ORIGINAL ARTICLE

Evaluation of the Efficacy and Adverse Effects of Herbal Steam Inhalation in Allergic Rhinitis Patients

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Background: The prevalence of allergic rhinitis (AR) is rising in Thailand and worldwide. AR causes nasal itching, sneezing, rhinorrhea, and congestion, impairing sleep, work, and daily life. Herbal steam inhalation, a traditional Thai remedy, is believed to improve circulation and relieve nasal obstruction. While herbal steam bath has shown benefits for AR, the efficacy of herbal steam inhalation remains unstudied.

Objective: To evaluate the efficacy, safety, and satisfaction of herbal steam inhalation in patients with AR.

Materials and Methods: Sixty-eight patients with AR were randomly assigned to receive either herbal steam inhalation (containing *Cymbopogon citratus*, *Citrus hystrix*, *Zingiber cassumunar*, *Curcuma longa*, *Zingiber officinale*, *Allium ascalonicum*, and camphor) or plain steam generated from water at 60°C for five minutes. Efficacy was assessed using the minimum cross-sectional area (MCA) by acoustic rhinometry, total nasal symptom score (TNSS), and visual analogue scale (VAS). Satisfaction and adverse events were recorded.

Results: Both groups showed significant improvement in VAS and TNSS ($p<0.05$) without significant intergroup differences or MCA change. Satisfaction levels were significantly higher in the herbal steam group ($p<0.05$). Mild adverse effects occurred in 13 herbal and 9 control participants. However, no serious events were reported.

Conclusion: Herbal steam inhalation is a safe and well-tolerated complementary therapy for AR. While it provides similar improvements in nasal patency and symptom scores compared to plain steam, it demonstrates significantly higher patient satisfaction, suggesting its potential role in enhancing patient comfort, treatment adherence, and serving as an alternative option for symptom relief.

Keywords: Herbal steam inhalation; Allergic rhinitis; Steam inhalation; Thai traditional medicine

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The global prevalence of allergic rhinitis (AR) is 10% to 40%, with the highest rates observed among children. In Thailand, the prevalence has been rising since the first national surveys. Among children aged 6 to 7 years, the prevalence is approximately 15%, which is higher than the global average of 9.1%, while among those aged 13 to 14 years, the prevalence is 17.5%, comparable to the global rate of 16%. The overall prevalence of AR continues to increase both worldwide and in Thailand, due to rising air pollution, which is a significant risk factor[1].

AR occurs when allergens enter the body, particularly through the nasal passages, leading to symptoms such as nasal itching, sneezing, rhinorrhea, and congestion. The severity of symptoms varies among patients, ranging from mild to severe, and may resolve spontaneously or require treatment. These symptoms negatively affect patients' quality of life, including sleep, learning, work performance, and social interactions[2].

In Thai traditional medicine, AR is believed to result from an imbalance among the four body elements: earth, water, wind, and fire. The condition is associated with an imbalance of the fire element in the upper part of the body, causing symptoms such as runny nose, nasal itching, congestion, sneezing, and excessive phlegm. These symptoms are influenced by environmental factors such as weather changes,

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odors, pollen, heat, and cold. Treatment approaches include herbal medicine, herbal steam baths, and herbal steam inhalation, known in Thai as "Sum Ya"[3].

At Thammasat Khu Khot Medical Center, treatments such as herbal therapy, massage, hot herbal compress, and herbal steam baths are used to restore elemental balance according to Thai traditional medicine principles. The clinic employs herbal steam inhalation to relieve AR symptoms, using aromatic herbs such as *Zingiber cassumunar* (plai), *Curcuma longa* (turmeric), *Cymbopogon citratus* (lemongrass), *Citrus hystrix* (kaffir lime), *Allium ascalonicum* (shallot), and camphor. These herbs are easily accessible and commonly used in Thai traditional medicine.

