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Kencur Supplementation for Attenuating Exercise-Induced Muscle Damage and Delayed-Onset Muscle Soreness

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Abstract

Delayed Onset Muscle Soreness (DOMS) is a pain that occurs after uncustomized eccentric exercise and can happen to anyone, both those who are athletes and other individuals. DOMS is usually felt 24-72 hours after exercise or activities that use eccentric movements, which interfere with the athlete's training activities and other individuals' daily activities. This study aimed to determine the effectiveness of kencur extract supplementation (kaempferia galanga linn) on DOMS and creatine kinase (CK) plasma levels after eccentric exercise. This research is quasi-experimental, using a randomized control group design as the design in this study. Research subjects (n = 28) were randomly divided into 2 groups, namely the kencur extract group (200 mg/day) and the placebo group (corn flour). The supplementation process in both groups was carried out for 5 days (3 days before and 2 days after) the eccentric exercise. DOMS pain (VAS) and blood samples (CK plasma) were taken 24 hours (pre) and 48 hours (post) after eccentric exercise. The destructive drill uses the 5 x 20 Eccentric depth jump drill. The data obtained in the form of changes in DOMS pain and CK plasma were then analyzed using ANOVA with sig. <0.005. Supplementation of galingale extract was effective in reducing DOMS pain with p = 0.008 (<0.05) and CK plasma value p = 0.000 (<0.05) compared to placebo after eccentric exercise. Supplementation of galingale extract (Kaempferia Galanga Linn) for 5 days is effective as an effort to reduce the risk of DOMS pain sensation and reduce the increase in muscle damage with CK as a marker after eccentric exercise.

Introduction

Nowadays, more and more people are doing sports activities to maintain health and improve their fitness level. In line with this trend, sports nutritionists are increasingly recognizing the need for different nutritional techniques to address metabolic adaptation challenges for athletes as well as sports enthusiasts. Delayed Onset Muscle Soreness (DOMS) is a phenomenon with negative consequences for physically active individuals as well as for people with a sedentary lifestyle who want to re-engage in exercise activities, or for individuals who simply want to improve their fitness level. Delayed Onset Muscle Soreness (DOMS) can be experienced by anyone, both athletes and non-athletes when doing eccentric activities or exercises with higher intensity than usual. DOMS is a sensation of pain or discomfort that occurs after eccentric exercise that is not usually performed (uncostumed) or performed with high intensity (Sulistyarto *et al*., 2022). DOMS pain will be felt for the first time 12-24 hours after doing eccentric exercise activities or eccentric muscle contraction activities and will gradually recover within 5-7 days. DOMS pain is caused by metabolic waste such as lactic acid in the muscles and extracellular fluid, which further irritates the ends of sensory fibers (Zulaini *et al*., 2021). Poorly controlled exercise can cause muscle breakdown, inflammation, and muscle soreness. Symptoms of DOMS include swelling, stiffness in the muscles, decreased ROM ability, loss or decrease in muscle strength, and the appearance of pain (Angelopoulos *et al*., 2022).

The most common symptom of DOMS

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is the sensation of muscle pain, this painful sensation can interfere with and reduce muscle ability (Fedewa *et al*., 2019). Several theories suspect to be a factor causing the DOMS pain sensation. Some studies suspect this pain sensation correlates with increased stressors within muscle tissue (Kodesh *et al*., 2022), another study suspected that increased prostaglandin production led to increased sensitivity of free nerve endings of irritated muscle tissue (Sonkodi, 2021). DOMS pain levels are higher in individuals who are not trained or participate in unusual activities and can result from excessive and prolonged eccentric muscle contractions. DOMS is thought to result from mechanical disruption of muscle fibers at the cellular level, decreased maximal muscle strength, increased plasma concentration of Creatine Kinase (CK), and decreased PCr/Pi ratio (Lund *et al*., 2007).

