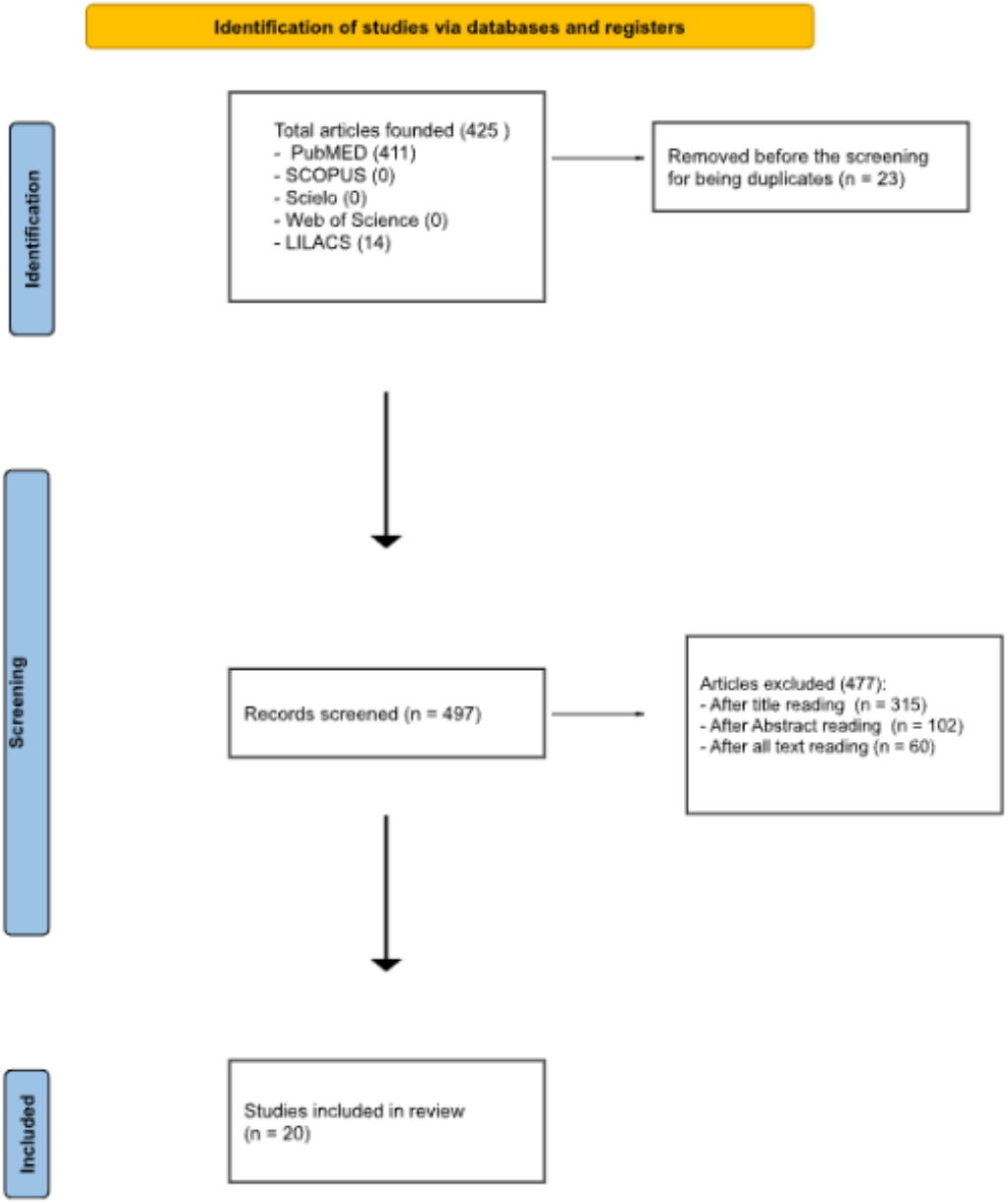
All data were manually extracted by the authors and data included country, study design, journal, impact factor, study type, population evaluated, treatment measure proposed, main results and conclusions. The articles were evaluated by their five years’ impact factor, cited by the own journals, and the category of journal according to their Qualis presented in Sucupira Plataform.