Herbal steam inhalation (Sum Ya) is a therapeutic option for relieving nasal symptoms such as congestion, rhinorrhea, and sneezing. Heat causes the volatile essential oils in herbs to evaporate, allowing patients to inhale them, which may help relieve nasal obstruction, open pores, and promote sweating. During the COVID-19 pandemic, herbal steam inhalation was commonly used to alleviate respiratory symptoms such as coughing, sneezing, and nasal congestion due to its simplicity and feasibility for home use[4].

A previous study using an herbal steam bath at 42 to 44°C for five minutes in patients with AR demonstrated improvements in total nasal airflow, nasal airway resistance (NAR), nasal cavity volume, and the mean minimum cross-sectional area (MCA) after treatment[5]. Another study found that an herbal steam bath performed for 30 minutes, three times per week for four consecutive weeks at 42 to 45°C, significantly improved nasal symptoms, including congestion, itching, rhinorrhea, and sneezing.

Therefore, this study aimed to evaluate the efficacy of herbal steam inhalation in relieving symptoms of AR compared with plain hot steam. The outcomes were assessed using the MCA, total nasal symptom score (TNSS), and visual analogue scale (VAS). Adverse effects were also recorded to ensure safety. Herbal steam inhalation offers a simple, low-cost, and home-based alternative to herbal sauna therapy. If proven effective, it could serve as a practical self-care option for patients with AR.

Materials and Methods

This study was a prospective, randomized, single-blind (assessor-blind), controlled trial conducted at Thammasat Hospital, Thammasat University, between June 2024 and September 2025 that included 68 patients with AR. The study was approved by the Medical Ethics Committee of the Faculty of Medicine, Thammasat University (Thai FDA-accredited, Registry No. MTU-EC-TM-1 088/67) and registered at the Thai Clinical Trials Registry (TCTR20250707014) prior to enrollment. Written informed consent was obtained from all participants.

Eligible participants were 18 to 60 years old with a confirmed diagnosis of AR following the Clinical practice guidelines for AR in Thai people (2022)[1] and at least two bilateral nasal symptoms (sneezing, rhinorrhea, itching, or congestion) occurring most days for one hour or longer and persisting for one year or more. Additional criteria included a history of allergen-triggered symptoms, family history of allergies, or improvement with second-generation antihistamines. Exclusion criteria were the use of anti-allergic medication within two weeks, known allergy to herbs, steam, or heat, and symptoms of dizziness or fatigue during screening.

Participants were randomly assigned to two groups:

Group 1 (herbal steam inhalation, HSI) received a mixture of seven herbs: *Cymbopogon citratus* (50 g), *Citrus hystrix* (50 g), *Zingiber cassumunar* (25 g), *Curcuma longa* (25 g), *Zingiber officinale* (10 g), *Allium ascalonicum* (10 g), and camphor (0.1 g), which was added to hot water at 60±2°C and soaked for about two minutes before use. Participants inhaled the steam for five minutes while covering their head and basin with towel.

Group 2 (control group, SI) inhaled steam generated from water at 60°C for five minutes using the same setup.

Sample size

The sample size was determined using the formula for testing two dependent means[6]. The mean and standard deviation values for nasal symptoms were derived from a previous study[7]. Based on mean1=1.16, mean2=0.77, SD1=0.67, and SD2=0.37, with a two-tailed α=0.05 and a power of 0.8, the calculated sample size was 31 participants per group. To account for potential dropouts, an additional 10% was added[8], resulting in a final sample size of 34 participants per group (total=68).

The random allocation sequence was generated using block randomization with a fixed block size of four to ensure balanced numbers of participants in each group throughout the study. The sequence

was created using a computer-based random number generator with an allocation ratio of 1:1 between the HSI and SI groups. The randomization list was stored in a restricted-access electronic file, and group assignments were made by a practitioner who was not involved in data collection or analysis.

Preparation of materials and herbal steam formula

The herbal steam formula consisted of ingredients listed in Table 1. Only fresh herbal materials free from visible contamination, mold, or spoilage were selected. All herbs were cleaned, prepared, and weighed according to a standardized formulation prior to each intervention session. Each ingredient was cut into small pieces (approximately 1 inch in size) and lightly crushed before being mixed together. The mixture was then soaked in hot water, followed by the addition of 0.1 g of camphor.

