Efficacy of Plai oil massage for the management of neck and shoulder pain: A traditional Thai herbal approach

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ABSTRACT

Neck and shoulder pain is a common musculoskeletal condition that restricts mobility and affects daily functioning. Although traditional Thai massage with herbal oils is widely practiced, scientific evidence on its effectiveness remains limited. This study examined the efficacy of Plai (*Zingiber cassumunar*) herbal massage oil in reducing neck and shoulder pain and improving cervical mobility. A two-group pretest–posttest design was conducted with 60 participants experiencing moderate pain, randomly assigned to either an intervention group receiving Plai oil massage for three consecutive days or a comparison group receiving standard health advice. Pain intensity (Numeric Rating Scale), cervical range of motion (ROM), and pressure pain threshold were assessed before and after treatment. Results showed that the intervention group had significant reductions in pain scores ($p < 0.001$), improved ROM, particularly in extension and right lateral flexion ($p = 0.009$ and $p < 0.001$), and increased pressure pain threshold ($p < 0.001$), whereas the comparison group showed no significant changes ($p > 0.05$). These findings indicate that Plai herbal massage oil is effective in relieving pain, enhancing mobility, and reducing muscle stiffness, supporting its role as a complementary therapy for musculoskeletal pain management.

1. Introduction

Neck and shoulder muscle pain is one of the most prevalent musculoskeletal issues, affecting individuals across all age groups (Cassou et al., 2002). In many instances, such pain is not serious and may be resolved spontaneously (Cohen and Hooten, 2017). However, chronic or recurrent neck and shoulder pain can interfere with daily activities and diminish quality of life (Gutierrez et al., 2007). A survey conducted with 316 university students in Thailand revealed that 58.5% reported experiencing musculoskeletal pain in some part of their bodies, with the neck (52.2%), lower back (39.9%), and shoulders (32.6%) being the most affected areas. There are various approaches to treating muscle pain, ranging from modern conventional medicine to traditional therapies. Modern treatments may include analgesic or anti-inflammatory medications, injections, surgery, and physiotherapy (El-Tallawy et al., 2021). On the other hand, traditional Thai medicine offers remedies such as herbal treatments, massage, and herbal compresses. Among these, massage therapy is widely recognized as an effective method for alleviating muscle aches and tension, as well as for reducing stress and anxiety in patients (Tsao, 2007).

Traditional Thai therapeutic massage, often combined with medicinal herbs, has been practiced for centuries and continues to play a vital role in holistic healthcare in Thailand (Netchanok et al., 2012). Today, Thai traditional medicine is frequently integrated with modern medical practices to provide more comprehensive care that addresses physical, mental, social, and spiritual well-being. The use of herbal medicines during massages, such as the application of topical herbal preparations, can enhance the therapy's pain-relieving effects (Bauer et al., 2016). When herbal oils are utilized in massage, their active compounds are absorbed through the skin into the affected muscles, offering additional anti-inflammatory and analgesic benefits (Alkanat et al., 2023).

Plai (*Zingiber cassumunar* Roxb.) is a medicinal plant belonging to the ginger family and has been utilized in Thai traditional medicine for treating

musculoskeletal conditions (Han et al., 2021). Also known as Bengal ginger, Plai exhibits anti-inflammatory and analgesic properties; its rhizomes are primarily used to alleviate pain, reduce swelling, and address issues such as sprains and bruises (Promdao et al., 2025). Traditionally, the rhizome is prepared by frying it in coconut oil to create a herbal liniment for topical application, believed to relieve muscle and joint pain while decreasing inflammation (Tunit et al., 2025). Plai oil is frequently blended with other herbal ingredients that enhance its effects (Tunit et al., 2025). Common components found in Thai massage balms include wintergreen oil (methyl salicylate) for its counterirritant and anti-inflammatory properties, clove oil (eugenol) to mitigate pain and swelling, menthol (derived from peppermint) for its cooling sensation and ability to ease muscle soreness, as well as borneol and camphor, which serve as counterirritants and enhance skin penetration (Netchanok et al., 2012). The combination of these ingredients works synergistically to relax tight muscles and enhance the therapeutic effects of massage. Given the potential benefits of Plai and these herbal components in alleviating muscle pain, this study seeks to develop a massage oil formula that incorporates Plai extract and evaluates its effectiveness in addressing discomfort in the neck and shoulders.