RESULTS

Study selection

The search strategy identified, initially, 425 citations (**Figure 1**). After the screening process, only 6 articles were in the final revision.

Figure 1 - Study selection flow for the systematic review.



Source: Lopes LCP, et al., 2025. Based on Page MJ, 2021.

Studies characteristics

The main characteristics of the included studies are summarized in Figure 2. Most studies were published in 2020 and developed in the United States of America. Each article evaluated one medicine during their development. The population evaluated in the trials studies range from 5 till 229 individuals. The studies, the treatment measures and their main results and conclusions are summarized in (**Figure 3**).

Figure 2 - Population, Study type, Aims, Treatment Measures proposed, Mainly results and Conclusions.

Study	Population	Study Type	Aims	Treatments Measures	Main results and conclusions
S1 - Khan MA, et al. (1973)	17	Double-blind study	To evaluate the efficacy of pyrithioxin on reduction of symptoms of alchohol hangover	Pyrithioxin	No significances were seen in the administration of pyrithioxin on reduction of symptoms of alchohol hangover
S2 - Myrsten, A. et al. (1980)	12	Double-blind study	To investigate the efficience of chlormethiazole on reduction of symptoms of alchohol hangover	Chlormethiazole	Chlormethiazole improved the psychomotor significantly and to reliev unpleasant physical symptons, but it did not impaired the fatigue and drowsiness
S3 - Gobin, R. M. et al. (1986)	10	Randomized, double-blind, crossover controlled study	To assess the effect of beta blockade in preventing the symptoms of hangover.	Beta blockade (Propranolol)	Propranolol does not prevent the symptoms of hangover.
S13 - Hara , M. et al. (2019)	229	A nationwide randomized, double-blind, placebo-controlled physicians' trial	To evaluate the efficacy of loxoprofen sodium for the alleviation of fatigue, headache, and nausea after hangover	Loxoprofen	Loxoprofen sodium was effective for relieving headaches after hangovers but did not alleviate general fatigue or nausea.
S14 - Verster J. . C. et al. (2020)	5	Double-blind study	To investigate the effects of a potential new hangover treatment, SJP-001 on hangover severity.	SJP-001 (220 milligrams naproxen and 60 milligrams fexofenadine)	Compared to placebo, SJP-001 significantly reduced overall hangover severity.
S17 - - Erikson, C. J. P. et al. (2020)	19	Randomized, double-blind and placebo-controlled	To investigate the effect of the amino acid L-cysteine on the alcohol/acetaldehyde related aftereffects.	L-cysteine	L-cysteine would reduce the need of drinking the next day with no or less hangover symptoms: nausea, headache, stress and anxiety.

Sources: Lopes LCP, et al., 2025.

Figure 3- Title, Authors, Years of publication, Journal, Qualis and the impact factor of included articles.

Study	Country	Journal	Qualis	Impact factor
S1 - Khan MA, et al. (1973)	United States of America	Quarterly Journal of Studies on Alcohol	A2	3.4
S2 - Myrsten, A. et al. (1980)	Germany	Psychopharmacology	A2	3.7
S3 - Gobin, R. M. et al. (1986)	United States of America	The American Journal of drug and Alcohol abuse	A3	3.9
S13 - Hara, M. et al. (2019)	Japan	Alcohol	A2	2.3
S14 - Verster J. C. et al. (2020)	Australia, Netherlands and United States of America	Journal of Clinical Medicine	A2	5.5
S17 - Erikson, C. J. P. et al. (2020)	Finland	Alcohol and Alcholismo	A3	2.8

Sources: Lopes LCP, et al., 2025.

DISCUSSION

The concept of drug repositioning, that is, the practice of repurposing medications initially developed and approved for one condition to treat another, has garnered significant attention in recent years (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). In the context of our study, many of the medications evaluated were originally designed for different therapeutic purposes but have been reallocated to target alcohol-related issues.