The steaming container used was a basin with a mouth diameter of 28 cm, covered with a cloth measuring 2×2 m.

Herbal steaming inhalation procedure

All herbal ingredients were placed in a 28-cm diameter basin, followed by the addition of 1,100 mL of hot water at 60±2°C, and the mixture was allowed to soak for approximately two minutes. Finally, 0.1 g of camphor was added immediately before use.

Participants were instructed to position their faces approximately 20 cm above the water. Both the head and the basin were covered with a 2×2 m cloth to confine the herbal vapor. The streaming process lasted for five minutes to ensure adequate inhalation of the volatile herbal components under controlled thermal conditions.

Outcome measurements

The study outcomes included the TNSS, VAS, treatment satisfaction, adverse events, and the cross-sectional area of the nasal cavity.

TNSS is a validated self-assessment tool for AR, consisting of four items: rhinorrhea, nasal itching, congestion, and sneezing. Each symptom is rated on a 4-point scale (0=none to 3=severe), yielding a total score from 0 to 12. Scores are interpreted as less than 3 as very mild, 3 to 6 as mild, 7 to 9 as moderate, and 10 to 12 as severe[9].

VAS is a 100-mm line ranging from no symptoms to most severe symptoms. Participants marked their symptom intensity, which was recorded as a score between 0 and 100 mm. The VAS is simple, reliable, and reproducible, and is widely used to monitor symptom severity and treatment response in AR[10].

Table 1. List of herbal medicines in herbal steam inhalation

No.	Scientific name	Part of use	Weight (g)
1	*Cymbopogon citratus*	Stem	50
2	*Citrus hystrix*	Fruit	50
3	*Zingiber cassumunar*	Rhizome	25
4	*Curcuma longa*	Rhizome	25
5	*Zingiber officinale*	Rhizome	10
6	*Allium ascalonicum*	Rhizome	10
7	Camphor	-	0.1

Acoustic rhinometry objectively measures the nasal cavity using sound wave reflection to determine the MCA and nasal volume. Measurements were performed in a quiet, temperature-controlled room before and after treatment. Participants were seated, and a suitable nosepiece was fitted gently to prevent air leakage. The method is fast, safe, reproducible, and requires minimal patient cooperation[11].

Statistical analysis

The data were evaluated using statistical software. The results were reported as mean ± standard deviation. The data were tested for normality and homogeneity in order to select a proper statistical test. Differences between groups were evaluated using the Independent Sample t-test or Mann-Whitney U test, while differences within groups were assessed using the paired t-test or Wilcoxon's test. The significance level of a p-value less than 0.05 was considered statistically significant. All statistical analyses were performed using Stata Statistical Software, version 17 (StataCorp LLC, College Station, TX, USA).

Results

Volunteers

Sixty-eight eligible AR patients were recruited from Thammasat University, Rangsit Campus. Participants who met the inclusion criteria were randomly assigned into two groups, with 34 participants in each group. This study was designed as a pre-and post-comparative study, as illustrated in Figure 1.

Baseline characteristics

The baseline characteristics of participants were comparable between the two groups. There were no statistically significant differences in gender, age, BMI, triggering factors, presence of concomitant

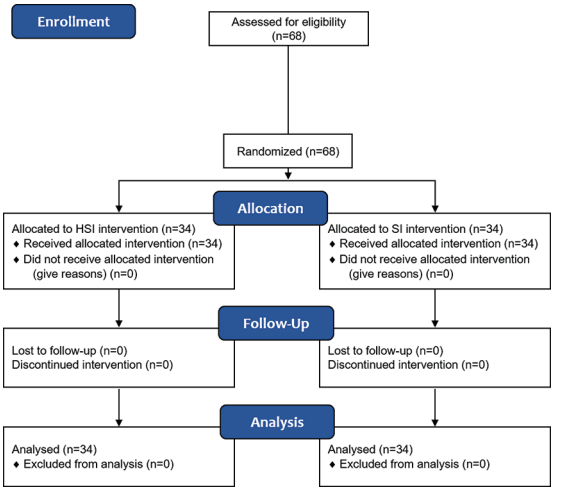

Figure 1. CONSORT flow diagram.

allergic disease, or family history of AR. Most participants reported symptoms occurring less than four days per week.