DOMS generally results in a significant decrease in muscle ability (Ringuet *et al*., 2021). Individuals who experience DOMS due to unusual exercise activities experience decreased eccentric, concentric, and isometric strength (Yoshida *et al.,* 2022). DOMS will gradually recover and subside after 5-7 days post-workout (Konrad *et al*., 2022). DOMS pain felt by individuals will interfere with training activities, competitive performance, and other activities, so efforts are needed to prevent and treat DOMS. Currently, several strategies have been pursued to overcome DOMS pain, including massage (Davis *et al.,* 2020), cryotherapy (Nogueira *et al*., 2020), active recovery (Akinci *et al.,* 2020), accounting (Chang *et al*., 2020), ultrasound therapy (Koeda *et al*., 2019), vitamin C and antioxidants (Budgeti & Irawan 2020; Torre *et al*., 2021), and turmeric (Curcumin)(Amalraj *et al.,* 2020). Nutritional interventions with antioxidant and anti-inflammatory properties have the opportunity to reduce DOMS, in particular the consumption of biologically active components.

Intervention through nutrition can be considered as a natural alternative to address DOMS. Kencur (Kaempferia Galanga linn) in recent years has been recognized as an important nutritional intervention due to its wide range of biological activities, including antimicrobials (Kumar, 2020), Anticancer (Ichwan *et al*., 2019), anti-inflammatory (Irawan *et al.,* 2022), Antitumor (Yang *et al*., 2018), Antioxidant (Khairullah *et al*., 2021), and various other biological activities of kencur. Based on this, kencur can be considered to have a beneficial effect on muscle damage, pain, and recovery. can positively impact DOMS, excessive stress from high-intensity exercise, and trigger biochemical and hormonal responses. Therefore, kencur with all these bioactive molecules would be a prospective approach to improve recovery from exercise and exercise for individuals who follow training or exercise programs. This study aimed to determine the effectiveness of extract supplementation Kencur (KAempferia Galanga Linn) in DOMS and muscle damage characterized by plasma Creatine Kinase (CK) post eccentric exercises.

Method

This research is a quasi-experiment, with a randomized control study design approach. This design was conceived to measure the effectiveness of kencur extract supplementation for 5 days against DOMS and changes in Creatine Kinase after eccentric exercise. This research has been approved by the Health Research Ethics Committee of Universitas Airlangga No: 104/EA/KEPK/2023.

The subjects in this study were 28 students of the Bachelor of Sports Science, at Universitas Negeri Surabaya. The subjects of this study had been informed and expressed willingness to participate as research subjects through informed consent. Based on the criteria of inclusion (male, able-bodied, active student, non-smoker, and non-alcoholic) and exclusion (in treatment, post-surgery, in injury condition) that had been determined, so that a total of 28 students were declared to have met the criteria and participated in this study. The research subjects were then divided randomly (simple random with the help of online applications) into 2 groups, namely the kencur extract group (KG) and placebo group (PL) with the number of KG 14 people and PL as many as 14 people.

The supplementation process was carried out for 5 days (3 days before and 2 days after eccentric exercise. The KG group received 200mg/day of kencur extract capsules, and the PL group received 200mg/day of cornstarch

capsules. The kencur extract capsules given were kencur extract capsules that were sold freely in the community. Study subjects took capsules after breakfast daily for 5 days. Consideration of dosage use based on studies by Khairullah (2021) and Abdullah (2020) conducted on the effectiveness of kencur extract as an antioxidant.

On the 3rd day the subjects of the study conducted Damaging exercises, namely eccentric exercises consisting of 5 sets x 20 eccentric depth jumps with a bench height of 60 cm, individual intervals of eccentric depth jump for 10 seconds, and pause the rest of each set for 2 minutes (Kirby *et al*., 2012). DOMS pain measurement using Visual Analog Scale (VAS) (Chang *et al*., 2021). VAS is a horizontal line of 10 cm, marked with 1-10 with descriptors from the left end (0) no aches and pains (10) on the right end used to monitor changes in pain felt. Measurement of perceived VAS in quadricep muscle in post-study subjects' eccentric depth jump. Measurement of Creatine Kinase (CK) levels using the Elisa method. DOMS pain measurement and CK blood sampling in study subjects were carried out 24 hours and 48 hours post eccentric depth jump. The design of this study can be seen in Figure 1.