This approach offers several advantages. Primarily the fact that these drugs have already undergone extensive safety testing and regulatory approval for their original indications, thereby shortening the timeline for clinical trials and reducing the costs associated with developing new medications (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Additionally, there is often a well-documented understanding of their pharmacokinetics and potential side effects, which can expedite their adoption in new therapeutic areas (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

However, there are also notable challenges and limitations to this strategy. A drug that is effective in one context may not necessarily exhibit the same efficacy when applied to a different condition, particularly when dealing with the complex biochemical pathways involved in alcohol metabolism and hangover recovery (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). Furthermore, while these drugs may be deemed safe for their initial use, their safety profile could change when prescribed for a new purpose, especially when considering long-term or off-label usage (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

This could result in unforeseen side effects or interactions with other medications that are commonly used in the treatment of alcohol-related conditions (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). Consequently, while drug repositioning holds promise as a cost-effective and time-efficient strategy, it also necessitates thorough and rigorous evaluation to ensure that the benefits outweigh the potential risks when applying these medications to new clinical scenarios (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Some studies have failed to demonstrate significant efficacy in the substances that they evaluated for the treatment of alcohol hangovers (KHAN MA, et al., 1973; GOBIN RM, et al., 1987). One possible explanation for these inconclusive results is the small sample sizes used in these trials, which inherently limit the statistical power of the analysis and hinder the generalizability of the findings to broader, more robust contexts (KHAN MA, et al., 1973; GOBIN RM, et al., 1987).

Additionally, these studies did not clearly specify whether the participants were chronic alcohol consumers, a factor that could substantially influence the outcomes (KHAN MA, et al., 1973; GOBIN RM, et al., 1987). Chronic drinkers often develop higher tolerance levels to alcohol, potentially leading to fewer or less severe hangover symptoms, or in some cases, no symptoms at all (KHAN MA, et al., 1973; GOBIN RM, et al., 1987).

This lack of distinction between occasional and habitual drinkers may have skewed the results, as the absence or reduction of hangover symptoms in long-term drinkers could have masked the true efficacy of the treatments being studied (KHAN MA, et al., 1973; GOBIN RM, et al., 1987). Furthermore, particularities from the evaluated medicine may be, too, a possible reason for their negative results (KHAN MA, et al., 1973; GOBIN RM, et al., 1987).

One possible reason Pyrithioxine, a neuroprotective agent, may not exert significant effects on alcohol hangover is its limited ability to address the multifactorial nature of hangover symptoms (KHAN MA, et al., 1973). Alcohol hangovers involve a complex interplay of dehydration, electrolyte imbalances, inflammatory responses, and the accumulation of toxic metabolites like acetaldehyde.

While Pyrithioxine may offer neuroprotective benefits by stabilizing neuronal membranes and mitigating oxidative stress, it does not directly counteract these physiological disruptions (KHAN MA, et al., 1973). Therefore, its effects might be insufficient to alleviate the broader spectrum of symptoms associated with hangovers, such as headaches, fatigue, and nausea (KHAN MA, et al., 1973). Similarly, beta-blockers like propranolol may fall short in mitigating alcohol hangovers due to their specific mechanism of action (GOBIN RM, et al., 1987). Propranolol works primarily by inhibiting the effects of catecholamines on the cardiovascular system, reducing heart rate and blood pressure.

While this may help alleviate symptoms such as anxiety or tremors that can accompany a hangover, propranolol does not address the core physiological issues induced by alcohol consumption, such as acetaldehyde toxicity, dehydration, or electrolyte imbalance (GOBIN RM, et al., 1987). Consequently, while beta-blockade might offer some symptomatic relief, it is unlikely to comprehensively prevent or treat the range of hangover-related discomforts (GOBIN RM, et al., 1987).

In contrast, other studies have demonstrated the effectiveness of certain substances in treating alcohol hangovers (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). Chlormethiazole is a sedative-hypnotic drug that has been explored for its potential to mitigate the effects of alcohol hangover, particularly due to its properties as a central nervous system depressant (MYRSTEN AL, et al., 1980). It works by enhancing the activity of gamma-aminobutyric acid (GABA), a neurotransmitter that inhibits excessive neural activity (MYRSTEN AL, et al., 1980).