1.1. Objectives

This study aimed to evaluate the efficacy of Plai (*Zingiber cassumunar*) herbal massage oil in alleviating neck and shoulder muscle pain and improving cervical mobility by comparing pre- and post-treatment pain levels and range of motion.

2. Methods

2.1. Study design and participants

This study employed a two-group pretest-posttest design to evaluate the effectiveness of Plai oil massage in reducing neck and shoulder pain and improving cervical mobility. Data collection was conducted from March 1 to May 31, 2022, at the Thai Traditional and Integrative Medicine Hospital, Sahawet campus, Suan Sunandha Rajabhat University. A total of 68 volunteers initially underwent screening, and after applying inclusion and exclusion criteria, 60 eligible participants aged 20–60 years were enrolled and equally allocated into two groups: intervention and comparison (30 participants per group).

The Inclusion criteria required participants to be adults (≥ 20 years), male or female, experiencing moderate neck and shoulder muscle pain (pain score ≥ 4 on a 0–10 scale). Exclusion criteria included neck or shoulder pain resulting from acute injuries or neurological disorders (e.g., recent accidents, brain/spinal cord conditions), known allergies to Plai oil or its components, cervical nerve compression signs (radiating numbness or weakness), and comorbidities contraindicating massage therapy (e.g., severe asthma, epilepsy, infectious diseases, severe osteoporosis). Additional exclusions included fever (> 38.5°C), uncontrolled hypertension (BP ≥ 160/100 mmHg with symptoms), structural pathologies, open wounds, chronic wounds, contagious skin lesions, or recent surgeries/injuries (within 24 hours) in the neck or shoulder region. All eligible participants were generally healthy and free from chronic conditions that could interfere with the intervention.

2.1.1. Intervention: Plai oil preparation and massage procedure

A Plai massage oil was created using traditional Thai herbal preparation techniques. Dried Plai rhizomes were coarsely crushed and macerated in 95% ethanol for seven days. The mixture was then filtered to remove solid particles, and the resulting liquid was concentrated by evaporating the ethanol under reduced pressure at 50 °C using a rotary evaporator. The concentrated Plai extract was subsequently heated to 60 °C to eliminate any remaining solvent until a stable semi-solid extract was obtained.

This Plai extract was thoroughly mixed with a base oil (coconut oil) and other herbal ingredients, including sage oil, clove oil, borneol, camphor, and menthol. The final mixture, which yielded a total of 1.5 liters of Plai herbal massage oil, was packaged into 15 mL bottles for use in the study. Before the treatment intervention, a skin patch test was conducted for each participant to ensure there were no allergic reactions to the Plai oil. A drop of the Plai oil was applied to the inner forearm of each participant and covered with an occlusive bandage for 12 hours. Skin observations for irritation (including redness, swelling, itching, burning, or rash) were made at both 12 hours and 24 hours after application. No adverse skin reactions were observed in any participant, confirming the oil's safety for use.

Each participant then underwent the massage intervention, which was administered by an experienced therapist trained in traditional Thai massage techniques. During the massage procedure, participants lay in a comfortable prone position. Approximately 10 drops of Plai massage oil were applied to the neck and shoulder region. The therapist performed a standardized massage focusing on the muscles in these areas, which involved gentle pressing with the thumbs along the nape and sweeping strokes from the neck muscles up to the base of the skull.

Each massage session lasted about 15 minutes, consisting of three cycles of a 5-minute massage routine (totaling 15 minutes per session). Participants received three massage sessions on three consecutive days, with approximately 24 hours between each session. This protocol was designed

based on traditional massage therapy practices and preliminary evidence suggesting the benefits of consecutive-day treatments. During each session, both the therapist and participants monitored for any immediate discomfort or skin issues, and none were reported.

Comparison Group: The comparison group received standard advice from their health officer on maintaining health during the study period. After completing the study activities, participants in the comparison group were offered the same massage intervention for preventive purposes.

2.1.2. Outcome measures and data collection

Baseline data were collected through a questionnaire and physical assessments prior to the initial massage session, with outcome measurements repeated following the final massage session. General demographic and health information was recorded, including age, sex, weight, height, body mass index (BMI), education level, occupation, typical daily postures (work habits), average monthly income, and any comorbid conditions.

The primary outcome measure for pain assessment was the Numeric Rating Scale (NRS) (Chien et al., 2013) for pain intensity in the neck and shoulders. Participants rated their pain on a scale from 0 to 10, where 0 signifies no pain and 10 represents the worst imaginable pain. For interpretative purposes, pain scores were categorized as follows: 1–3 for mild pain, 4–6 for moderate pain, and 7–10 for severe pain. Pain ratings were specifically recorded for neck movements that commonly elicited discomfort, namely neck flexion (bending the head forward) and lateral flexion (tilting the head to the left and right).

