Effectiveness of Ginger Root (Zingiber officinale) on Running-Induced Muscle Soreness and Function: A Pilot Study

Patrick B. Wilson, PhD, RD • Old Dominion University; John S. Fitzgerald, PhD • University of North Dakota; Gregory S. Rhodes, MEd • University of Minnesota and Fort Lewis College; Chris J. Lundstrom, PhD • University of Minnesota; and Stacy J. Ingraham, PhD • Crown College

Context: Analgesics are commonly used by individuals undertaking endurance training; unfortunately, many commonly-used analgesics cause significant adverse effects. Ginger root (Zingiber officinale) has been used effectively as an analgesic in several contexts, but to date, no research is available to evaluate ginger root’s effects in the context of endurance training. Objective: Determine whether ginger root supplementation reduces muscle soreness and prevents impairments in muscle function following a long-distance training run. Design: Randomized, double-blind, placebo-controlled trial. Setting: University marathon training course. Participants: Twenty college students (n = 8 for ginger root group and n = 12 for placebo group). Intervention: Supplementation with 2.2 g·day⁻¹ of ginger root or placebo for three days before, the day of, and the day after a 20–22 mile training run. Main Outcome Measures: Four days before and 24-hr postrun, participants rated soreness on a 100-mm visual analog scale, while vertical jump (VJ), peak force, and average rate of force development (RFD) were assessed during a squat jump. Quade’s rank analysis of covariance was used to assess between-group differences. Results: Median (range) soreness during jogging at 24-hr postrun was lower with ginger root supplementation (37 mm, 15–58) compared with placebo (62 mm, 6–85) (F = 4.6, p = .04). No significant differences for VJ, peak force, and RFD were found between groups. Conclusions: Ginger root may modestly reduce muscle soreness stemming from long-distance running, although it may have little to no effect on measures of muscle function during a VJ. Future studies should explore the mechanisms responsible for reductions in running-induced muscle soreness, as well as evaluate the benefit-to-risk profile of ginger root in the context of endurance training. Key Words: exercise, nutrition, pain

Between 50–70% of athletes competing in triathlons, marathons, and ultra-marathons regularly use analgesics, most typically in the form of nonsteroidal anti-inflammatory drugs (NSAIDs).¹⁻² The use of NSAIDs among active individuals raises a host of concerns.³ In the short-term, NSAIDs can suppress muscle protein synthesis following exercise⁴ and may blunt the rise in collagen synthesis following prolonged running,⁵ suggesting that NSAID usage could have detrimental effects on connective tissue remodeling.⁶ In addition, NSAIDs reduce gastrointestinal (GI) integrity during exercise⁷ and cause bronchoconstriction in individuals with exercise-induced asthma.⁸ Moreover, NSAID usage during exercise competition is associated with adverse events, including race withdrawal.⁹ hos-
Analgesics are commonly used by physically active individuals to reduce soreness. The analgesic effects of ginger root are examined for a marathon training run. 2.2 g·day⁻¹ of ginger root may reduce soreness associated with a 20–22 mile run.

The botanical ginger root (Zingiber officinale) has been used to reduce pain in several populations, including soreness that stems from resistance training exercise. The mechanisms responsible for the analgesic properties of ginger root remain an active area of research and likely involve the blocking of cyclooxygenase (COX) enzymes and agonistic effects on the transient receptor potential vanilloid 1. Ginger root, in contrast to NSAIDs, may act as a promoter of GI integrity and has demonstrated bronchodilatory effects. These GI-promoting and bronchodilatory properties of ginger root—along with its purported analgesic effects—make it a potentially appealing compound for the management of endurance-exercise-related pain.

Despite some research examining ginger as an analgesic for resistance-training-induced soreness, no studies have examined whether ginger root reduces muscle soreness and improves muscle function in the context of endurance training and competition. Given that NSAIDs can cause substantial adverse effects, additional research is needed to evaluate the analgesic properties of alternative compounds, including nutraceuticals. Thus, the purpose of this pilot investigation was to examine the effectiveness of ginger root for reducing muscle soreness and improving muscle function following a long-distance training run. Students enrolled in a marathon training course were recruited for a randomized, parallel-group, double-blind, placebo-controlled trial supplementing 2.2 g·day⁻¹ of ginger root or placebo for three days before, the day of, and the day after a 20–22 mile training run. We hypothesized that ginger root supplementation would result in less muscle soreness and improved muscle function.