Since alcohol also increases GABA activity, Chlormethiazole may help to counteract the over-excitation of the brain that occurs during the withdrawal phase, which is a hallmark of hangover symptoms like restlessness, anxiety, and irritability (MYRSTEN AL, et al., 1980). By stabilizing the nervous system and reducing hyperactivity, Chlormethiazole may alleviate the discomfort associated with alcohol withdrawal, though its use is limited by potential side effects, such as drowsiness and respiratory depression, which necessitates careful monitoring (MYRSTEN AL, et al., 1980).

Loxoprofen, a nonsteroidal anti-inflammatory drug (NSAID), is known for its efficacy in reducing inflammation and pain, two key components of the alcohol hangover experience 9HARA M, et al., 2020). Alcohol consumption leads to the production of pro-inflammatory cytokines, which contribute to headache, muscle aches, and other inflammatory symptoms characteristic of hangovers HARA M, et al., 2020). Loxoprofen works by inhibiting the cyclooxygenase (COX) enzymes, which play a central role in the production of prostaglandins—molecules responsible for inflammation and pain (HARA M, et al., 2020).

By blocking this pathway, Loxoprofen can significantly reduce the intensity of hangover symptoms such as headaches, body aches, and general malaise (HARA M, et al., 2020). However, as with other NSAIDs, caution must be exercised due to the potential risk of gastrointestinal irritation, especially in individuals with a history of ulcers or frequent alcohol consumption (HARA M, et al., 2020).

SJP-001, a combination of 220 milligrams of naproxen and 60 milligrams of fexofenadine, targets both the inflammatory and histaminergic pathways associated with alcohol hangover (VERSTER JC, et al., 2020). Naproxen, an NSAID, functions similarly to Loxoprofen by inhibiting COX enzymes and reducing the production of pro-inflammatory prostaglandins, thereby alleviating pain and inflammation caused by alcohol consumption (VERSTER JC, et al., 2020).

Fexofenadine, on the other hand, is an antihistamine that blocks histamine H1 receptors (VERSTER JC, et al., 2020). Since alcohol consumption can increase histamine release, leading to symptoms like headache, flushing, and congestion, fexofenadine helps to counteract these effects by preventing histamine from binding to its receptors (VERSTER JC, et al., 2020).

This dual-action formulation addresses both the inflammatory and allergic-like responses to alcohol, offering a more comprehensive approach to hangover relief (VERSTER JC, et al., 2020). However, it is essential to monitor for potential side effects, such as drowsiness or gastrointestinal discomfort (VERSTER JC, et al., 2020). L-cysteine is an amino acid that has gained attention for its role in detoxifying the body from the harmful byproducts of alcohol metabolism, particularly acetaldehyde (ERIKSSON CJP, et al., 2020).

Acetaldehyde is a toxic metabolite produced when alcohol is broken down in the liver, and its accumulation is largely responsible for many of the unpleasant symptoms of a hangover, including nausea, headache, and fatigue. L-cysteine acts as a precursor to glutathione, a potent antioxidant that helps neutralize acetaldehyde and facilitate its elimination from the body (ERIKSSON CJP, et al., 2020). By boosting glutathione levels, L-cysteine may enhance the liver's capacity to process and detoxify acetaldehyde, thereby reducing the severity and duration of hangover symptoms (ERIKSSON CJP, et al., 2020).

Moreover, L-cysteine's antioxidant properties may help protect cells from oxidative stress induced by alcohol consumption, providing additional protective effects (ERIKSSON CJP, et al., 2020). While its potential as a hangover remedy is promising, further studies are needed to fully understand its efficacy and optimal dosage in human populations (ERIKSSON CJP, et al., 2020). In summary, the efficacy observed in these studies may be attributed to the antioxidant, immunomodulatory, and neuromodulatory properties of the evaluated substances (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

These compounds are believed to influence key reactions in the alcohol metabolization process, mitigating the production of harmful byproducts, and thereby preventing or reducing the onset of the biochemical cascades responsible for hangover symptoms (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). By intervening in these pathways, such substances could potentially alleviate the characteristic signs and symptoms associated with alcohol hangovers (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). However, despite these promising results, these studies are not without significant limitations (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