When comparing vital signs between the two groups, only diastolic blood pressure showed a statistically significant difference. However, all blood pressure values remained within the normal range according to the Thai Hypertension Society (2019). Other vital sign parameters, including body temperature, heart rate, respiratory rate, and systolic blood pressure, did not differ significantly between the groups (Table 2).

Efficacy

Total nasal symptom score:

TNSS before and after steaming revealed that nasal itching, sneezing, and total scores significantly decreased within both groups. Although nasal obstruction and rhinorrhea scores also decreased, the reductions were not statistically significant only in the HSI group (p=0.010). When comparing between groups, no significant differences were observed for most variables, except rhinorrhea after steaming, which demonstrated a statistically significant difference between groups (p=0.036) (Table 3).

Visual analogue scale:

VAS showed that nasal congestion, itching, and sneezing scores significantly decreased within both groups after steaming. Rhinorrhea scores also decreased in both groups. However, a statistically significant reduction was observed only in the SI group. When comparing between groups, no significant differences were found in any of the evaluated variables (Table 4).

Table 2. Baseline characteristics

Variable	Intervention		p-value
	HSI	SI	
Female; n (%)	24 (70.59)	23 (67.65)	0.793
Age (years); mean [SD]	24.91 [7.82]	23.97 [7.46]	0.853
BMI (kg/m^2); mean [SD]	22.63 [3.90]	24.01 [3.92]	0.151
Triggering factors; n (%)			
Dust	33 (97.06)	32 (94.12)	1.000
Smoke	14 (41.18)	10 (29.41)	0.310
Pollen	6 (17.65)	1 (2.94)	0.105
Others	10 (29.41)	11 (32.35)	0.793
Symptoms <4 days/week; n (%)	19 (55.88)	18 (52.94)	0.808
Other allergic disease; n (%)	12 (35.29)	11 (32.35)	0.798
Family history of AR; n (%)	25 (73.53)	22 (64.71)	0.431
Vital sign; n (%)			
Body temperature (°C)	36.36 (0.27)	36.25 (0.47)	0.209
Pulse rate (bpm)	81.00 (11.92)	75.94 (9.22)	0.055
Respiratory rate (bpm)	15.59 (1.96)	16.03 (2.15)	0.380
Systolic blood pressure (mmHg)	118.47 (10.98)	115.82 (9.27)	0.287
Diastolic blood pressure (mmHg)	72.88 (9.53)	68.68 (7.42)	0.046

SD=standard deviation; BMI=body mass index; AR=allergic rhinitis; HSI=herbal steam inhalation; SI=steam inhalation

Comparisons between groups were analyzed using t-test, chi-square test, or Fisher exact test, as appropriate.

Table 3. Vital sign

Vital sign	Intervention; mean (SD)		p-value
	HSI	SI	
Body temperature (°C)	36.36 (0.27)	36.25 (0.47)	0.209
Pulse rate (bpm)	81.00 (11.92)	75.94 (9.22)	0.055
Respiratory rate (bpm)	15.59 (1.96)	16.03 (2.15)	0.380
Systolic blood pressure (mmHg)	118.47 (10.98)	115.82 (9.27)	0.287
Diastolic blood pressure (mmHg)	72.88 (9.53)	68.68 (7.42)	0.046

SD=standard deviation; HSI=herbal steam inhalation; SI=steam inhalation

Comparisons between groups were analyzed using t-test.

Acoustic rhinometry:

There was no significant difference between the two groups in nasal cross-sectional area or nasal volume. However, a significant difference was observed in the right-side distance parameter within the herb steam group (Table 5).