Procedures and Findings

Participants
Participants were recruited from a university-based marathon training course. Exclusion criteria included injury preventing a 20–22 mile run, analgesic use, antidepressant use, blood-thinning medication use, and presence of any bleeding disorder. Study procedures were approved by the university’s institutional review board and all participants signed an informed consent document. Overall, 23 participants were enrolled in the study. One participant was lost to follow-up, one sustained an injury, and one competed in a triathlon instead of the training run. Analytic sample sizes were n = 8 for ginger root and n = 12 for placebo (Table 1). Students enrolled in the course had been participating in marathon training for approximately four months when the supplementation protocol and study assessments occurred. Students underwent three to five training sessions per week, with gradual increases in mileage. Average weekly mileage was approximately 20 miles per week, and for the week before data collection, mileage was set at approximately 30 miles.

Outcomes
Participants attended a prerun session four days before completing a 20–22 mile training run. Participants rated muscle soreness on a 100-mm visual analog scale, which has been shown to be a valid and reliable approach to assessing human pain. Soreness measures included the front lower leg (FLL), back lower leg (BLL), front upper leg (FUL), back upper leg (BUL), gluteals (GLU), during a stand-to-sit (STS), and during jogging at a pace equal to 12 on the Rating of Analgesics

### Key Points
- Analgesics are commonly used by physically active individuals to reduce soreness.
- The analgesic effects of ginger root are examined for a marathon training run.
- 2.2 g·day⁻¹ of ginger root may reduce soreness associated with a 20–22 mile run.

### Procedures and Findings

#### Participants
Participants were recruited from a university-based marathon training course. Exclusion criteria included injury preventing a 20–22 mile run, analgesic use, antidepressant use, blood-thinning medication use, and presence of any bleeding disorder. Study procedures were approved by the university’s institutional review board and all participants signed an informed consent document. Overall, 23 participants were enrolled in the study. One participant was lost to follow-up, one sustained an injury, and one competed in a triathlon instead of the training run. Analytic sample sizes were n = 8 for ginger root and n = 12 for placebo (Table 1). Students enrolled in the course had been participating in marathon training for approximately four months when the supplementation protocol and study assessments occurred. Students underwent three to five training sessions per week, with gradual increases in mileage. Average weekly mileage was approximately 20 miles per week, and for the week before data collection, mileage was set at approximately 30 miles.

#### Outcomes
Participants attended a prerun session four days before completing a 20–22 mile training run. Participants rated muscle soreness on a 100-mm visual analog scale, which has been shown to be a valid and reliable approach to assessing human pain. Soreness measures included the front lower leg (FLL), back lower leg (BLL), front upper leg (FUL), back upper leg (BUL), gluteals (GLU), during a stand-to-sit (STS), and during jogging at a pace equal to 12 on the Rating of Analgesics.

---

### Table 1 Characteristics of the Sample by Group Assignment and Sex

<table>
<thead>
<tr>
<th>Ginger (n = 8)</th>
<th>Placebo (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men</strong> (n = 3)</td>
<td><strong>Women</strong> (n = 5)</td>
</tr>
<tr>
<td>Age</td>
<td>21 (20–21)</td>
</tr>
<tr>
<td>Height (inches)</td>
<td>68 (68–68)</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>151 (134–155)</td>
</tr>
</tbody>
</table>

Note: Values are presented as median (range).
athon running in highly-trained runners. Furthermore, reductions in vertical jump height that last for days have been reported after marathon running likely results from a combination of mechanical strain and metabolic factors. The resulting damage from prolonged running may result in decreased force production. Reductions in vertical jump height that last for days have been reported after marathon running in highly-trained runners. Furthermore, Petersen et al. documented an increased ground contact time needed to perform the countermovement jump after a marathon. We used jumping mechanography to investigate muscle function due to its ability to detect these changes. In line with the aforementioned research, 24 hr following the training run participants in this study experienced a mean reduction in jump height of 1.8 cm (Eta squared = .64; p < .001).