As highlighted in various reviews, the substances evaluated tend to target specific aspects of the complex physiological cascades involved in alcohol hangover, often addressing only one or a limited subset of the myriad symptoms experienced (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). This narrow focus may limit their overall effectiveness in providing comprehensive relief (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Moreover, when subjected to meta-analyses and comparative statistical evaluations, the scientific robustness of these studies is often called into question (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). Issues such as small sample sizes, insufficient methodological rigor, varying result assessment criteria, and challenges with reproducibility collectively reduce the strength of the conclusions drawn from these investigations (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

As such, while these substances may hold potential, further research with more rigorous designs is required to establish their efficacy on a broader scale (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). A possible explanation for these positive results may be related to advancements in research methodologies and improved understanding of the underlying mechanisms of alcohol hangover over time (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

These studies, more recently developed, are likely to have benefited from larger and more diverse sample sizes, as well as more rigorous study designs, such as double-blind placebo-controlled trials and advanced statistical methods, which contribute to more reliable and valid results (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Additionally, the development of more targeted therapeutic agents, informed by the latest research on alcohol metabolism and its physiological effects, may have increased the likelihood of success in these newer studies (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). In contrast, earlier studies, which did not yield positive results, may have faced limitations such as smaller participant pools, less refined research protocols, or a limited understanding of the biochemical pathways involved in hangover and alcohol metabolism (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

As research in this area has evolved, so too have the strategies for addressing alcohol hangover, with newer medications possibly being more specifically designed to target the precise mechanisms that cause hangover symptoms (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

This trend underscores the importance of continual progress in clinical research, as the refinement of methodologies and therapeutic approaches contributes to more successful outcomes in the development of treatments (MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). The evaluated studies expand the discussion by emphasizing that individual factors significantly influence how the body responds to medications aimed at treating alcohol hangover (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Age, for example, affects metabolic rates, with younger individuals typically metabolizing alcohol more quickly than older adults, who may experience slower clearance of alcohol and its byproducts due to reduced liver function (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Gender differences also play a crucial role; women generally have lower levels of alcohol dehydrogenase, the enzyme responsible for breaking down alcohol, leading to higher blood alcohol concentrations and potentially different responses to medications (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). Body composition, particularly the proportion of muscle to fat, further complicates alcohol metabolism and medication efficacy (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Since alcohol is water-soluble, individuals with higher muscle mass, which contains more water, may dilute alcohol more efficiently than those with higher fat composition, potentially altering the effectiveness of treatments designed to mitigate hangover symptoms (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). The type of beverage consumed is another factor, as drinks with higher alcohol content or congeners (chemical byproducts of fermentation) can result in more severe hangovers and may require different therapeutic approaches (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Medical history and the use of other medications are also critical, as pre-existing liver conditions or metabolic disorders can impair alcohol metabolism and increase susceptibility to the harmful effects of both alcohol and its treatment (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Additionally, individuals taking medications that interact with liver enzymes, such as those metabolized by the cytochrome P450 system, could experience altered drug metabolism, reducing the efficacy or increasing the toxicity of hangover treatments (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Other health conditions, such as diabetes or cardiovascular disease, may further influence how the body processes alcohol and responds to medications, making it essential to tailor treatments to the individual's unique physiological profile (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020).

Ultimately, these individual factors create a complex landscape where the effectiveness of medications designed to treat alcohol hangover is highly variable, highlighting the need for personalized approaches to treatment and further research into how these variables interact with therapeutic interventions (KHAN MA, et al., 1973; GOBIN RM, et al., 1987; MYRSTEN AL, et al., 1980; HARA M, et al., 2020; VERSTER JC, et al., 2020; ERIKSSON CJP, et al., 2020). There remains a strong demand, both from alcohol consumers and from society at large, for a reliable and effective treatment to mitigate the effects of alcohol hangover (VERSTER JC, et al., 2020). This need is driven not only by individual experiences but also by the broader socioeconomic consequences that hangovers impose on communities (VERSTER JC, et al., 2020). In response, new research has been advancing in the field, with a focus on exploring metabolic pathways, including those involving mitochondrial antioxidant mechanisms and nitric oxide functions (VERSTER JC, et al., 2020).

