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From ancient roots to modern routes: a systematic review of ginger's anti-motion sickness efficacy in randomized clinical trials and animal studies

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Motion sickness is a neurosensory dysfunction characterised by nausea, vomiting, dizziness, and general discomfort. Although there are conventional medications for this condition, interest in herbal alternatives like ginger (*Zingiber officinale*) is growing due to its broad biological activities and safety profile. Usually, females are more prone to motion sickness. Ginger contains phenolic chemicals that have anti-inflammatory, anti-microbial, anti-cancer, neuroprotective, anti-diabetic, cardiovascular, anti-obesity, anti-emetic, and protective actions against respiratory illnesses. These biological activities have led to its usage in traditional medicine to treat symptoms such as motion sickness, morning sickness, nausea, vomiting, indigestion, nausea and vomiting induced by chemotherapy and pregnancy. This systematic review of randomised controlled trials (RCTs) and animal studies was conducted using PubMed, Web of Science, and DOAJ in accordance with PRISMA guidelines. Four RCTs (involving 469 participants) and only one animal study met the inclusion criteria, and ginger was administered in doses ranging from 500 to 2,000 mg. One RCT study, which used low-dose ginger, revealed ginger to be less beneficial than a multivitamin-based treatment, whereas three trials reported a significant decrease in nausea and vomiting compared to a placebo. There were no significant side effects noted. In conclusion, these investigations have shown that ginger is effective and tolerable in treating motion sickness. Although there is a lot of evidence supporting ginger's safety, effectiveness, and reduction of motion sickness, additional research is needed to ensure its efficacy.

KEY WORDS: motion sickness, ginger, *Zingiber officinale*, antiemetic effect, nausea and vomiting, randomized controlled trials, animal study, complementary and alternative medicine

Motion sickness is a complex illness, distinguished by symptoms such as headache, blurred vision, anorexia, nausea, vomiting, fatigue, yawning, salivation, dizziness, and spatial disorientation [Rolnick and Lubow 1991, Paillard *et al*. 2011, Leung and Hon, 2019]. Sopite syndrome is a less well-known symptom that can last even in the absence of nausea [Lackner 2014]. It involves excessive exhaustion, drowsiness, behavioural changes, and lack of motivation [Golding 2006, Paillard *et al*. 2011]. Usually affecting youngsters between the ages of 6 and 9, the illness is more common in girls (27.3%) than in boys (16.8%) [Golding 2006, Shupak and Gordon 2006, Sharma and Aparna 1997]. Schizophrenia patients also exhibit heightened susceptibility [Sharma and Aparna 1997]. Its prevalence is greatly influenced by environmental conditions and modes of transportation (road, air, water, space, and virtual reality environments); rates are slightly greater among Northeast Indians and Tibetans (28%) than among Northwest Indians (26%) [Paillard *et al.* 2013, Nunes *et al*. 2020]. Neurosensory conflict between the vestibular, proprioceptive, and visual systems is a part of pathophysiology [Paillard *et al*. 2013, Nunes *et al*. 2020, Ding *et al*. 2013]. Autonomic reactions like nausea and vomiting occur when these systems send contradictory signals, as happens when driving in a closed car [Zhong *et al.* 2022]. The inner ear's vestibular system is crucial, and symptoms are intensified by visual and proprioceptive abnormalities [Paillard *et al.* 2013, Nunes *et al.* 2020, Murdin *et al*. 2011]. Neuroactive substances that block histaminergic and cholinergic pathways, such as amphetamines, scopolamine, and antihistamines, are used in conventional treatments to lessen symptoms [Rolnick and Lubow 1991, Nunes *et al.* 2020]. On the other hand, these are frequently linked to negative side effects include tiredness (65%), vertigo (35%), disorientation (25%), sleeplessness (45%), and tremors (35%) [Weerts