Participants were instructed to squat down to 90º knee flexion and maintain that position until instructed to jump for maximal height. The force platform sampling frequency was 1,202 Hz and was filtered using a 50 Hz fourth-order Butterworth low-pass filter. Takeoff was when the net force trace equaled the unloaded force platform value plus peak residual from a 0.3 s period during flight. The vertical velocity of the center of mass at takeoff was calculated from ground reaction force using the forward dynamics approach. Average rate of force development (RFD) was calculated as peak force divided by time to peak force. Jump height was determined as the square of the vertical velocity of center of mass at takeoff divided by two times gravity.

Participants completed a 20–22 mile training run four days after the baseline visit, starting at 7:30 a.m. The range in distance covered was due to the fact that students varied in their individual training progression. The students ran two miles farther than their previous longest run during training. Average distances covered in the ginger root and placebo groups were 21.6 and 21.5 miles, respectively. The run was done on a paved bike path, mostly consisting of asphalt, with small sections of concrete, and there were minimal changes in elevation (course ranged from 727 to 908 feet above sea level). The following day, participants repeated the outcome assessments in the same order as during the prerun session. Training volume was low on the days between the pre- and postrun assessments, with a total of three days off and one 40 min easy run two days before the 20–22 mile training run.

**Ginger Root and Placebo Supplementation**

After completion of prerun assessments, participants were randomized to five days of 2.2 g·day⁻¹ of ginger root or placebo (rice flour). The dosage used was based on previous work showing reductions in resistance training soreness with roughly 2 g·day⁻¹ of ginger. The supplements and placebos were provided by NOW Foods (Bloomingdale, IL). We did not attempt to control the levels of ginger constituents (6-, 8-, 10-gingerol, and 6-shogaol) in the supplements. However, to ensure the supplements had adequate levels of gingerols and shogaols, the supplements were sent to an independent laboratory (GAAS Analytical, Tucson, AZ) for testing via reversed phase high-performance liquid chromatography. The analysis detected 2.79 mg·g⁻¹ of 6-gingerol, 0.43 mg·g⁻¹ of 8-gingerol, 0.54 mg·g⁻¹ of 10-gingerol, and 2.48 mg·g⁻¹ of 6-shogaol, which are similar concentrations to those detected in commercially-available supplements. Randomization was carried out using blocks of six to ensure a relatively equal distribution of participants in each group. Participants were instructed to take two capsules two times per day immediately before eating. Adherence was checked using self-report logs and by counting capsules remaining in bottles at the end of the study.

To evaluate participant blinding, participants filled out a form after taking one to two days’ worth of capsules. This timeframe was chosen to avoid the possible effects of differential efficacy on muscle soreness (e.g., participants correctly guessing ginger root because it produced soreness relief). Participants were allowed to guess whether they were taking ginger root, placebo, or that they didn’t know. Participants also rated guess confidence on a scale from 1 to 5 (1 = not confident, 3 = moderately, 5 = nearly certain) and provided an open-ended rationale for their guess.

**Statistical Analysis**

Data were evaluated for normality using the Shapiro-Wilk test. Because of nonnormality, all data are
presented as medians (ranges). Quade’s rank analysis of covariance (ANCOVA) was used to assess differences between the ginger root and placebo groups. Each variable was rank-transformed and unstandardized regression residuals were computed using each prerun value as a predictor of the postrun value. Residuals were entered into a one-way analysis of variance as the dependent variable, and treatment group was considered the factor. A two-tailed significance value of \( p < .05 \) was used for all tests. Data were analyzed with SPSS (IBM, Armonk, NY).