Additionally, promising results have emerged from in vitro studies and animal models, particularly mice, which offer valuable insights into the potential for developing new therapeutic interventions (VERSTER JC, et al., 2020). As these investigations progress, there is a growing expectation that novel formulations will be discovered, capable of addressing the symptoms and causes of hangovers (VERSTER JC, et al., 2020). However, their widespread use remains contingent upon rigorous scientific validation through controlled human studies, which are essential to establishing their efficacy and safety (VERSTER JC, et al., 2020).

It is important to highlight that the number of products available for the treatment of alcohol hangover far exceeds those identified in this literature review. In fact, a study by Verster et al. revealed that a search on an online shopping platform yielded over 80 products marketed for this purpose (VERSTER JC, et al., 2020). However, upon closer evaluation, the authors observed that many of these products were not subject to regulation by the United States Food and Drug Administration (FDA), and none had undergone rigorous scientific studies that could substantiate their effectiveness in humans (VERSTER JC, et al., 2020).

This lack of regulation and scientific backing underscores the need for greater public awareness and education on the matter. Verster and colleagues emphasize the importance of providing the population with accurate and reliable information to ensure that individuals can make informed choices, ultimately helping society to effectively address and alleviate the symptoms of alcohol hangover (VERSTER JC, et al., 2020). It is important to consider that cultural differences in alcohol consumption and the social significance of hangovers vary widely around the world, reflecting the values, traditions and specific social norms (SUDHINARASET M, et al, 2016; ARESI, G., et al, 2021).

In some cultures, alcohol consumption is a practice deeply rooted in social, religious or family rituals, and is seen as a way to strengthen community bonds and celebrate important moments (ARESI, G., et al, 2021). For example, in countries such as France and Italy, moderate consumption of alcohol, especially wine, is often associated with gastronomy and social interaction. (ARESI, G., et al, 2021) In these contexts, hangovers may be seen as an unwanted side effect of excess, but not necessarily carrying a strong negative connotation (SUDHINARASET M, et al, 2016; ARESI, G., et al, 2021).

In societies where excessive consumption is more common, such as parts of Central and Eastern Europe, hangovers may be treated with a mixture of humor and resignation, and are a widely accepted phenomenon (SUDHINARASET M, et al, 2016; ARESI, G., et al, 2021). On the other hand, in cultures where alcohol consumption is restricted or prohibited, as in whether for religious reasons, as in many Islamic countries, or due to stricter social norms, a hangover can carry a more severe stigma, being seen as a moral failing or a behavioral deviation. (SUDHINARASET M, et al, 2016; ARESI, G., et al, 2021)

In this sense, alcohol consumption is a significant contributor to the global economy, and is an industry that includes production, distribution, retail and marketing. (THAVORNCHAROENSAP, M., et al, 2009; MANTHEY J, et al, 2021; XU, Y et al, 2022) However, excessive consumption also generates substantial costs, especially those associated with hangovers and their effects (XU, Y et al, 2022). Loss of productivity at work, absenteeism, accidents and the medical costs associated with treating intoxication and subsequent hangover conditions, such as dehydration and gastrointestinal disorders, represent a significant economic burden (MANTHEY J, et al, 2021).

This has led to the development of a growing market for products and treatments aimed at mitigating hangover symptoms, such as supplements, isotonic drinks and specific medications. (MANTHEY J, et al, 2021) Pharmaceutical companies and wellness industries have invested in research to find effective solutions, attracting consumers who seek to minimize the impacts of hangovers on their professional and social lives (THAVORNCHAROENSAP, M., et al, 2009). In short, while alcohol consumption drives the economy, the costs associated with hangovers create a demand for interventions that may also become a profitable part of this economic cycle (XU, Y et al, 2022). Therefore, evaluating and discussing alcohol hangovers and their treatment takes into account the analysis of the pharmacological properties of medications and individual and social factors, which permeate different spheres of life and correlate with global economic and public health issues.

FINAL CONSIDERATIONS

Alcohol Hangover is a condition of high prevalence and with profound socioeconomic impacts. A wide range of treatment measures are presented by the literature, with only a few producing positive effects on reducing the symptoms of alcohol hangover. Individual factors should be taken into account when evaluating the impact of potential medications that aim to manage such a condition.

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