et al. 2014]. These restrictions have led to an increase in interest in herbal medicines, especially ginger (*Zingiber officinale*), a rhizome belonging to the Zingiberaceae family [Betz *et al*. 2005]. Bioactive substances found in ginger, such as shogaols and gingerols, are well-known for their digestive and anti-nausea effects [Mao *et al.* 2019]. It has long been used to treat motion sickness, chemotherapy-induced nausea, and pregnancy-related nausea [Tóth *et al*. 2018, Choi *et al.* 2022, Crichton *et al*. 2019, Saberi *et al*. 2014]. The antiemetic effect of ginger is further supported by preclinical and mechanistic research. Zhong *et al*. [2022] found that ginger extract improves balance and endurance while lowering plasma levels of acetylcholine and histamine, which in turn lowers motion-sickness-like behaviours in mice [Paillard *et al*. 2013]. Ginger is safe and effective in clinical trials and systematic reviews, although further research is required [Kiyama 2020, Lien *et al*. 2003, Tariq *et al.* 2024]. Mentha piperita, Mentha spicata (Lamiaceae), Atropa belladonna, Scopolia carniolica, Datura spp., and Hyoscyamus niger (Solanaceae) are further herbal treatments. Still, there is not enough proof to support their safety and effectiveness [Yarnell 2016]. An examination of patents shows a sharp increase in ginger-related inventions, particularly from 2011 to 2017, with uses ranging from food items to pharmaceutical formulations [Matin *et al*. 2025]. Through randomised clinical trials, this review attempts to critically evaluate ginger's safety and effectiveness in preventing and treating motion sickness, showcasing it as a potential, all-natural substitute for conventional therapies [Tóth *et al*. 2018].

Methods

Inclusion and exclusion criteria

This systematic review included randomized controlled trials (RCTs) and an animal study with original data in English, focusing on motion sickness induced by extreme motion, motion vehicles, or visually presented motion. The studies included human participants and a rodent model with motion sickness caused by travel or lab simulation, and primarily interventions involved anti-motion sickness drugs, with the test group receiving ginger and the control group receiving dimenhydrinate, promethazine, or a placebo, with considerations for gender, age, and duration. The primary outcome was evaluating ginger's impact on Motion Sickness Assessment Questionnaire (MSAQ) scores and evaluating treatment tolerability. This review excluded some studies based on the criteria such as non-randomized studies, studies on post-operative nausea and vomiting, chemotherapy-induced nausea, nausea and vomiting during pregnancy, or non-motion-related sickness, or if they lacked proper information on ginger's pharmacology in treating motion sickness.

Search strategy

A detailed search was done by two reviewers by screening the titles/abstracts and full texts using several electronic databases, including PubMed, WoS (Web of

Science), and DOAJ, to identify studies examining the effectiveness of ginger in managing motion sickness, and disagreement was resolved by a third reviewer. The search approach focused on studies published from the inception of each database till November 24, 2024 and employed a combination of keywords. The following motion sickness words used were "motion sickness," "kinetosis," "travel sickness," "space sickness," "car sickness," "seasickness," "cybersickness," "simulator sickness," "air sickness," "virtual reality sickness," "Motion-induced nausea," "motion-induced vomiting," "motion-induced vertigo," "motion-induced dizziness," and "visually induced nausea, "Ginger," "*Zingiber officinale*," and "Zingiberis rhizome." A total of 63 articles were sourced from WoS, while 45 articles were obtained from PubMed. After deduplication, 72 exclusive articles were embedded for screening (Fig. 1).

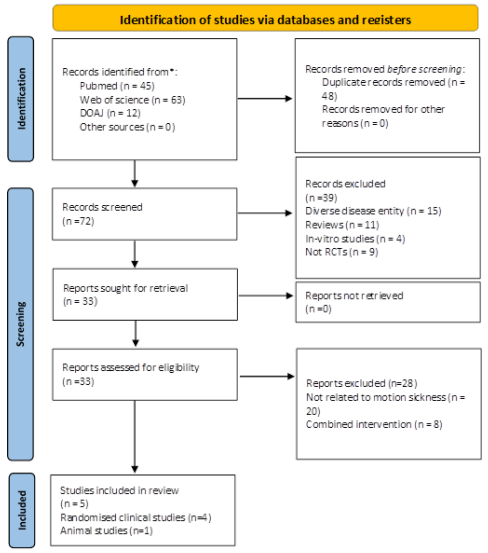

Fig. 1. PRISMA flow diagram for study selection.

