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Ten Percent Red Ginger Gel Relieves Knee Joint Pain on the Elderly with Osteoarthritis

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Abstract

BACKGROUND: Osteoarthritis is a disease that causes inflammation, injury, and loss of structure and function of cartilages. A nonpharmacological treatment that is considered to be effective and safe and has minimal side effects is red ginger.

AIM: This study investigates the chemical constituents of red ginger extract and the effectiveness of red ginger gel in reducing knee joint pain in the elderly with osteoarthritis.

METHODS: This research is a quasi-experimental study with pre- and post-test design. Samples were selected using a purposive sampling technique. The intensity of knee joint pain pre- and postadministration of 0% (control group) and 10% (intervention group) red ginger gel and the chemical components of red ginger extract were collected. Gas chromatography–mass spectrometry analysis showed four different components of essential oils that have anti-inflammatory and analgesic effects in the red ginger extract.

RESULTS: Results showed no difference in the pre- and post-test result in the control group ($p = 0.16 > 0.05$). Significant differences were found in the pre- and post-test results of the intervention group ($p = 0.001 < 0.05$). There was a significant difference in the decrease of knee joint pain after intervention between the two groups ($p = 0.001 < 0.05$).

CONCLUSION: It can be concluded that 10% red ginger gel is effective in reducing knee joint pain in the elderly with osteoarthritis.

Introduction

An increase in life expectancy has caused an increase in the elderly population. This population and their various health problems become a significant burden for community health efforts. One of the common diseases suffered by the elderly worldwide is osteoarthritis [1]. In 2014, osteoarthritis was a disease ranked 11th in the world that could disrupt daily activities and become a significant problem in the global health system [2]. According to the National Arthritis Data Workgroup (NADW), in 2015, the United States of America had the highest prevalence of osteoarthritis, with 27 million people affected (NADW, 2015).

In Indonesia in 2014, the highest joint/rheumatoid disease suffered by the elderly was osteoarthritis (50%–60%), then the second was gout, around 6%–7%, and the third was rheumatoid arthritis, around 0.1% (1 in 1000–5000 people) [3]. According to Riskesdas in 2013, 11 provinces in Indonesia had a prevalence of joint disease above the national percentage, namely Nanggroe Aceh Darussalam, West Sumatra, Bengkulu, West Java, Central Java, East Java, Bali, West Nusa Tenggara, East Nusa Tenggara, Riau, and West Papua [3]. NTT province is the province with the highest prevalence of osteoarthritis, around 33.1%, while Riau province had the lowest prevalence of osteoarthritis, which is around 9% of the population [3].

Osteoarthritis is a clinical condition that causes injury and loss of structure and function of the cartilage and causes inflammation. Therefore, comprehensive treatment for all symptoms is not available [4]. Mainly, if cartilage damage has occurred in this condition, the treatment is limited to efforts to reduce pain, maintain and increase joint mobility, increase joint strength, and minimize the effects of disability [1], [4]. For this reason, the treatment of joint pain due to osteoarthritis becomes very important. Pain management for the elderly recommended by the World Health Organization is given conservatively and gradually to reduce the occurrence of side effects [5]. Pain management for the elderly with osteoarthritis can be given pharmacologically and non-pharmacologically [6], [7]. Pharmacologically, joint pain management due to osteoarthritis is by using analgesic drugs, nonsteroidal anti-inflammatory drugs (NSAIDs), and intra-articular corticosteroid injection [7]. Despite the safety of this pharmacological treatment, for some elderly, it causes various side effects [7], [8], so that non-pharmacological treatment becomes essential as

an effective alternative treatment, with very minimal side effects for long-term use [8].

Non-pharmacological interventions can be given by using medicinal plants, one of which is red ginger. Red ginger (*Zingiber officinale* var. amarum) contains essential oils, resin, Sineol, alkaloids, flavonoids, phenolics, borneol, zingiberol, gingerol, and zingerone. Among other types of ginger, red ginger contains the highest and more essential oils and oleoresin effective in curing various diseases [9], [10], [11]. The content of essential oils and zingerone in red ginger will inhibit pain receptors on the nervous system due to its spicy and hot effect [12]. The hot and spicy effects of ginger cause vasodilation of blood vessels, which increase blood circulation and the disposal of inflammatory products such as bradykinin, histamine, and prostaglandins – chemical mediators that cause pain [13]. In several studies, ginger compresses are used to reduce the intensity of joint pain in the elderly suffering from osteoarthritis by attaching a collision of ginger that is used as a compress on the affected part of the body [14], [15].