Satisfaction

The analysis of post-treatment satisfaction revealed that the HSI group reported a significantly higher level of satisfaction compared with the SI group (Table 6).

Adverse events

No serious adverse events were reported in either group. Mild adverse events occurred in 13

Table 4. Total nasal symptom score (TNSS) before and after steam inhalation

Variables	Time	Intervention; median (IQR)		p-value
		HSI	SI	
Nasal congestion (0-3)	Before	1.00 (0.00, 2.00)	1.00 (0.00, 2.00)	0.521
	After	0.50 (0.00, 1.00)	1.00 (0.00. 1.00)	0.995
	p-value	0.010*	0.070	-
Nasal itching (0-3)	Before	0.50 (0.00, 2.00)	1.00 (0.00, 1.00)	0.607
	After	0.00 (0.00, 1.00)	0.00 (0.00, 1.00)	0.622
	p-value	0.006*	0.021*	-
Sneezing (0-3)	Before	0.00 (0.00, 1.00)	0.00 (0.00, 0.00)	0.283
	After	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.710
	p-value	0.007*	0.025*	-
Rhinorrhea (0-3)	Before	0.00 (0.00, 1.00)	0.00 (0.00, 1.00)	0.130
	After	0.00 (0.00, 1.00)	0.00 (0.00, 0.00)	0.036**
	p-value	0.424	0.302	-
Total TNSS (0-3)	Before	2.50 (1.00, 5.00)	2.00 (1.00, 4.00)	0.254
	After	1.00 (0.00, 3.00)	1.00 (0.00, 2.00)	0.408
	p-value	0.0008*	0.0005*	-

IQR=interquartile range; HSI=herbal steam inhalation; SI=steam inhalation
* Significant difference within group (before vs. after), ** Significant difference between groups (HSI vs. SI)

Table 5. Visual analogue scale (VAS) before and after steam inhalation

Variables	Time	Intervention; median (IQR)		p-value
		HSI	SI	
Nasal congestion (0-10)	Before	2.85 (0.70, 5.40)	2.50 (0.90, 4.60)	0.404
	After	1.10 (0.00, 3.60)	0.95 (0.00, 2.30)	0.728
	p-value	0.0004*	0.0005*	-
Nasal itching (0-10)	Before	1.15 (0.00, 4.20)	1.25 (0.00, 2.50)	0.500
	After	0.10 (0.00, 0.90)	0.20 (0.00, 1.30)	0.319
	p-value	0.0001*	0.001*	-
Sneezing (0-10)	Before	0.80 (0.00, 2.30)	0.05 (0.00, 0.90)	0.112
	After	0.00 (0.00, 0.40)	0.00 (0.00, 0.20)	0.757
	p-value	0.001*	0.012*	-
Rhinorrhea (0-10)	Before	0.40 (0.00, 2.60)	0.50 (0.00, 2.20)	0.930
	After	0.30 (0.00, 2.50)	0.20 (0.00, 0.90)	0.353
	p-value	0.072	0.019*	-

IQR=interquartile range; HSI=herbal steam inhalation; SI=steam inhalation
* Significant difference within group (before vs. after), ** Significant difference between groups (HSI vs. SI)

participants in the HSI group and nine in the SI group. The observed effects were minor, including mild breathing discomfort and facial warmth due to exposure to hot steam, and subsided within five minutes after the steaming session.