Literature screening and data extraction

The study utilized Microsoft Excel for document management. A total of 72 articles were retrieved after duplicates were removed through the search strategy. Initially, four reviewers individually evaluated each article according to title/abstract and full text. Screening and data extraction were conducted as per the stated protocol. If an article didn't fit the relevancy requirements, it was excluded. After further review, 33 relevant articles were identified, and following thorough cross-checking by reviewers. Reviewers extracted data based on the details of animal study and clinical trials, sample size, age, population characteristics, study design, ginger dose, comparison intervention, outcome measures, results, and adverse events. Finally, 4 articles were

selected. There are many relevant clinical studies, but they are excluded as they are not randomized trials. We did not perform a meta-analysis because of the limited number of included studies (n = 4) and significant clinical and methodological heterogeneity, including differences in ginger dosage, formulations, study populations, and outcome measures. Instead, a qualitative (narrative) synthesis of the results was carried out. Even though our protocol included subgroup and sensitivity analyses, the lack of sufficient and inconsistent data across studies prevented these from being carried out. These four articles were examined in Randomized clinical trials and were assessed for risk bias by the Cochrane RoB2 tool [Sterne *et al.* 2019, Flemyng *et al.* 2020].

Risk of bias assessment

The studies involved are assessed by four authors using the Cochrane Rob-2 Excel tool [Sterne *et al.* 2019, Flemyng *et al*. 2020]. The available literature was judged by 3 levels (low risk of bias, unclear risk of bias, high risk of bias) and assessed based on five domains such as randomization process, deviation from intended intervention, selective bias (improper Inadequate random sequence generation, allocation concealments), performance bias (Lack of blinding of participants and personnel), reporting bias (selective reporting), attrition bias (incomplete outcome data), detection bias (Lack of blinding of outcome assessors), Cochrane assessment accessed on July 30, 2025 [Sterne *et al*. 2019, Flemyng *et al.* 2020, Spinks and Wasiak 2011, Higgins *et al.* 2011]. (Cochrane handbook for systematic reviews of interventions).

Results

Literature earch

The study selection process, adhering to PRISMA guidelines, is illustrated in Figure 1 https://www.prisma-statement.org/. Before screening, 108 records were first found in databases, and 36 duplicates were eliminated. 41 of the 72 records that remained were excluded for various reasons, including the fact that they were reviews or non-randomized controlled trials. Of the 31 papers that were still searched for retrieval, all were successfully retrieved, and their eligibility was evaluated. 27 of them were excluded because of their uneven disease or intervention focus. In the end, the final review contained four studies, encompassing 339 participants randomized either to Ginger or to the control group.

Study Characteristics

Features of the study are shown in Table 1. The included human studies (n = 4) were conducted in Taiwan, Denmark, the USA, and Brazil. Sample sizes of the RCTs ranged from 18 to 335. Participants in a 2002 study by Han-Chung Lien [Lien *et al.* 2003] received 1,000 mg or 2,000 mg of ginger capsules an hour before experimental procedures that included vasopressin infusion and circular vection. In comparison to the placebo group, the study found that both ginger doses were similarly helpful in

Table 1.1. Characteristics of studies included in the review

S. No	Published year	Lead author	Journal	No of cases	Gender (male/ female)	Age (yrs)	Research type	Dose
1	2003	Lien *et al.*	*American Journal of Physiology-Gastrointestinal and Liver Physiology*	18	(08/10)	18-40	double arm	1,000 mg or 2,000 mg of ginger capsules or a placebo was given to Participants, 60 minutes before the experiment
2	1988	Grontved *et al.*	*Acta Otolaryngology (Stockh)*	80	not specified	16-19	double arm	40 received 1 g of powdered ginger root; 40 received 1 g of lactose as a placebo
3	1982	Mowrey, Clayson	*The Lancet*	36	(18/18)	18-20	three-arm	two capsules of powdered chickweed herb (Stellaria media) as a placebo; 100mg of dimenhydramine as another group; two gelatin capsules of powdered rhizome of Z. officinale (940mg total) are used as a test group
4	2023	Nunes *et al.*	*Current Therapeutic Research*	335	(154/181)	18-65	double arm	group A: a combination of GABA tartrate, glutamic acid, dibasic calcium phosphate, thiamine nitrate, pyridoxine chloride, and cyanocobalamin was given in the doses of 100mg, 50mg, 25mg, 10mg, and 5µg respectively, and given as coated tablets; group B: 160 mg of dry rhizome extract of ginger which consists of 8 mg of gingerols given as coated tablets

lowering the severity and onset of nausea, with symptoms manifesting later and going away sooner. Additionally, ginger decreased vasopressin levels, which are linked to motion sickness and tachygastria by almost 21%. Crucially, no adverse effects were mentioned. In a double-arm experiment with naval cadets in 1988, Aksel Grøntved