To objectively evaluate muscle tenderness and sensitivity to soft-tissue pain, a pressure algometer (force gauge) was employed to measure the pressure pain threshold at tender points in the neck and shoulder muscles. The algometer provides readings in units of force (e.g., Newtons or kgf), indicating the amount of pressure needed to elicit pain. A higher reading signifies increased tissue hardness or pain threshold, meaning the muscle is more resistant to pressure before pain is experienced. Measurements were taken at standardized locations on the trapezius and neck extensor muscles on both sides.

Neck mobility was assessed using a goniometer to determine the range of motion (ROM) of the cervical spine. The angles of neck movements—flexion, extension, left lateral flexion, and right lateral flexion—were recorded in degrees (Lind et al., 2022). Each movement was measured as the maximum pain-free range that the participant could achieve.

Following the intervention, participants' pain levels, pressure pain thresholds, and neck ranges of motion were reassessed using the same instruments and protocols. Additionally, participants were asked about their overall satisfaction with the treatment and whether they experienced any delayed adverse

effects, such as skin irritation or other complaints, within 24 hours following each massage. A follow-up phone call was conducted 3, 7, and 14 days after the final massage to inquire about any delayed skin reactions or other issues; none were reported.

2.2. Statistical analysis

Data was analyzed using appropriate statistical methods. Descriptive statistics summarized participants' demographic and baseline characteristics, reported as frequencies, percentages, means, and standard deviations (SD). To evaluate differences within groups (pre- vs. post-intervention), paired t-tests were applied for normally distributed continuous variables, including pain scores, pressure pain thresholds, and ROM. Additionally, independent t-tests were used to compare changes between the intervention and comparison groups. The significance level was set at $\alpha = 0.05$ (two-tailed), and p-values less than 0.05 were considered statistically significant. Analyses were performed using SPSS software, version 25.

3. Results

3.1. Baseline characteristics

The study included 60 participants divided equally into intervention and comparison groups (30 each). Both groups were predominantly female (76.7% vs. 73.3%) and mostly aged 20–29 years (66.7% vs. 60.0%). The majority had normal or slightly high body weight, with similar weight and height distributions across groups. BMI categories were comparable, with most participants classified as overweight or obese (≥ 25.0). Most participants were single (76.7% vs. 70.0%), had a monthly income below 30,000 Baht, and held a bachelor's degree (76.7% in both groups). The most common occupation was student (66.7% vs. 60.0%), and the typical work posture was mostly sitting (73.3% vs. 70.0%). Few participants had chronic diseases (6.7% vs. 10.0%). These baseline details are summarized in Table 1.

3.2. Pain and range of motion outcomes

All participants completed the intervention and assessments. In the intervention group, there was a significant reduction in neck pain across all movements (neck flexion pain, lateral flexion (left), and lateral flexion (right)) after Plai oil massage (p < 0.001). Conversely, the comparison group showed minimal, non-significant changes in pain scores (p > 0.05), indicating no intervention effect. Overall, these findings suggest that Plai oil massage effectively reduced neck pain, whereas no significant changes occurred in the control group. These baseline details are summarized in Table 2.

In Table 3, participants in the intervention group showed significant improvements in cervical range

of motion (ROM) after receiving Plai oil massage. Specifically, neck extension increased from 38.50° ± 9.30° to 43.17° ± 10.95° (p = 0.009). Moreover, neck flexion (chin to chest) decreased slightly from 46.67° ± 7.58° to 42.83° ± 8.97° (p = 0.028), indicating less forward bending after the massage. Right lateral flexion improved from 52.30° ± 8.87° to 54.93° ±

7.36° (p < 0.001), while left lateral flexion showed a small, non-significant change (p = 0.117). In contrast, the comparison group exhibited no significant changes in any movement (all p > 0.70). Overall, the Plai oil massage significantly enhanced neck mobility in key directions, whereas no improvement was seen in the control group.