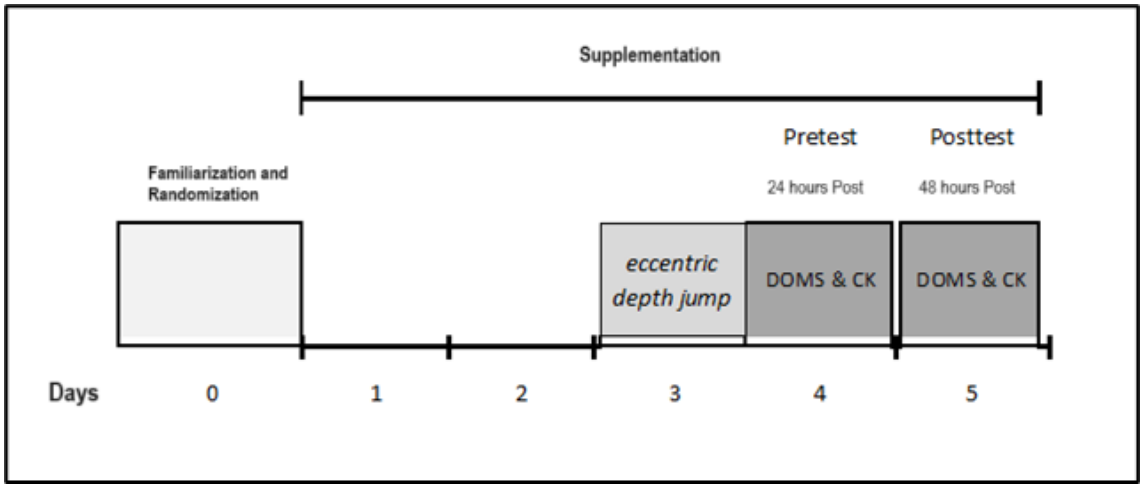

Figure 1. Research Design

The data that has been obtained is then analyzed statistically. Descriptive statistical analysis was used to display the characteristics of the study subjects, DOMS and CK. The data normality test was performed with the Kolmogorov-smirnov test to see the distribution of data distribution. The normality test was used to determine the hypothesis test. If the data is normally distributed, then the hypothesis test uses the paired sample t-test, while if the data is not normally distributed, the hypothesis test uses the Mann Whitney test. The hypothesis test was used to analyze differences between groups, with the value of the degree of meaning if the value of Sig.<0.05 with a confidence interval of 95%. Furthermore, to obtain a large size of the effect, Cohen's d test was used to determine how big the difference was between the intervention group (KG) and the control group (PL).

RESULTS AND DISCUSSION

This research was conducted at the FIO Unesa Campus, in May 2023. The research subjects were active students of the S1 Sports Science study program who had met the inclusion and exclusion criteria, so the number of participants was 28 people. Participants were then randomly divided into 2 groups, namely the kencur group (KG) and the placebo group (PL) with the number of each group as many as 14 people. The characteristics of participants including age, height, weight, and Body Mass Index (BMI) can be seen in Table 1.

Table 1. Participant Characteristics

	N	Min	Max	Mean
Age	28	18	21	19,46
Height	28	156	177	167,71
Weight	28	47	66	59,25
IMT	28	18,38	23,03	21,05

Primary Data Source

Based on Table 1 shown above, it can be seen that the average age of participants was 19.46 years (±0.793), average height was 167.71 cm (±4.59), average body weight was 59.25 (±4.96) and BMI was 21.05 (±1.30). Data on changes in DOMS pain sensation and plasma CK levels in the kencur supplement group (KG) and placebo group (PL) between 24 hours and 48 hours post (Post) eccentric depth jump obtained data that there was an average difference in DOMS pain sensation between 24 hours and 48 hours after eccentric depth jump, namely 1.5 (± 0.720) in the Kencur (KG) group and 0.5 (± 0.536) in the placebo (PL) group. In Table 2 above, we can also see the difference in plasma CK between 24 hours and 48 hours after the eccentric depth jump, namely 33.65 (± 19.712) in the Kencur (KG) group and 13.01 (± 14.020) in the placebo (PL) group.