Table 1.2. Summary outcomes and side effects in included studies

S.No	Published year	Lead author	Duration	Outcomes		Key findings	Side effects	
				control group	test group		control group	test group
1	2003	Lien *et al.*	circular vection studies: single session duration (approximately 45 minutes); vasopressin infusion studies: single session duration (approximately 90 minutes); each patient underwent multiple sessions on separate days	in the control group (Placebo), participants experienced moderate to severe nausea, with a score of 2.5 and experienced a rapid onset of nausea, with symptoms developing after 5.6 minutes and taking a recovery time of up to 60 minutes;circular vection increased tachygastria by 28.9% and vasopressin levels increased by 5.3 pg/ml	in the test group (Ginger), participants experienced nausea severity scores ranges 1.7 -1.8 and experienced delayed onset of nausea with symptoms developing after 8.5 - 9.7 minutes, and takes a faster recovery time of up to 45 minutes; ginger decreased tachygastria by approximately 21% and also decreases the vasopressin level by 3.7-2.7 pg/ml	the control group experienced higher nausea severity and higher vasopressin levels on the other side the test group (ginger treated) showed improvement in preventing motion sickness symptoms at both 1000 mg and 2000 mg which showed the same level of effectiveness	no side effects	no side effects
2	1988	Grontved *et al.*	after the capsules were ingested; the experiment lasted for 4 hours	in the control group (placebo), based on vomiting, Five participants vomited two or more times and More participants reported experiencing cold sweating and symptoms of nausea and vertigo were more frequent and severe in the placebo group.	in the test group (ginger root), based on vomiting, No participants vomited more than once and some cadets reported cold sweating symptoms of nausea and vertigo were less severe in the ginger group	The study reported that ginger root is effective in reducing seasickness like vomiting, cold sweating, nausea, and vertigo. Regarding vomiting, the protection index of ginger is 72%	no side effects	no side effects
3	1982	Mowrey, Clayson	the duration was up to 6 minutes of chair rotation and capsules were administered 20-25 minutes before the rotation	in the control group (placebo), participants were unable to tolerate the rotating chair for a full 6 minutes, indicating severe motion sickness symptoms; three participants vomited during the experiment; gastrointestinal sensations are most rapidly increased; in the dimenhydrinate group, none of the participants were able to tolerate the rotation for a full 6 minutes; indicating moderate effectiveness; gastrointestinal sensation is slower than placebo	in the test group (ginger), 9 participants remained in the revolving chair for the full 6 minutes, showing the highest tolerance and superior in reducing motion sickness symptoms; it shows the slowest increase in gastrointestinal sensation	ginger showed the most effectiveness in the reduction of motion sickness symptoms compared to other groups; the participants involved in the ginger group showed the highest tolerance time in the chair rotation	unclear	unclear
4	2023	Nunes *et al.*	the study was four trips and the medicated tablets were administered before 15 minutes of trip 2-4.	control group (Ginger): Significant reduction in MSAQ score; percentage of patients with a ≥20 points reduction in MSAQ score on trip2: 43.6%, trip3: 50.9% , and trip4: 55.1%.	test group (Gaba combination): superior reduction in motion sickness symptoms compare to the control group; percentage of patients with a ≥20 points reduction in MSAQ score on trip2: 54.1%, trip3: 62.3%, trip4: 66.4%	both control group and test group treatments were effective in reducing motion sickness a a test group is more effective than the control group	gastrointestinal side effects like bloating, latulence, burning tongue.	neurolo-gical side effects like sleepiness