Table 1: Sociodemographic characteristics of the participants

Demographic characteristics		Intervention group		Comparison group	
		Number (n)	Percent (%)	Number (n)	Percent (%)
Sex	Female	23	76.67	22	73.33
	Male	7	23.33	8	26.67
Age (years)	20 – 29	20	66.67	18	60.00
	30 – 39	5	16.67	6	20.00
	40 – 49	3	10.00	4	13.33
	> 50	2	6.67	2	6.67
Weight (Kg)	40 – 49	6	20.00	5	16.67
	50 – 59	8	26.67	7	23.33
	60 – 69	8	26.67	9	30.00
	70 – 79	5	16.66	6	20.00
	> 80	3	10.00	3	10.00
Height (cm)	150 – 159	12	40.00	11	36.67
	160 – 169	10	33.33	10	33.33
	170 – 179	8	26.67	9	30.00
Body mass index (BMI)	< 18.5	6	20.00	4	13.33
	18.5 – 22.9	5	16.67	6	20.00
	23.0 – 24.9	6	20.00	6	20.00
	25.0 – 29.9	6	20.00	8	26.67
	> 30	7	23.33	6	20.00
Marital status	Single	23	76.67	21	70.00
	Married	7	23.33	9	30.00
Monthly income (Thai Baht)	< 10,000	18	60.00	16	53.33
	10,001 – 30,000	11	36.67	12	40.00
	> 30,000	1	3.33	2	6.67
Education level	Secondary/vocational	6	20.00	5	16.67
	Diploma	1	3.33	2	6.67
	Bachelor's degree	23	76.67	23	76.66
Occupation	Trader/business owner	2	6.67	3	10.00
	Student	20	66.67	18	60.00
	Hired labor/employee	6	20.00	7	23.33
	Other (e.g., manual trade)	2	6.66	2	6.67
Typical work posture	Mostly sitting work	22	73.33	21	70.00
	Heavy lifting tasks	3	10.00	4	13.33
	Prolonged standing/walking	5	16.67	5	16.67
Underlying disease	None (healthy)	28	93.30	27	90.00
	Has a chronic disease	2	6.70	3	10.00

Table 2: Neck pain scores (NRS) before and after Plai oil massage

Neck movement	Pain before (mean ± SD)	Pain after (mean ± SD)	t-value	p-value
Intervention group				
Neck flexion (forward)	5.13 ± 1.53	2.97 ± 2.03	8.527	< 0.001
Lateral flexion (left)	4.73 ± 1.48	2.93 ± 1.87	6.924	< 0.001
Lateral flexion (right)	4.70 ± 1.51	2.67 ± 1.77	8.401	< 0.001
Comparison group				
Neck flexion (forward)	4.52 ± 1.49	4.42 ± 1.32	0.452	0.654
Lateral flexion (left)	4.84 ± 1.62	4.63 ± 1.64	0.821	0.419
Lateral flexion (right)	4.62 ± 1.46	4.61 ± 1.72	0.124	0.904

Table 3: Cervical range of motion (degrees) before and after Plai oil massage

Neck movement	ROM before (mean ± SD)	ROM after (mean ± SD)	t-value	p-value
Intervention group				
Flexion (chin to chest)	46.67° ± 7.58°	42.83° ± 8.97°	2.316	0.028
Extension (look upward)	38.50° ± 9.30°	43.17° ± 10.95°	−2.783	0.009
Lateral flexion (left)	52.83° ± 10.96°	50.83° ± 9.20°	1.618	0.117
Lateral flexion (right)	52.30° ± 8.87°	54.93° ± 7.36°	−4.111	< 0.001
Comparison group				
Flexion (chin to chest)	45.80° ± 7.90°	45.50° ± 8.10°	0.382	0.703
Extension (look upward)	38.10° ± 9.20°	38.40° ± 9.00°	-0.291	0.772
Lateral flexion (left)	52.00° ± 10.00°	51.80° ± 9.80°	0.255	0.799
Lateral flexion (right)	52.10° ± 8.90°	52.50° ± 8.70°	-0.316	0.754

3.3. Pressure pain threshold (algometer)

Table 4 shows *that* the intervention group showed significant pain reduction after Plai oil massage (p < 0.001), with neck flexion decreasing

from 5.13 to 2.97, and similar improvements in lateral flexions. The comparison group showed no significant changes. Cervical mobility improved in the intervention group for neck extension (38.50° to 43.17°; p = 0.009) and right lateral flexion (52.30° to

54.93°; p < 0.001), with no meaningful changes in the comparison group. Plai oil massage effectively reduced pain and improved neck mobility compared to no intervention.