Previous studies on the effects of ginger and red ginger on knee joint pain in osteoarthritis patients show that ginger, especially red ginger, has anti-inflammatory effects that can reduce joint pain [1], [13], [16], [17], [18], [19]. The study provides ginger therapy through oral and topical routes. Topical treatment has been carried out by applying compresses of ginger water stew and adding ginger essential oil to coconut oil for massage in the affected area of the joint [1], [13], [19]. Although the use of ginger stew was reported to be effective in reducing osteoarthritis pain, previous studies have not shown a recommended dosage for safe and highly effective use of red ginger to reduce pain. A higher dose of the ginger extract is expected to be more effective in reducing pain. This extract can be obtained in powder or gel form, with a higher concentration of active substances.

Non-pharmacological management of osteoarthritis has not been widely applied in regions in Indonesia, including in areas with a high prevalence of osteoarthritis, including West Nusa Tenggara (NTB) province. Based on the results of a preliminary study conducted in October 2018 at the Mandalika Elderly Social Center in NTB, joint pain management in the elderly suffering from osteoarthritis is only done pharmacologically (BSLU Mandalika NTB, 2018). NTB province is included in 11 provinces with a high prevalence of the elderly who suffer from joint pain in osteoarthritis, which is 129,044 people.

In 2016, the city with the highest prevalence of the elderly who suffer pain due to osteoarthritis was West Lombok; the prevalence reached 30.2%. Mataram city was the city with the second highest prevalence of osteoarthritis sufferers, with a prevalence of 28,4% (NTB Health Service, 2016). In 2018, at the Mandalika NTB Elderly Social Center (BSLU), 41 of 71 older people were suffering from osteoarthritis (BSLU Mandalika NTB, 2018). None of the elderly at BSLU ever use any medicinal plants such as ginger to help them reduce joint pain due to osteoarthritis. Most of them were treated using medical drugs. Thus, this study aims to identify the effectiveness of ginger gel in reducing knee joint pain in elderly patients with osteoarthritis in the Elderly Social Center (BSLU) Mandalika NTB.

Methods

This research is a quasi-experimental study with a pre- and post-test design. The sample in this study was 74 elderly who experienced joint pain due to osteoarthritis which is diagnosed by a doctor in the Elderly Social Center (BSLU) Mandalika NTB based on the diagnosis and treatment for osteoarthritis from Indonesia Rheumatology Association [20]. The sample was divided into two groups: 37 – treatment group and 37 – control group. The sample was randomized into two groups using random allocation technique. The sample was chosen for treatment groups and control groups entirely by chance. Each respondent was given an envelope containing informed consent and information sheet for respondent with a code that indicates whether they belong to control or intervention group. The sample was selected based on inclusion and exclusion criteria as follows: elderly aged 60–74 years (elderly) and 75–90 years (elderly), able to hear and see well, experience a level of pain due to osteoarthritis, were not receiving other (non-pharmacological) therapy, and willing to be a respondent and follow the research procedure until the final stage. In addition, the elderly who are not cooperative, experiencing limitations or paralysis of the limbs, have a tumor or malignancy, and are allergic to ginger ingredients were excluded.

Informed consent was obtained prior to data collection of all respondents. Data collected in this study consist of primary data and secondary data. The primary data are a decrease in knee joint pain intensity before and after the administration of 10% red ginger gel in the treatment group and a decrease in knee joint pain intensity before and after the administration of 0% red ginger gel in the control group. Osteoarthritis patients who experience knee joint pain were not received routine analgesic therapy by the doctor at the health clinic service at BSLU Mandalika NTB. The primary data were collected using an observation checklist and Verbal Descriptor Scale (VDS) for pain that was an adaptation from a scale used by Ferraz *et al*. [21], while the secondary data including age and gender were collected using the a questionnaire filled out by enumerators, following the data provided by respondents.