et al. [1988] gave one group one gram of powdered ginger root and the other group lactose as a placebo. The symptoms of seasickness, such as nausea, vertigo, vomiting, and cold sweats, significantly decreased in the participants who took ginger. Interestingly, no one in the ginger group experienced repeated vomiting, and the study determined that ginger had a 72% protective index. Since no negative effects were observed, ginger is a suitable and safe choice in this situation. Daniel B. Mowrey [Mowrey and Clayson, 1982] evaluated the effectiveness of 940 mg of powdered ginger rhizome in capsule form against a regular medication (100 mg of dimenhydrinate) and a placebo (chickweed herb) in a previous 1982 study. In a 6-minute chair rotation test that mimicked motion sickness, ginger helped 9 out of 12 people finish, outperforming both the placebo and the medication substitute. Its ability to lessen nausea and associated symptoms was further demonstrated by the fact that it caused the slowest increase in gastrointestinal discomfort. However, no side effects were explicitly mentioned in the study. Carlos P. Nunes, MD [Nunes *et al.* 2023], conducted the most recent study in 2023. It compared a test group that received a combination of GABA tartrate, glutamic acid, and B vitamins with a control group that received 160 mg of dry rhizome ginger extract (including 8 mg of gingerols). Prior to trips intended to cause motion sickness, both groups took their drugs as coated tablets. With 43.6% to 55.1% of subjects experiencing a ≥20-point improvement over several flights, Ginger showed a significant decrease in Motion Sickness Assessment Questionnaire (MSAQ) ratings [Gianaros *et al*. 2001]. Despite its effectiveness, the GABA combo was significantly more beneficial [Nunes *et al*. 2023]. While the test group had neurological symptoms like tiredness, the ginger group reported mild side effects like bloating, gas, and burning tongue. Risk bias determinations are provided in Figure 2. Because of the significant variation in research outcomes, interventions, and comparators, a qualitative synthesis of the findings was carried out instead of a quantitative meta-analysis.

Fig. 2. Risk of bias assessment. A: Risk of bias assessment for included studies B: Risk of bias table according to the Cochrane risk of bias tool.

Effectiveness of ginger on motion sickness

Analysis of 4 RCTs: 3 RCTs showed an effective response in the ginger group in preventing motion sickness. However, one RCT has shown lesser efficacy in the ginger group than in the combination therapy in preventing motion sickness and

reported both groups are safer with an analysis of the MSQA score. The absolute motion sickness assessment questionnaire scores of the ginger group in trips 2, 3, and 4 are 6404, 5903, and 5671, respectively. And physicians' assessment with a total possible score of 1650, the ginger group scored 1124, and the combination therapy group scored 1299, because compared to other studies, this study has a lower dose of ginger of 160 mg [Sharma and Aparna 1997]. The other 3 studies have a minimum dose of 1000 mg or 1 g, but there is no significant difference between the two groups. This showed that a minimum dose of 1000 mg of ginger is more effective in reducing motion sickness. In the three-arm study, the ginger-treated group showed the highest tolerance, and it showed the slowest increase in gastrointestinal sensation, so it gradually reduced motion sickness symptoms [Mowrey, Clayson 1982]. The effect of Ginger was measured on seasickness; the symptom score of the ginger and placebo groups was measured here. Symptom score was reduced in the ginger group compared to the placebo group. In terms of vomiting, the Protection Index (PI) is 72% [Grøntved *et al*. 1988]. Ginger with a dose of 1,000 mg significantly reduced the severity of nausea of circular vection, and 45 min after stopping circular vection. There was no difference in the effects of 1,000 or 2,000 mg of ginger on nausea reduction [Lien *et al.* 2003]. After a detailed analysis of included studies, ginger has proven to have potential efficacy in the prevention of motion sickness.