Furthermore, a data normality test was carried out to determine the distribution of data from each DOMS and CK variable. The normality test in this study used the Kolmogorov-Smirnov test. The results of the normality test showed data that all variables in this study had a p-value of > 0.05. It can be said that all variable data in both DOMS and CK have a normal distribution. Based on the results of the normality test that has been presented above which shows that the data on all variables are normally distributed, then the paired t-test is used to test the hypothesis. This paired t-test aims to determine the average difference of the variable changes in DOMS and CK pain sensation between the Kencur group (KG) and the control group (PL). The results of the Paired t-test on the DOMS variable can be seen in Table 2.

Table 2 shows the results of the difference test on the mean of the variable change in DOMS pain between the intervention group (KG) and the control group (PL). Based on the paired t-test, a p-value of 0.008 (<0.05) was obtained, which can be assumed that there is a significant difference in the average DOMS pain between the kencur (KG) group and the placebo (PL) group.

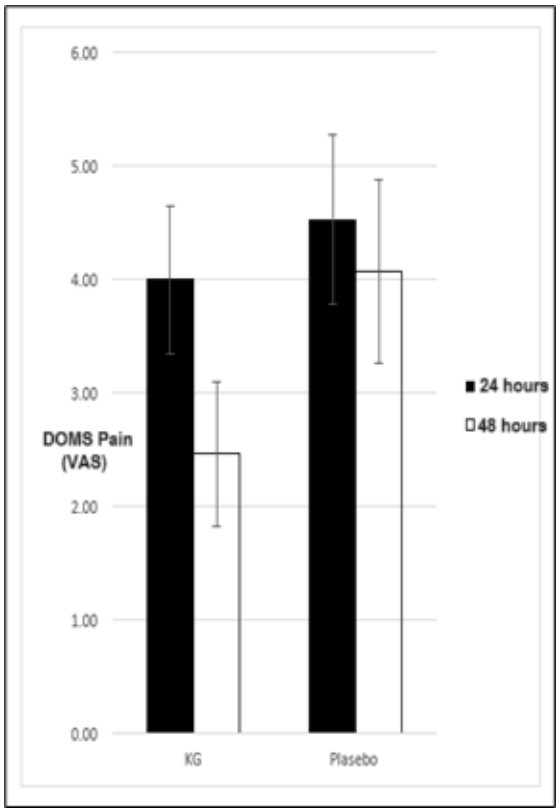

Figure 2. Changes in DOMS Pain at 24 Hours and 48 Hours Post-Workout Eccentric Depth Jump

Based on Figure 2 above, it can be seen that there is a decrease in DOMS pain at 48 hours after eccentric depth jump exercise between the kencur (KG) group and the placebo group (PL). Figure 2 shows that the KG

Table 2. Differences in DOMS Pain Sensation Study Subjects.

DOMS		Mean	±SD	Δ	p
KG	24 hours (Pre)	4,000	±0.650	1,571	0,000
	48 hours (Post)	2,464	±0.634		
PL	24 hours (Pre)	4,536	±0.805	0,464	0,006
	48 hours (Post)	4,071	±0.978		
ΔKG – ΔPL		1,536	± 0.720		0,001
		0,464	± 0.536		

Primary data source

Table 3. Differences in Plasma Creatine Kinase (CK) Study Subjects

CK (U/L)		Mean	±SD	Δ	p
KG	24 hours (Pre)	154,04	±13,870	33,65	0,000
	48 hours (Post)	120,39	± 8,303		
PL	24 hours (Pre)	174,10	± 14,212	(-)13,01	0,000
	48 hours (Post)	187,10	± 14,357		
ΔKG – ΔPL		33,65	± 19,712		0,000
		(-)13,01	± 14,020		

Primary data source

kencur group experienced a greater reduction in DOMS pain compared to the placebo group (p = 0.008 (<0.05)). This can be interpreted that 5 days of kencur extract supplementation is effective in reducing post-exercise DOMS pain eccentric depth jump. The paired t-test results were also used to determine the average change in *Creatine Kinase* (CK) levels between 24 hours and 48 hours after eccentric *depth jump* exercise in the kencur (KG) group with the placebo group (PL). The changes from CK are shown in Table 3.