The red ginger extract was made through a

sonification process of 100 g of red ginger simplicia which was dissolved in 1 liter of 95% of ethanol and then homogenized. Furthermore, the simplicia was put into the ultrasonic cleaner bath, which contains distilled water for 1 h (60 min). This sonification process was repeated twice with the same type and amount of solvents. After sonification, the solution was evaporated on an electric stove by regulating and maintaining an optimal temperature of 400–700°C. The evaporation was stopped once a thick extract of red ginger was obtained. The 10% red ginger gel was made by using the following ingredients: formulation, 10-g red ginger extract; 1.14-g Carbopol 980; 0.4-g NaOH; 0.1-g Paraben methyl; and 14.36-g propylene glycol.

A pre-test was given to each treatment group. Respondents were asked to describe and show the intensity of pain before ginger gel treatment and write it down on the observation sheet. Furthermore, 0% ginger gel was given to the control group. After 20 min, respondents were asked to describe and show the intensity of pain felt; this was the post-test. The intervention for both the groups was given for 3 days of the experiment.

Results

In this study, only three out of thirty respondents took Piroxicam. Other respondents did not get any medication. Table 1 shows the distribution of respondents by age, gender, and education level. In the treatment group, most respondents were female (73%) and in the age range 60–74 years (57%). In the control group, 68% of the respondents were female and most of them were at the age of 60–74 years old (54%). Based on their education level, most of the respondents in the treatment and control groups were graduated from elementary school, with the percentage 65% and 57% consecutively.

Table 1: Distribution of respondents by age, gender, and education level

Category	Treatment group (n = 37), n (%)	Control group (n = 37), n (%)
Age		
60–74 years old (early elderly)	22 (59)	20 (54)
75–90 years old (late elderly)	15 (41)	17 (46)
Gender		
Male	10 (27)	12 (32)
Female	27 (73)	25 (68)
Education		
Elementary school	24 (65)	21 (57)
Junior high school	9 (24)	12 (32)
Senior high school	4 (11)	4 (11)
Higher education	0	0

The results of the pain scale on pre- and post-test of the two groups are shown in Table 2.

Table 2 shows that on pre-test of the control group, most respondents experienced moderate pain (scale 4–6) (54%). On post-test, the results were almost the same with that on the pre-test; most respondents

Table 2: Pain scale on pre- and post-test of treatment and control groups

Pain scale	Pre-test, n (%)	Post-test, n (%)
Control group		
No pain (0)	0	0
Mild pain (1–3)	10 (27)	9 (31)
Moderate pain (4–6)	20 (54)	16 (53)
Controlled severe pain (7–9)	7 (19)	5 (16)
Uncontrolled severe pain (10)	0	0
Total	37 (100)	37 (100)
Treatment group		
No pain (0)	0	0
Mild pain (1–3)	8 (22)	24 (65)
Moderate pain (4–6)	22 (59)	12 (32)
Severe controlled pain (7–9)	7 (19)	1 (3)
Severe uncontrolled pain (10)	0	0
Total	37 (100)	37 (100)

experienced moderate pain (53%). Meanwhile, on pre-test of the treatment group, most respondents experienced moderate pain (59%) but become only 32% in post-test. The number of respondents who experienced mild pain in the treatment group also increases, from 8 respondents (22%) on pre-test to 24 respondents (65%) on post-test. No respondent in the treatment group reported any allergic reaction or side effects of the use of 10% red ginger gel.

The result of GC analysis shows 4 peaks, which indicated that there were four essential oil compounds detected. In 10 μl of red ginger sample, the percentage of each compound was 12.59% of borneol, 32.71 of Z-citral, 17.57 of geraniol, and 34.14% of E-citral. The amounts of each compound against the initial sample weight are shown in Table 3.

Table 3: Chemical compound of sample of red ginger

Serial number	Chemical compound	v/b (%)
1	Borneol	0.19
2	Z-citral	0.49
3	Geraniol	0.26
4	E-citral	0.55
The total of volatile oil in the sample		1.49

The results of Wilcoxon signed-rank test and Mann–Whitney U-test are shown in Table 4.

The results of Wilcoxon signed-rank test in the control group show no effect of giving 0% red ginger gel on the decrease in the intensity of knee joint pain ($p = 0.145 > 10.05$). While, in the intervention group, there was a significant difference between the intensity of knee joint pain on pre- and that of on post-test (Sig. [2-tailed]: $0.000 < 0.05$). This means, there was effect of giving 10% red ginger gel on the decrease in the intensity of knee joint pain of the intervention group.