Side effects

Results from the four trials that made up this review's evaluation of ginger's safety profile in preventing motion sickness consistently showed that ginger is typically well tolerated, with only mild to moderate adverse effects occasionally recorded. Two of the trials explicitly reported no negative effects, whereas the other two reported mild neurological or gastrointestinal side effects, especially at larger dosages**.**

In a rotating chair trial, Mowrey and Clayson [1982] discovered that ginger prevented motion nausea better than dimenhydrinate (Dramamine). The lack of adverse reports indicates a good safety profile, even though no side effects were reported. The idea that ginger is safe and well-tolerated in real-world, high-motion situations is further supported by Study 2, which was carried out on naval cadets by Grøntved *et al.* [988] and specifically reported no adverse effects among those who received 1 gram of powdered ginger root. On the other hand, ginger was shown to be generally safe with few adverse effects in Study 3 by Lien *et al*. [2003]. However, the authors did note that moderate gastrointestinal irritation could occur, especially at higher dosages of 1,000 mg to 2,000 mg [Lien *et al*. 2003]. The implication was that ginger's tolerance would marginally decline at higher dosages, even if adverse effects were not quantitatively described. A standardised ginger rhizome extract (160 mg with 8 mg of gingerols) was compared to a GABA-vitamin combination in Study 4 by Nunes *et al.* [2023]. This study found that the ginger group experienced more frequent gastrointestinal side effects, such as burning tongue, flatulence, and bloating. Furthermore, although they were recorded, moderate neurological symptoms, including headaches, were less

common than in the comparison group. Notably, all side effects were categorised as low to moderate in severity, and no significant adverse events were noted. Ginger showed a better safety profile than traditional treatments like antihistamines (like dimenhydrinate) and antimuscarinics (like scopolamine), as it did not cause common side effects like drowsiness, dry mouth, sedation, or vision problems. But according to the 2023 study [Nunes *et al.* 2023], some people may have more gastrointestinal distress from ginger than from combined or traditional treatments. In the animal study conducted using Kunming mice, the animals did not exhibit any evidence of toxicity, behavioural discomfort, or aberrant biochemical values, indicating that ginger extract was well tolerated [Zhong *et al.* 2022].

Discussion

This systematic review evaluated four randomised controlled studies (RCTs) and one animal study evaluating ginger's effectiveness in reducing motion sickness symptoms in both lab and real-world situations were examined in this systematic review. In the animal study [Zhong *et al*. 2022], male Kunming mice were used to provoke motion sickness using a validated rotational-stimulation device. In mice, rotation is a common vestibular disturbance model that results in typical nausea-like responses as piloerection, tremors, immobility, faeces, and poor balance. The motion sickness index score, balance beam performance (time to cross and foot slips), and extensive swimming tests were all part of the extensive battery of behavioural tests used to evaluate malaise-associated fatigue. These behavioural results were bolstered by biochemical assessments of serotonin, acetylcholine, and histamine as well as metabolic profiling using LC-MS/MS to assess systemic changes brought on by motion stress. Ginger prolonged intensive swimming endurance, enhanced balance-beam performance, and dramatically decreased the motion sickness index, all of which suggested less vestibular-induced discomfort. Biochemically, ginger restored several metabolic processes that were disturbed by rotation, such as fatty acid oxidation, bile acid metabolism, and glycometabolism, and reduced the levels of histamine and acetylcholine, accentuating the anti-motion sickness effect of ginger in animal models.

The idea that ginger is useful in treating motion sickness is supported by the fact that three of the four trials showed a significant decrease in nausea and vomiting in those who received ginger [Lien *et al*. 2003, Mowrey and Clayson 1982, Grøntved *et al*. 1988]. Previous research, carried out in 1982, 1988, and 2002, also showed positive results. For instance, 940 mg of ginger was found to be more beneficial than 100 mg of dimenhydrinate in reducing nausea and vomiting in Mowrey's 1982 study [Mowrey and Clayson 1982], which involved 36 volunteers between the ages of 18 and 20 [Mowrey and Clayson 1982]. Another trial included 80 volunteers, aged 16 to 19, who participated in another research in which 40 were given 1g of powdered ginger and the other 40 were given 1g of lactose as a placebo for four hours [Grøntved