Table 3 shows the results of the difference test on the mean of the variable change *in Creatine Kinase* (CK) between the intervention group (KG) and the control group (PL). Based on the *paired t-test, a* p-value of 0.000 (<0.05) was obtained, which can be assumed that there is a significant difference in the average *Creatine Kinase* (CK) between the kencur (KG) group and the placebo (PL) group.

Based on Figure 3, it can be seen that there was a decrease in plasma at 48 hours after eccentric depth jump exercise in the kencur (KG) group, but the results were different in the placebo group (PL) who experienced an increase in plasma CK. Figure 3 shows that the KG kencur group had a greater reduction in DOMS pain compared to the placebo group (p = 0.000 (<0.05)). This can be interpreted that 5 days of kencur extract supplementation is effective in reducing post-exercise DOMS pain eccentric depth jump. To determine the magnitude of the effect of the difference between the intervention group (KG) and the control group (PL) on the variables DOMS and CK in this study, a large effect test was carried out using Cohen's d formula. Based on the results of the large effect test shown in Table 7 above, Cohen's d score for the DOMS pain

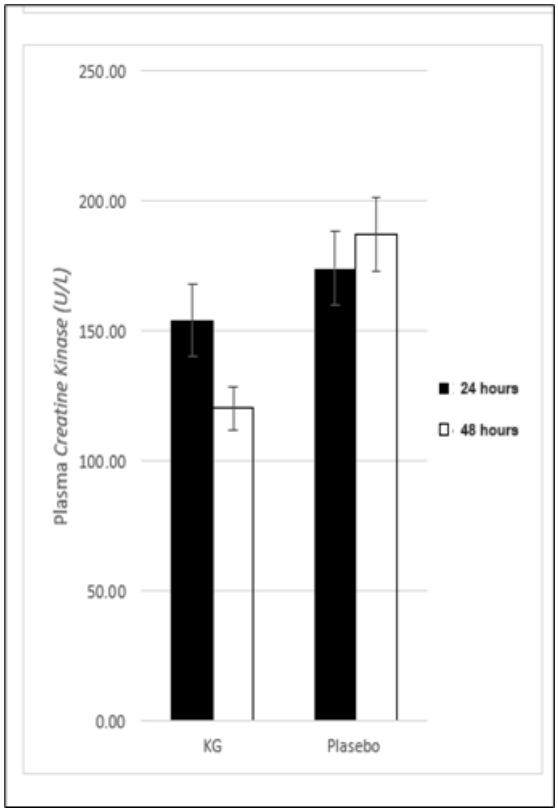

Figure 3. Changes in Plasma CK at 24 hours and 48 hours post-workout eccentric depth jump.

variable was 1.70, while for the CK variable Cohen's d test results showed a score of 2.73, based on these results, it can be interpreted that the effect of kencur extract supplements on DOMS and CK pain is in the high category.

This study aims to determine the effectiveness of kencur extract supplementation (kaempferia galanga linn) for 5 days against DOMS pain and muscle damage characterized by Creatine Kinase (CK) caused by eccentric exercise in students of the Bachelor of Sports Science, Universitas Negeri Surabaya. Based on the results of the study above, information was obtained that there was a significant decrease in the average pain of DOMS and plasma CK in

the kencur extract (KG) group measured at 24 hours and 48 hours after eccentric depth jump. Different results were shown in the placebo group which found that although there was a significant decrease in mean DOMS pain between 24 hours and 48 hours after eccentric depth jump, there was a significant increase in mean plasma CK in the placebo group. So the data concluded that supplementation of kencur extract (kaempferia galanga linn) for 5 days against DOMS pain and muscle damage characterized by Creatine Kinase (CK).