### Results

Median (range) prerun, postrun, and change values for muscle soreness are presented in Table 2. The results of the Quade’s rank ANCOVAs for soreness indicated the only difference between the groups was for jogging at 24-hr postrun (\( F = 4.6, p = .04 \)). The difference was similar after excluding one participant in the placebo group that did not ingest at least 80% of the capsules (\( F = 4.3, p = .05 \)). Individual muscle soreness ratings during jogging are shown in Figure 1. Table 3 presents

### Table 2. Muscle Soreness Ratings Before and After the 20–22 Mile Training Run

<table>
<thead>
<tr>
<th>4 Days Prerun</th>
<th>24-hr Postrun</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ginger</td>
<td>Placebo</td>
<td>Ginger</td>
</tr>
<tr>
<td>Median (Range)</td>
<td>Median (Range)</td>
<td>Median (Range)</td>
</tr>
<tr>
<td>FLL 1 (0 to 7)</td>
<td>0 (0 to 23)</td>
<td>3 (0 to 11)</td>
</tr>
<tr>
<td>BLL 0.5 (0 to 46)</td>
<td>4.5 (0 to 46)</td>
<td>9 (4 to 46)</td>
</tr>
<tr>
<td>FUL 1.5 (0 to 25)</td>
<td>6.5 (0 to 51)</td>
<td>19.5 (5 to 55)</td>
</tr>
<tr>
<td>BUL 23 (0 to 64)</td>
<td>27 (0 to 73)</td>
<td>32.5 (10 to 61)</td>
</tr>
<tr>
<td>GLU 2 (0 to 51)</td>
<td>5.5 (0 to 24)</td>
<td>13.5 (0 to 28)</td>
</tr>
<tr>
<td>STS 2 (0 to 9)</td>
<td>9 (0 to 40)</td>
<td>24.5 (7 to 55)</td>
</tr>
<tr>
<td>Jogging 9 (0 to 27)</td>
<td>21.5 (0 to 63)</td>
<td>37 (15 to 58)*</td>
</tr>
</tbody>
</table>

Abbreviations: FLL = front lower leg; BLL = back lower leg; FUL = front upper leg; BUL = back upper leg; GLU = gluteals; STS = stand-to-sit.

* \( P < .05 \) between ginger root and placebo. All measurements were on a 0–100 mm visual analog scale.

---

**Figure 1** Individual muscle soreness ratings during jogging.
the vertical jump data, and there were no differences between groups for jump height ($F = 0.01, p = .93$), peak force ($F = 0.59, p = .45$), and average RFD ($F = 0.01, p = .92$).

Table 4 shows the results of the blinding assessment. Five of eight participants in the ginger root group correctly guessed ginger. Two participants reported a ginger smell and one a ginger taste. However, the other two participants that correctly guessed ginger root said they had no specific reason to guess ginger. No serious adverse events were reported by participants.

**Discussion**

This randomized, double-blind, placebo-controlled trial evaluated the effects of 2.2 g·day$^{-1}$ of ginger root on muscle soreness and function among individuals undergoing a 20–22 mile bout of running. Importantly, participants were in the midst of marathon training, providing substantial ecological validity in the context of the everyday rigors of training. The results provide tentative evidence that ginger root may reduce post-exercise soreness experienced while engaging in dynamic movements such as jogging. Ginger root, however, did not have an effect on muscle function during a vertical jump, although our sample size was not large enough to detect small to moderate effects.

Our results show a reduction in muscle soreness without any substantial benefit for muscle function, supporting the results from Black et al.,$^{12}$ who found that 11 days of ginger supplementation (2 g·day$^{-1}$) reduced soreness from elbow flexor exercises but had no clear effect on muscle function. The study compared ground, raw ginger and heat-treated ginger consumption to placebo, and both forms of ginger reduced soreness by a similar magnitude (by 25% and 23% relative to placebo, respectively, $p < .05$). Despite the reductions in soreness, no significant effects were found for isometric force at 90° of elbow flexion, range of motion, or arm volume. Other studies also support the notion that reductions in muscle soreness with nutraceutical supplementation do not necessarily equate to simultaneous improvements in muscle function.$^{27-29}$ The discordant effects of ginger root on muscle soreness and function

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Vertical Jump Mechanography Before and After the 20–22 Mile Training Run</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ginger (n = 8)</td>
</tr>
<tr>
<td></td>
<td>Med (Range) Med (Range)</td>
</tr>
<tr>
<td>Jump height (m)</td>
<td>0.232 (.167 to .335)</td>
</tr>
<tr>
<td>Peak force (N)</td>
<td>725 (445 to 826)</td>
</tr>
<tr>
<td>Average RFD (N·s$^{-1}$)</td>
<td>2564 (1393 to 3774)</td>
</tr>
<tr>
<td>Change</td>
<td>0.013 (-0.033 to -0.001)</td>
</tr>
</tbody>
</table>