et al. 1988]. Another study, which involved 18 participants between the ages of 18 and 40, examined 1000 mg and 2000 mg dosages of ginger before a 45-90-minute motion sickness simulation [Lien *et al*. 2003]. However, a large-scale experiment with 335 people in 2023 suggested that combo therapy might be more effective than ginger alone [Nunes *et al*. 2023]. In this study, Group B (165 participants) received 160 mg of ginger extract, while Group A (170 participants) received a combination of gamma-aminobutyric acid, glutamic acid, calcium, thiamine, pyridoxine, and cyanocobalamin. whereas 160 mg of ginger extract was given to Group B (165 participants) [Nunes *et al*. 2023]. Although the incidence of vomiting was somewhat decreased in the ginger group, this impact was noticeably smaller than in the combination group, and ginger was also linked to several neurological and gastrointestinal adverse effects [Nunes *et al*. 2023]. These results imply that the efficiency of ginger may vary with dosage. The 2023 trial utilised a much lower dose (160 mg) than previous studies, which may have decreased its efficacy because the previous studies employed high doses (1000-2000 mg). Numerous factors, such as variations in ginger formulation, dosage, study design (crossover versus parallel group), and the type of motion stimuli (e.g., sea voyage, circular vection, or chronic susceptibility conditions), can be blamed for the discrepancy in outcomes among studies. Two studies pointed out that greater dosages may result in neurological symptoms such as headaches and gastrointestinal discomfort, even though the majority of studies showed few or no negative effects [Palatty *et al*. 2013]. However, physical assessments and observation throughout the trial periods showed that ginger was generally well tolerated [Nunes *et al*. 2020]. Ginger works through a variety of mechanisms (Fig. 3).

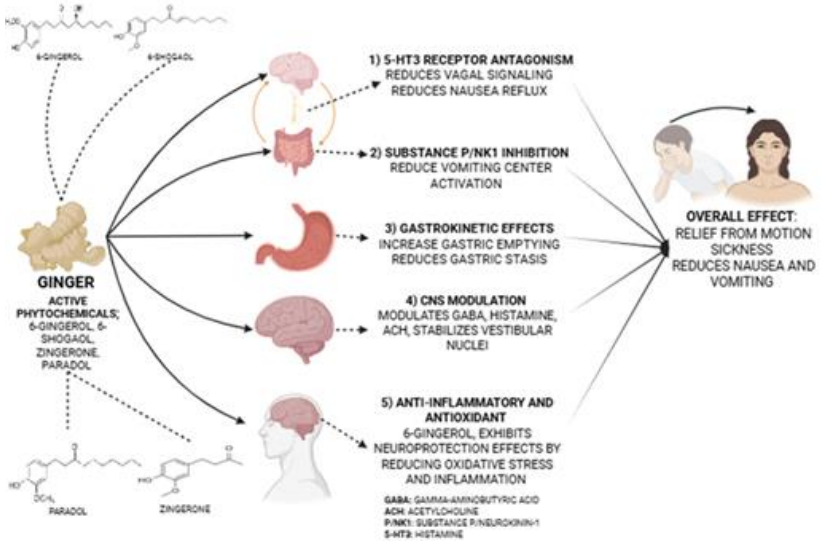

Fig. 3. Schematic representation of the multifaceted mechanisms of ginger in alleviating motion sickness.

Together, its anticholinergic and anti-5HT3 receptor actions, inhibition of prostaglandin and leukotriene production, and anti-inflammatory and antioxidant properties improve gastrointestinal motility and reduce nausea [Lien *et al*. 2003, Rahimzadeh *et al*. 2023, Bryer 2005, Ha *et al*. 2024]. Motion sickness is caused by neurosensory conflicts between the vestibular, ocular, and proprioceptive systems, which these measures help to alleviate [Holtmann *et al*. 1989]. Ginger avoids the sedative and neurological side effects that are frequently connected to centrally acting antiemetics by going straight to the gut. Despite its widespread historical use and apparent promise as a cure for motion sickness, the available data is not without flaws. The included trials differed greatly in terms of follow-up time, dosage standardisation, and sample size. The majority of earlier research lacked long-term follow-up and had tiny sample sizes. Crucially, it is challenging to establish inferences on the best dosing schedules due to the wide range of dosages, which can range from as little as 160 mg to as high as 2000 mg [Lien *et al*. 2003]. Furthermore, bias in participant responses may have been introduced by some methodological faults, such as the absence of blinding in some experiments (because of the unique taste and smell of ginger) - Nunes *et al*. [2023]. Furthermore, nothing is known about the long-term effectiveness of ginger, particularly in people who are subjected to long-term motion stressors such as prolonged sea cruises spanning weeks or months [Grøntved *et al*. 1988]. Large-scale, multicenter RCTs with constant dosage, extended follow-up periods, and appropriate blinding should be the main emphasis of future research in order to completely comprehend ginger's potential as a treatment agent for motion sickness. Studies that compare ginger to contemporary combo medications may help solidify its position in clinical practice. Further comprehension of ginger's antiemetic effects may be gained by investigating the processes via which it affects vestibular modulation and stomach rhythm. According to the results of this comprehensive study, ginger is a reasonably safe, well-tolerated, and effective treatment for motion sickness. Even though it might not always be more effective than combination or pharmaceutical treatments, it is nevertheless a useful natural cure, especially for people looking for alternatives to traditional medications. The current gaps should be filled, dosage recommendations should be improved, and ginger's therapeutic potential should be further explored using high-quality evidence in future studies. Our results show that while ginger may not be the best option for everyone, it has a lot of potential as a supplement or alternative treatment for motion sickness.