Discussion

Herbal steam inhalation using aromatic herbs has been traditionally practiced for a long time. The herbs used in this study are commonly available

Table 6. Acoustic rhinometry before and after steam inhalation

Variables	Time	Intervention; median (IQR)		p-value
		HSI	SI	
MCA left	Before	0.46 (0.37, 0.63)	0.41 (0.29, 0.53)	0.262
	After	0.46 (0.37, 0.63)	0.41 (0.29, 0.53)	0.303
	p-value	0.436	0.188	-
MCA right	Before	0.45 (0.33, 0.56)	0.44 (0.34, 0.54)	0.708
	After	0.41 (0.30, 0.67)	0.43 (0.33, 0.52)	0.589
	p-value	0.215	0.657	-
Nasal volume left	Before	4.77 (3.77, 6.72)	4.88 (3.53, 6.68)	0.611
	After	5.51 (3.93, 7.53)	4.89 (3.89, 6.30)	0.556
	p-value	0.064	0.242	-
Nasal volume right	Before	5.20 (3.85, 6.81)	4.57 (3.81, 6.28)	0.278
	After	5.29 (4.09, 7.12)	4.54 (4.08, 5.55)	0.146
	p-value	0.126	0.912	-
Distance left	Before	1.38 (1.38, 1.56)	1.56 (1.38, 1.73)	0.236
	After	1.56 (1.38, 1.58)	1.38 (1.38, 1.73)	0.879
	p-value	0.299	0.508	-
Distance right	Before	1.56 (1.38, 1.73)	1.56 (1.38, 1.73)	0.432
	After	1.56 (1.38, 1.73)	1.56 (1.38, 1.73)	0.141
	p-value	0.038*	0.678	-

IQR=interquartile range; MCA=minimum cross-sectional area; HSI=herbal steam inhalation; SI=steam inhalation
* Significant difference within group (before vs. after), ** Significant difference between groups (HSI vs. SI)

and naturally fragrant. The formula currently used at Thammasat Ku Kot Medical Center includes *Cymbopogon citratus* (50 g), *Citrus hystrix* (50 g), *Zingiber cassumunar* (25 g), *Curcuma longa* (25 g), *Zingiber officinale* (10 g), *Allium ascalonicum* (10 g), and camphor (0.1 g). The therapy utilizes the aromatic essential oils, combined with the heat and humidity from steam, to relieve nasal congestion in patients with AR.

Although the precise mechanisms underlying symptom relief remain unclear, previous studies have demonstrated that thermal water therapies are associated with significant improvements in nasal mucociliary transport time (NMTT)[12]. In addition, thermal inhalation has been shown to modulate immune responses by reducing the excessive secretion of T helper 1 (Th1)-related cytokines, including interleukin (IL)-2 and interferon-γ, as well as Th2-related cytokine IL-4, while increasing levels of IL-10, an anti-inflammatory cytokine[13].

Previous studies have reported that steam inhalation at 42 to 44°C for five minutes significantly relieves nasal congestion in patients with AR and also helps alleviate other symptoms such as itching, sneezing, rhinorrhea, headache, facial pain, and postnasal drip. Total nasal airflow, NAR, nasal volume, and mean MCA tended to improve after

steam inhalation, with airflow increasing by 13% and NAR decreasing by 11%, although these changes did not reach statistical significance[3]. The findings of that study are consistent with the results of the present research.

In addition, a crossover study was conducted in 30 patients with chronic AR. Participants received three different treatments in separate weeks: 1) Large Particle Water Vapor 43°C for 20 minutes (using Rhinotherm), 2) Molecular Water Vapor at 41°C for 20 minutes, and 3) Simple Saline Solution Nasal Irrigation at 39°C using the Water Pik device for 15 minutes. The results showed that Large Particle Water Vapor treatment also reduced histamine concentration, with a significant decrease lasting up to four hours after treatment[14].

Herbal steam inhalation involves the inhalation of steam infused with aromatic herbs. An in vitro study reported that inhalation of essential oil products derived from shallot (*Allium ascalonicum*) and kaffir lime (*Citrus hystrix*) effectively relieved nasal congestion, reduced rhinorrhea, and promoted relaxation[15].

Ginger (*Zingiber officinale*) has demonstrated antiallergic properties in vitro, with an IC_{50} value of 12.93±1.28 µg/mL. The major active compounds, 6-shogaol and 6-gingerol, exhibited the strongest antiallergic effects, with IC_{50} value of 0.28±0.11 mg/mL (1.01 µM) and 18.30±3.38 mg/mL (62.16 µM), respectively[16]. Moreover, a clinical study comparing oral administration of ginger extract (500 mg/day) with loratadine (10 mg/day) found that ginger extract significantly reduced the Nasal Symptom Score in patients with AR and tended to increase nasal cavity volume[17].