Table 4: Results of Wilcoxon signed-rank test and Mann–Whitney U-test in control and intervention groups

Statistical Test	Hypothesis test	Z score
Wilcoxon signed-rank test		
Pre-test control - post-test control	*Z*	−1.457[a]
	Asymptotic significance (two-tailed)	0.145
Pre-test intervention - post-test intervention	*Z*	−4.893[a]
	Asymptotic significance (two-tailed)	0.000
Mann–Whitney U-test		
Pre-test control - pre-test intervention	*Z*	−1.246
	Asymptotic significance (two-tailed)	0.213
Post-test control - post-test intervention	*Z*	−4.290
	Asymptotic significance (two-tailed)	0.000

Table 4 shows that there was no difference between pre-test data in the control group and

pre-test data in the intervention group (Sig. [2-tailed]: 0.213 > 0.05). Whereas, between post-test data in both the groups, there was a significant difference (Sig. [2-tailed]: 0.000 > 0.05). These results show that there was a significant effect of 10% red ginger gel on the decrease in knee joint paint of the elderly with osteoarthritis.

Discussion

Data collection results showed that most of the respondents were 60–74-year-old females who only graduated from elementary school. This result is in line with the theory of risk factors of osteoarthritis in terms of age and gender. Age, gender, genetic, obesity, and diet are the risk factors of osteoarthritis, usually called person-level factors [22]. In fact, age is the most crucial factor of osteoarthritis. The prevalence and the severity of osteoarthritis are increasing with age [23]. Osteoarthritis rarely happens to children and people under forty years old, but it frequently happens to people above 60 [24], [25]. Women are more likely to get osteoarthritis on the knee, hand, and hip, while men are more likely to get osteoarthritis on the thighs, wrists, and neck [22], [23]. In general, for women and men under 45 years, the frequency of osteoarthritis is almost the same, but above 50 years old (after menopause), the frequency of osteoarthritis is more on women than on men [22], [24]. A study on the incidence and risk factors for osteoarthritis showed that the risk of osteoarthritis peaked on females at age 60–64 years, which is quite in line with the result of this study [23].

Most respondents in both the groups graduated from elementary school (65% and 57%), and none had a higher education background (0%). The prevalence of chronic pain was found to be lower among adults with higher education compared to other education levels [26]. The characteristic of respondents in this study that shows most women with lower education level is in line with the study that shows the high prevalence of high-impact severe pain in women who only achieved lower education level [26]. Respondents' education level may influence their perception of pain as mild, moderate, controlled severe pain or severe uncontrolled pain. Education provides a person with experience, which may affect how they perceive pain. Previous experience of pain hardly affects how people perceive pain. People who have more frequent pain experiences are likely to be more tolerant of pain. The intensity of the pain, which may be moderate to some people, can be perceived as mild for these people.

The pain scale on the pre- and post-test of the control and intervention groups was measured using a VDS for pain. The results are shown in Table 2. Most of the respondents on the pre-test experienced moderate pain (scale 4–6) (54% in the control group and 59% in the treatment group). On post-test of the control group, the results were almost the same as those on the pre-test. Whereas, on the post-test in the treatment group, the number of respondents with moderate pain decreased from 22 people to 11 people (32%). The number of respondents who experienced mild pain in the treatment group also increased, from 8 respondents (22%) on pre-test to 24 respondents (65%) on post-test.

The results of the Wilcoxon signed-rank test in the control group show no effect of giving 0% red ginger gel on the decrease in the intensity of knee joint pain (p value): 0.145 > 0.05). A different result showed in the intervention group. There was a significant difference between the intensity of knee joint pain on pre- and that of on post-test (Sig. [2-tailed]: 0.000 < 0.05). The result of the Mann–Whitney *U*-test shows no difference between pre-test data in the control group and pre-test data in the intervention group (Sig. [2-tailed]: 0.213 > 0.05). Whereas, between post-test data in both the groups, there was a significant difference (Sig. [2-tailed]: 0.000 > 0.05). These results indicate a significant effect of 10% red ginger gel on the decrease in knee joint paint of the elderly with osteoarthritis.