Limitations

According to current evidence, this systematic review is among the few that focus exclusively on the role of ginger in treating motion sickness. Only English-language publications that were available through specific databases were included in our review, which might have introduced publication and language bias. Additional information might have been found in unpublished or non-English studies. It is still possible that pertinent research indexed in other sources or unpublished literature was

overlooked, even though we examined four major databases to guarantee a thorough evaluation. There was a lack of information regarding ginger's long-term safety and efficacy, and the majority of studies merely evaluated its immediate effects. This could have affected the completeness of the evidence given and induced selection bias. For mechanistic understanding, a single supporting preclinical study in mice (rotation-induced vestibular model) was also examined; however, animal results cannot be directly applied to humans and hence only function as added evidence. Furthermore, because ginger formulations, doses, outcome measures, and administration techniques vary widely, a meta-analysis was not practical. Furthermore, some demographics were studied, including motion sickness patients, navy cadets, healthy volunteers, and people exposed to circular vection. "The findings' capacity to be applied to a larger population may be limited by this group-specific focus. Studies on several outcomes, like the frequency of vomiting, dizziness, and the length of symptom alleviation, were also limited. The body of studies supporting the use of ginger to treat motion sickness has to be strengthened. This systematic review is among the few that focus exclusively on the use of ginger in the treatment of motion sickness, based on the available data. To bolster the body of data supporting the use of ginger to treat motion sickness, further research is required.

Future directions

In this systematic review, the included studies have promising evidence that Ginger shows an effective response against motion sickness and has fewer adverse effects compared to current therapies in some studies that have investigated. Based on the existing studies, there are limited studies with small sample sizes, ranging from less than 100 volunteers in three studies and 370 volunteers in one study. The ginger doses differ between each study, varying from 8 mg to 2gm and the study duration varies in each study from 25 minutes to 7 days. In current studies, three RCTs showed that ginger is effective against motion sickness, but one RCT has shown that combination therapy is more effective in motion sickness than ginger. To analyse ginger's potential, future research should concentrate on high-quality trials, comparative effectiveness, ideal dosage, and investigate the underlying mechanism of ginger's effect on gastric rhythm or vestibular modulation. So, further studies are required to identify a precise mechanism of action because, in previous studies, there is no definite mechanism of action and the effectiveness of Ginger on motion sickness. Moreover, large-scale sample sizes, randomized clinical trials, standardized ginger dose, consistent study duration, comparing the effectiveness of ginger to conventional treatments, and reliable outcomes are needed to prove the efficacy of ginger in preventing motion sickness.

Conclusion

This comprehensive analysis of four randomized controlled studies supports the efficacy and safety of ginger (*Zingiber officinale*) as a natural remedy for motion sickness. Given the consistency of benefit at doses around 1,000 mg and the favorable

safety profile observed across trials, ginger can be considered a viable adjunct or standalone prophylactic measure for motion sickness, particularly in individuals seeking non-sedating alternatives. Besides, ginger is a highly accessible therapeutic option when compared to that of modern medicine. However, more extensive multicentric RCTs - involving comparative interventional arms, focused on dose–response and formulation-specific effects - are required to conclusively prove its comparative efficacy, safety, and clinical relevance.

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Competing interests

The authors declare no conflict of interest.

Data availability statement

No new datasets were created. All data analyzed were extracted from published articles.

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