Psychological stress and anxiety are additional factors that exacerbate allergic symptoms. It has been reported that anxiety symptoms are 1.41 times higher in individuals with allergies compared with those without allergies[18]. Previous experimental studies have demonstrated that inhalation of bergamot essential oil at a concentration of 2.5% effectively reduces anxiety and attenuates physiological stress responses in animal models, producing anxiolytic effects comparable to standard anxiolytic drug diazepam[19]. Furthermore, clinical evidence indicates that lemongrass aromatherapy, administered by diluting four drops (0.2 mL) of essential oil in 100 mL of distilled water, followed by applying four drops of the diluted solution onto sterile gauze and placing it near the nostrils and the philtrum to allow continuous inhalation throughout the treatment period (approximately 35 minutes), resulted in significant reductions in systolic blood pressure, heart rate, and anxiety scores in patients undergoing scaling and root planning[20].

Regarding cytotoxicity, a previous study using specimens of healthy primary nasal epithelium demonstrated that curcumin from Curcuma longa did not exhibit cytotoxic effects on nasal epithelial cells. No significant changes in cell proliferation were observed after 24 hours of exposure, and curcumin showed no adverse effects on cell viability[21].

Further studies should be conducted to identify and quantify the active compounds in the essential oils of the herbal ingredients, in order to enhance scientific understanding and support future academic applications. Long-term safety and the recurrence interval of AR following herbal steam inhalation.

Limitation

This study employed a single-blind randomized design. The distinct aroma of the herbal formulation may have influenced participants' perceptions and satisfaction scores, potentially introducing expectancy and placebo-related bias.

Conclusion

Herbal steam and hot water steam inhalation at 60±2°C for five minutes significantly alleviated nasal congestion, itching, sneezing, and rhinorrhea compared with the conditions before steaming. However, acoustic rhinometry measurements showed no significant differences in nasal cavity parameters before and after steaming in either group.

What is already known about this topic?

Inhalation of steam at 42 to 44°C for five minutes significantly relieves nasal congestion in patients with AR and helps alleviate other symptoms such as itching, sneezing, rhinorrhea, headache, facial pain, and postnasal drip.

What does this study add?

Herbal steam inhalation containing *Cymbopogon citratus* (50 g), *Citrus hystrix* (50 g), *Zingiber cassumunar* (25 g), *Curcuma longa* (25 g), *Zingiber officinale* (10 g), *Allium ascalonicum* (10 g), and camphor (0.1 g) is a safe and effective alternative approach for relieving symptoms of AR. These findings support the role of steam inhalation as an adjunctive and alternative option for managing AR symptoms.

Authors' contribution

Conceptualization: NM; Methodology: NM, KP, KT, SI, and CC; Investigation: NM, KP, KT, SI, WC, and AI; Data curation: NM and PK; Formal analysis: NM and PK; Writing-original draft: NM; Writing-review and editing: NM; Supervision: AI and WC. All authors have read and approved the final manuscript.

Data availability statement

The datasets generated or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

The study was approved by the Medical Ethics Committee of the Faculty of medicine, Thammasat University (Thai FDA-accredited; Registry No. MTU-EC-TM-1 088/67). Written informed consent was obtained from all participants.

Clinical trial registration

This study was registered with the Thai Clinical Trials Registry, TCTR20250707014.

Use of artificial intelligence

Artificial Intelligence (AI) tools, specifically ChatGPT (Open AI), were used to assist in language editing and improving the clarity and structure of manuscript. The AI tool was not used for data analysis, interpretation of results, or generation of scientific conclusions. All content was critically reviewed and approved by the authors, who take full responsibility for the accuracy and integrity of the work.

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Conflicts of interest

The authors declare no conflict of interest.

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