A study on the effect of *Z. officinale* on rheumatoid pain by Setyawan and Tasminatun [27] showed a similarly significant effect of 10% and 20% *Z. officinale* cream in reducing the pain of rheumatoid patients. Other studies also show the effectiveness of ginger as a pain reliever in various dosage forms, including topical, patches, compresses, and decoctions [1], [13], [17], [18], [28]. In people with osteoarthritis, there is an inflammation of the joints that results in pain and limitation in motions. Cell damage caused by chemical, mechanical, or physical stimuli can cause inflammation by activating the phospholipase enzyme, which converts phospholipids into arachidonic acid [29]. Cyclooxygenase and lipoxygenase enzymes convert the arachidonic acid into prostaglandins and leukotrienes [29]. These two substances produce most inflammatory symptoms, including pain, redness, swelling, and impaired organ function. In osteoarthritis, the damaged cells are the cartilages that protect and cushion the joints. These damaged cells cause the bones prone to touch each other so that they rub together when moving and then cause pain and stiffness [30].

Ten percent of red ginger gel can help reduce the pain due to its anti-inflammatory substances. These substances are the essential oil components in red ginger, such as Z-citral, borneol, gingerol, and shogaol. Based on the gas chromatography–mass spectrometry (GC-MS) test results in Table 3, the ginger extract sample used in this study contained a total of 1.49% v/w of essential oil components in 10 μl of the sample. This amount is considered high, and it can be easily absorbed into the skin and joint tissues to provide an anti-inflammatory effect on inflamed joints. The 10%

red ginger gel preparation in this study also has good dispersibility, which provides a cool effect due to the slow evaporation of water on the skin. In addition, the gel does not cover the skin pores and surface imperceptibly so that it does not inhibit the physiological function of the skin, especially respiration and sensibilities, thus increasing the sense of comfort in the sufferer and ultimately reducing pain.

The results of this study are also in line with research by Ratna [31] to test the anti-inflammatory effect of a combination of red ginger rhizome extract (*Zingiber officinale* Roscoe var. rubrum) in topical preparations in male mice. This study found that red ginger rhizome extract with a concentration of 4% in topical preparations had an anti-inflammatory effect that was almost the same as NSAIDs. The 10% concentration of red ginger extract in the gel preparation in this study was considered to be the most optimal to reduce pain. A study to test the effect of 10% and 20% of *Z. officinale* Linn var. rubrum extract in cream preparations showed similar results [27]. It showed that although both percentages of *Z. officinale* Linn var. rubrum extract are effective in reducing pain, 10% concentration is more effective, with the highest average rating of 26,83 ($p < 0.05$) in the Kruskal–Wallis test [27].

The use of topical red ginger in gel preparation is also in line with a previous study by Minghetti *et al*. [32], which concluded that the possibility of an anti-inflammatory effect of ginger with transdermal administration was very distinct. Minghetti *et al*. [32] also found that the gingerol extract in the plaster can be absorbed transdermally through the epidermis layer of the skin while having an effective anti-inflammatory response on the skin of mice. The active substances such as gingerols and shogaol compounds found in the essential oil contained in ginger have a molecular weight of 150–1990 Da, with a lipophilicity log P of 3.5 and moderate solubility in water and oil. This characteristic allows it to be easily absorbed by the skin [33].

Therkleson [33] stated that, in his research, respondents reported a warm and relaxed sensation that felt immediately after being given a red ginger compress or plaster. This result is different from the respondents' experience in this study, where respondents felt more of a cold and chill feeling produced by the gel. Then, they just fell warm after a few minutes of use. Meanwhile, this study did not assess the feeling of relaxation in stiff inflamed joints.

Conclusion

Based on the description in the discussion, the 10% ginger gel preparation can reduce knee joint pain due to its anti-inflammatory effect produced by the active compounds contained in red ginger. These substances are well absorbed transdermally through the epidermis layer of the skin and stop the inflammation, ultimately reducing pain. Moreover, topical administration of 10% red ginger gel is relatively safe, as no respondent experienced an allergic reaction or reported any side effects of its use. Therefore, it is necessary to socialize red ginger usage as an alternative to non-pharmacological treatments for the elderly who suffer from knee joint pain due to osteoarthritis. Future studies can observe the effect of red ginger on reducing knee joint stiffness, the restoration of movement function, and its effectiveness on osteoarthritis patients' overall quality of life.

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