Table 4: Pressure pain threshold (algometer) measurements before and after each Plai oil massage session

Measurement (Session)	Before massage (mean ± SD)	After massage (mean ± SD)	t-value	p-value
Intervention group				
Day 3 (pre vs post)	70.57 ± 5.64	68.13 ± 5.33	11.217	< 0.001
Day 7 (pre vs post)	67.57 ± 6.49	65.53 ± 7.11	5.408	< 0.001
Day 14 (pre vs post)	63.30 ± 6.41	60.53 ± 6.44	11.857	< 0.001
Comparison group				
Day 3 (pre vs post)	69.90 ± 5.70	69.70 ± 5.80	0.415	0.680
Day 7 (pre vs post)	68.80 ± 6.00	68.50 ± 6.10	0.523	0.602
Day 14 (pre vs post)	67.50 ± 6.20	67.30 ± 6.10	0.289	0.774

No adverse events were reported during the study. All participants tolerated the Plai oil massage well, and no skin irritation or other side effects were observed either immediately post-massage or during *the* follow-up period. Participants generally reported positive feedback, noting a reduction in pain and a sensation of muscle relaxation in the neck and shoulder region after using the Plai massage oil.

4. Discussion

This study demonstrated that massage using Plai (*Zingiber cassumunar*) herbal oil can significantly reduce neck and shoulder muscle pain while improving certain aspects of neck mobility. After 3, 7, and 14 consecutive days of receiving massages with Plai oil, participants reported a decrease in self-assessed pain levels from moderate to mild, and these improvements were statistically significant. The findings support the traditional use of Plai for musculoskeletal pain relief and suggest that incorporating Plai oil into massage therapy can enhance pain reduction outcomes.

The formulated Plai massage oil utilized in this study exhibited a clear yellow hue, characteristic of Plai extract, and featured a distinctive herbal aroma derived from ingredients such as clove, camphor, borneol, and menthol. These additional components not only provide a soothing scent but also likely contribute to the oil's therapeutic effects. For example, menthol and camphor create a cooling sensation that can help diminish the perception of pain, while clove oil contains eugenol, known for its analgesic and anti-inflammatory properties (Tunit et al., 2025). Furthermore, the pleasant fragrance of the oil may promote relaxation during the massage, complementing the physical benefits of the therapy (Tsao, 2007).

The notable reduction in pain observed in this study aligns well with findings from previous research. A study in Thailand reported that the effectiveness of Plai oil massage in comparison to palm oil massage for alleviating muscle pain in the neck and shoulders of office workers with chronic neck pain. Their findings indicated that massage with Plai oil yielded greater pain relief on the pain scores (p < 0.001) and enhanced neck movements, with statistically significant differences in pain scores and range of motion observed between pre- and post-treatment assessments (p < 0.001). Our results resonate with these earlier findings, as we also noted a significant reduction in pain and improvement in neck extension following Plai oil massage. This alignment with prior studies reinforces evidence that the active compounds in Plai oil, such as curcumin and zerumbone, known for their anti-inflammatory properties, can amplify the pain-relieving effects of massage (Tunit et al., 2025).

The changes in neck range of motion observed in our participants align with the findings of Leesiriwattanagul et al. (2014), who compared Plai oil massage to traditional (oil-free) massage in individuals experiencing neck and shoulder pain. In their study, participants exhibited initial limitations in neck flexion and right lateral flexion, which significantly improved after receiving Plai oil massage (Leesiriwattanagul et al., 2014). Conversely, left lateral flexion, where there was no baseline limitation, showed no significant change. We noted a similar trend in our results: neck flexion and right lateral flexion demonstrated the most considerable improvements (or least decline) following the intervention, while left lateral flexion remained essentially unchanged, likely because participants did not experience difficulties with leftward movement prior to treatment. These findings suggest that Plai oil massage is particularly effective in enhancing movement in directions that were previously restricted due to pain or muscle tightness. Interestingly, the slight decrease in the measured flexion angle in our results was somewhat unexpected; however, this may be attributed to variability in the measuring technique or a cautious approach by participants to avoid pain during the post-test assessment. Notably, even in instances where the range of motion metrics did not dramatically increase, participants reported that movements felt easier or less painful following the massage, indicating a qualitative improvement in their functional ability.