Abbreviations: RFD = rate of force development.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Assessment of Participant Blinding Success</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ginger (n = 8)</td>
</tr>
<tr>
<td></td>
<td>Guessed Ginger</td>
</tr>
<tr>
<td>Number (n)</td>
<td>5 1 2</td>
</tr>
<tr>
<td>Median confidence (1–5)</td>
<td>3 1 N/A</td>
</tr>
</tbody>
</table>

$^*$Results among participants that consumed at least 80% of their capsules. Confidence ranged from 1 to 5 ($1 =$ not confident, $3 =$ moderately, $5 =$ nearly certain).
may stem from the fact that these outcomes are caused by different mechanisms and reflect different phenomena.30 Previous research supports the notion that COX inhibition—which is a primary pathway of ginger root—reduces muscle soreness but has little effect of muscle function.31

Several lines of research support the biological plausibility of ginger root as an analgesic. Clinical trials in osteoarthritis, dysmenorrhea, and eccentric-based resistance training provide supportive data in humans.31 The specific mechanisms by which ginger root reduces pain are still being explored, but at this point, the effects of ginger root are partially attributable to the inhibition of COX enzymes.11 Ginger may selectively inhibit COX-2 with limited effects on COX-1,32 and this selective inhibition of COX-2 helps account for the differential effects of ginger and NSAIDs on GI integrity, since COX-1 plays an important role in stimulating stomach mucosal prostaglandin synthesis.33 Beyond effects on COX enzymes, ginger root is an agonizer of the transient receptor potential vanilloid 1,11 which is expressed throughout nervous system tissues and plays an important role in pain processing.34

Strengths of this study include the ecological validity stemming from the participants’ background training. Most studies examining the effectiveness of dietary supplements on muscle soreness have used relatively artificial exercise stimuli. Furthermore, the measurement of ginger constituents (gingerols and shogaols) is a clear strength, since a significant proportion of prior studies did not standardize the amounts of ginger constituents or provide estimates from laboratory analysis.11 The amounts of gingerols and shogaols found in our supplements were similar to amounts detected in commercially-available supplements.25

Limitations to the study include the small sample size, which did not provide statistical power to detect small to modest effects for the muscle function measures. In addition, men in the placebo group had a higher median body weight compared with those in the ginger root group, although there is no specific reason for us to believe this would substantially influence the results. The distance for the training run also varied slightly between individuals; however, the average distances covered were similar between groups (21.5 and 21.6 miles), making it an unlikely explanation for the differences in soreness between groups. Finally, we did not assess changes in COX enzymes or other pain-mediating pathways, which precludes making definitive statements about mechanisms responsible for the reductions in muscle soreness.

In conclusion, supplementation with 2.2 g·day⁻¹ of ginger root for five days may be effective at reducing jogging-related muscle soreness stemming from a 20–22 mile bout of running. Despite apparent benefits for muscle soreness, ginger root may not be an effective means of speeding muscle function recovery following prolonged endurance running. Future studies should compare the effectiveness and safety of ginger root to other commonly-used substances (NSAIDs) for the reduction of running-related pain.

Acknowledgments

The authors thank the students of Physical Education 1262 Marathon Training for their participation. The authors also express their gratitude to the students that volunteered time to test the participants of the study. We thank NOW Foods for donating the supplements and placebos.

References


---

**Patrick B. Wilson** is an assistant professor in the Department of Human Movement Sciences, Old Dominion University, Norfolk, VA.

**John S. Fitzgerald** is an assistant professor in the Department of Kinesiology and Public Health Education, University of North Dakota, Grand Forks, ND.

**Gregory S. Rhodes** is a PhD candidate at the University of Minnesota, Minneapolis, MN, and a visiting lecturer at Fort Lewis College, Durango, CO.

**Chris J. Lundstrom** is a lecturer in the School of Kinesiology, University of Minnesota, Minneapolis, MN.

**Stacy J. Ingraham** is a professor at Crown College, St. Bonifacius, MN.

**Jatin P. Ambeagoonkar, PhD, ATC, OTR, CSCS**, George Mason University, is the report editor for this article.