Several previous studies have shown that there is a correlation between the incidence of DOMS and muscle damage due to exercise and sports activities (Amalraj *et al.,* 2020; McFarlin *et al*., 2016; Nakhostin-Roohi *et al*., 2016; Sulistyarto *et al*., 2022). Eccentric training can result in DOMS resulting in impairment or a large decrease in strength and can last 5 – 7 days, with conditions peaking 24-48 hours after exercise (Konrad *et al*., 2022; Lewis *et al.,* 2012; da Silva *et al*., 2018). Delayed-onset muscle pain (DOMS) is a multifactorial process associated with muscle pain, stiffness, swelling, tenderness, altered joint kinematics, muscle fiber disorders, acute tissue damage, and decreased strength and strength. DOMS is a multifactorial process associated with muscle pain, stiffness, swelling, tenderness, altered joint kinematics, muscle fiber disorders, acute tissue damage, and decreased strength (Matsumura *et al.,* 2015; Rynders *et al*., 2014). DOMS, which presents as tenderness and muscle soreness that occurs after eccentric exercise, is also associated with sarcomere disorders and the inflammatory response that ensues (Connolly *et al.,* 2003). The mechanism of DOMS is still unknown, but inflammation and reactive oxygen species (ROS) are thought to be the main causes of DOMS and other possible causes include disruption of the excitation/contraction sequencing process, myofilament disorganization, z-line dilation and streaming, and a resistant response that creates a collection of mononuclear cells (Jenkins *et al*., 2013). Several strategies have been put in place to reduce DOMS such as hyperbaric oxygen, anti-inflammatory drugs, massage, cryotherapy, homeopathy, stretching, electrotherapy modalities, ultrasound, rest, and moderate exercise (Mickleborough *et al*., 2015; Pumpa *et al*., 2011).

Nutritional interventions that have antioxidant and anti-inflammatory properties are relevant efforts to reduce DOMS, especially the consumption of nutrients that have bioactive components (Howatson *et al*., 2010; Lamb *et al*., 2019; Lorensia *et al*., 2022). Through consideration of natural alternative therapies to overcome DOMS, kencur (Kaempferia galanga linn) in recent years has been recognized as an important natural intervention due to its wide range of biological activities, including antimicrobial, anticancer, anti-inflammatory, antitumor, antioxidant, radioprotective, cardioprotective, and neuroprotective properties (Irawan *et al.,* 2022). The results of this study have shown that consumption of kencur extract has the potential to relieve DOMS pain and markers of Creatine Kinase (CK) muscle damage. Based on observations in this study, kencur extract supplementation for 5 days against eccentric depth jump, potentially reduced DOMS occurring, and muscle damage reactions compared to placebo.

Increased Creatine Kinase (CK) in blood plasma is generally considered an indirect marker of muscle injury (Baird *et al*., 2012). CK levels decreased in the kencur extract supplement group, conversely, CK levels increased in subjects with placebo, meaning that kencur extract may lower the risk of DOMS-related muscle damage caused by eccentric exercise and may also speed up DOMS recovery. Several studies have reported that kencur has anti-inflammatory and antioxidant effects that are believed to significantly reduce oxidative stress levels and inflammatory responses (Sagita *et al*., 2022; Samodra & Febrina, 2020; Yao *et al*., 2018). Kencur causes a significant decrease in DOMS-related pain symptoms, which is associated with a decrease in plasma CK due to the bioability activity of kencur (Banwo *et al*., 2021). The kencur formulation also acts as an anti-inflammatory and analgesic therapy to manage rheumatoid arthritis by reducing inflammation (Shi *et al*., 2020). Studies conducted on kencur ethanol extract found that the bioactive of kencur also has a function as a pain reliever by acting as an antinociceptive (Ridtitid *et al*., 2008). This data shows that consuming kencur extract can

reduce muscle damage due to eccentric muscle activity and facilitate the restoration of muscle function. Antioxidant and anti-inflammatory activity contained in kencur (Kaempferia Galanga Linn) is thought to be a factor causing the reduction in post-DOMS and plasma CK pain eccentric depth jump on this study. This is because kencur contains phenolic compounds and compounds diarylheptanoid which functions as an antioxidant (Ali *et al*., 2018; Kumar, 2020) and anti-inflammatory (Wang *et al*., 2013; Yao *et al*., 2018).

Conclusion

Supplementation of kencur extract (Kaempferia Galanga linn) for 5 days was able to reduce the risk of pain Delayed onset muscle soreness DOMS and muscle damage characterized by increased Creatine Kinase (CK) after eccentric exercise with high intensity. This is due to the antioxidant and anti-inflammatory content of kencur extract. The suggestion for future research is to develop research on the bioactive content of kencur extract (Kaempferia Galanga Linn) and develop other markers such as antioxidants and anti-inflammatory.

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