The utilization of an algometer to evaluate muscle tenderness offered an objective perspective on muscular changes. We observed a decrease in the pressure pain threshold following each massage session, indicating that less force was required to elicit pain in the muscles. While this may initially appear counterintuitive—since one might expect the threshold to increase if pain sensitivity decreases—it likely indicates a reduction in muscle tone or hardness. After the massage, the muscles became more relaxed and pliable, allowing the algometer to penetrate the tissue with less resistance (Cohen and

Hooten, 2017). Participants also reported feeling that their neck and shoulder areas were "looser" after the treatments. Therefore, the findings from the algometer, in conjunction with subjective assessments, suggest that Plai oil massage effectively reduced muscle stiffness and tenderness, contributing to a sense of overall pain relief and comfort.

Additionally, it is worth noting the potential holistic benefits of the herbal massage oil. In addition to the pain metrics, the aromatic and medicinal properties of the oil may have offered further therapeutic advantages, such as fostering relaxation and enhancing circulation in the affected areas (Alkanat et al., 2023). Traditional Thai medicine emphasizes a holistic approach; interestingly, the integration of herbal elements in this study serves both as a physical treatment and an aromatherapy component (Han et al., 2021). The psychological benefit of experiencing a pleasant scent, along with the cultural familiarity of Thai herbal remedies, may have further enriched the participants' perception of treatment efficacy.

Given the promising results, further research and development of the Plai massage oil product are warranted. Future studies could investigate the effectiveness of this herbal massage oil on various musculoskeletal pain conditions, such as lower back pain and knee osteoarthritis, to assess its broader applicability. Additionally, product development could focus on improving the formulation and usability of the oil. For instance, creating variations of the Plai massage oil with different natural fragrances may better cater to user preferences and increase its acceptability. Research from this study has documented numerous Thai floral scents that possess potential therapeutic properties. Incorporating these natural fragrances, such as jasmine and ylang-ylang, into the massage oils could offer consumers more options and enhance the overall relaxation experience.

Interestingly, the results indicated a slight decrease in neck flexion following the intervention, which contrasts with the improvements observed in other movements. This outcome may be attributed to several factors. Firstly, participants might have exercised caution during the post-test to avoid discomfort, leading to a reduced recorded range. Additionally, variability in goniometric measurements and participant positioning could have influenced this result, as even minor differences in posture can significantly impact cervical range measurements. Notably, despite the reduction in the measured angle, participants consistently reported decreased pain and greater comfort during neck flexion after the intervention, suggesting a qualitative improvement in functional capability. Future studies should incorporate repeated measurements or advanced digital tools to minimize variability and validate these findings.

Another practical consideration is conducting stability tests on the herbal oil to ensure it has a reasonable shelf life and maintains the consistent potency of active ingredients over time. Furthermore, enhancing the packaging—such as using modern, easy-to-use bottles or spray formats—could make the product more convenient for daily use, both at home and in clinical settings. These improvements would help translate the research findings into a viable community health product.

5. Limitations

This study has several limitations that warrant consideration. First, despite increasing the sample size to 60 participants, the relatively small sample size restricts the statistical power and generalizability of the findings. Second, the intervention period was brief, lasting only three consecutive days, which leaves the long-term effects of Plai oil massage on pain and mobility unclear. Third, although a comparison group was utilized, blinding was not possible, potentially introducing performance or expectation bias. Furthermore, the sample was predominantly composed of young adults and individuals affiliated with a university, which may not reflect the broader population experiencing musculoskeletal pain. While the pain assessment included both subjective measures (Numeric Rating Scale) and an objective measure (pressure pain threshold), the study did not incorporate biochemical markers or imaging to substantiate physiological changes. Lastly, the slight decrease in neck flexion observed post-intervention may indicate measurement variability or cautious movement by participants, rather than a genuine decline in mobility. Future research should address these limitations by employing randomized controlled trials with larger and more diverse populations, extended follow-up periods, and additional objective biomarkers to verify treatment efficacy.

6. Conclusion

Plai (*Zingiber cassumunar*) oil massage significantly reduced neck pain and improved cervical mobility in selected movements compared to the comparison group, supporting its effectiveness as a complementary therapy for managing neck and shoulder discomfort. These results highlight its potential for integration into clinical practice and self-care routines for musculoskeletal pain management. Given its ease of use, accessibility, and demonstrated therapeutic benefits, Plai oil massage represents a practical, herbal-based approach for pain relief and mobility enhancement. Future research should further explore its long-term effects and applicability in broader populations.

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Compliance with ethical standards

Ethical considerations

The study received approval from the Institutional Review Board (IRB) at Suan Sunandha Rajabhat University (Approval No. COA No.1-008/2022). This study was also conducted in accordance with the Declaration of Helsinki. All study participants gave their informed consent prior to data collection. Anonymity had been assured.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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