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Effects of Emu Oil in Delayed Onset Muscle Soreness of the Quadriceps

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EFFECTS OF EMU OIL ON DELAYED ONSET MUSCLE SORENESS OF THE QUADRICEPS

by

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Michaelyn Sebold

EFFECTS OF EMU OIL ON DELAYED ONSET MUSCLE SORENESS OF THE QUADRICEPS

Michaelyn Sebold, M.A.

Western Michigan University, 2004

Limited research on emu oil has shown evidence of anti-inflammatory activity. Currently, emu oil has been used anecdotally to reduce soreness after physical activity. The purpose of the study was to examine the effects of emu oil on delayed onset muscle soreness in the quadriceps. The objectives were to examine whether emu oil decreased soreness perceptually and physiologically after eccentric exercises on a leg extension machine.

The research design was a double blind format. Subjects were randomly assigned to three groups. Those three groups were randomly assigned to a given treatment order (control, placebo, or treatment). This was a counter-balanced study, allowing for subjects to serve as their own control. A repeated measures analysis of variance (RM ANOVA) was performed to analyze the data.

Results showed no significant effect on creatine kinase levels but did decrease muscle soreness. Significance was found perceptually through the visual analog scale at 36-hours post-exercise in the emu oil condition.

In conclusion, there was a subjective decrease in soreness with regard to the emu oil treatment but that may not have been related to decreased muscle damage.

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INTRODUCTION

Delayed onset muscle soreness (DOMS) is a common phenomenon that is experienced by many individuals following physical activity. It is often described as a sensation of muscular discomfort and pain during active contractions that occur in a delayed fashion after strenuous exercise. The severity of DOMS can range from a dull ache to unbearable pain (3,15). Symptoms such as muscle stiffness, point tenderness, and aching usually develop in the first 24 hours and disappear within five to seven days (11).

There are two basic mechanisms to explain how exercise initiates muscle damage (17). Mechanical and metabolic mechanisms seem to initiate a sequence of inflammatory and immunological events that lead to muscle fiber damage. Mechanical stress has been proposed to account for the damage, specifically mechanical shear forces that are produced during exercise. Mechanical stress derives from the activity the muscle performs. Eccentric activity has shown to initiate the most intense effects from DOMS (9, 16,19). The mechanical shear forces produced during eccentric contractions can cause disruption in skeletal muscle and connective tissue leading to an inflammatory response. Metabolic stress focuses on the role of disturbances in normal cellular metabolism as the result of exhaustive endurance exercise. Insufficient rates of mitochondrial adenosine triphosphate, ischemia, hypoxia, and general waste accumulation are metabolic stressors that may account for DOMS.

The increased concentration of proteins in plasma after exercise is one method to determine muscle damage. Proteins that are often abundant following exercise are:

(1) lactate dehydrogenase, (2) aspartate aminotransferase, (3) myoglobin, (4) troponin, and (5) creatine kinase (CK). For the purposes of this study, CK was the chosen marker due to the frequency of its use in other research to indicate DOMS. The increased presence of this protein reflects skeletal muscle damage and a change in tissue structure. Elevations in CK begin around 24 hours post-exercise and peak between 48 and 72 hours (10,11).

Many methods have been used to decrease the symptoms of DOMS. Non-steroidal anti-inflammatories (1,9), passive stretching (13), counterirritant creams (6), and fish oil (10) have all been used to minimize the effects of DOMS after exercise. Results of these studies indicate no effective method in the treatment of DOMS symptoms. Another method being researched in the treatment of DOMS is emu oil. Emu oil is a natural substance extracted from the fatty tissue of the emu bird. The oil naturally contains a high level of linolenic acid (a substance that may ease muscle aches and joint pain) (20) and oleic acid, which provides a local anti-inflammatory effect (18).

In humans, research studies indicate that patients suffering from arthritis who applied emu oil significantly relieved their pain, morning stiffness, and swelling (8). Most research involving emu oil has been conducted predominantly on mice or rats to determine its effect on limiting inflammation (12).

Current research is limited in regards to therapeutic effects of emu oil to decrease DOMS. Most reports of the effects of emu oil are anecdotal. The purpose of this study was to determine if topical emu oil could decrease delayed onset muscle soreness of the quadriceps muscle after an eccentric leg extension exercise bout.

METHODS AND PROCEDURES

Subjects

Six men (ages: 22.8 ± 3.8 years; weight: 87.8 ± 21.6 kg) and 6 women (ages: 22.2 ± 1.8 years; weight: 69.3 ± 13 kg) volunteered to participate in this study. Subjects were non-competitive athletes living non-sedentary lifestyles. Exclusion criteria for participants included: (1) taking non-steroidal anti-inflammatory medication, (2) participation in unaccustomed physical activity ten or more hours per week, (3) participation in competitive sports, (4) known bleeding disorders, (5) bruising, swelling, or infection to the right quadriceps muscle, and (6) over 40 years of age. All 12 subjects were fully informed of the purpose of this study and the nature of the potential risks associated with the procedures. All subjects read and signed an informed consent document approved by the Western Michigan University Human Subjects Institutional Review Board.

Procedures

The study was divided into three conditions, each lasting three days per week, and separated by a washout period of one week in order to allow the subjects to recover. Prior to the first session, subjects came to the Exercise Physiology Laboratory at Western Michigan University (WMU) in order to perform an eccentric one repetition maximum (1RM) test on the leg extension machine. The 1RM was used as the starting weight for all three trials. After determining the 1RM, subjects were randomly assigned to one of three trials: (1) DOMS protocol followed by the application of emu oil, (2) DOMS protocol followed by the application of a placebo, or (3) DOMS protocol and no topical application. This was a counter-balanced study

where randomization of the conditions was conducted throughout the entire study and all subjects completed each of the three conditions.

Subjects were asked to refrain from unaccustomed physical activity 24 hours prior to participating in each trial session. On the first day of each trial, subjects went to Sindecuse Health Center on the WMU campus to have a baseline blood draw. Each draw was a venipuncture procedure with 8mL of blood taken from the ante-cubital region on the right or left arm. Blood samples were then sent to Borgess Medical Center for analysis. The baseline blood draw was necessary in order to determine each subject's creatine kinase levels prior to exercising. Following the completion of the baseline blood draw, subjects returned to the Exercise Physiology Laboratory to perform the eccentric DOMS exercise protocol.

Eccentric exercises performed on a leg extension machine were used to induce DOMS. The investigator lifted the weight, and beginning at full extension, the subject lowered the weight slowly at a four second count until the knee was flexed at a 90 degree angle. The subjects started at their 1RM and when they could not perform the eccentric exercise in a controlled manner, the weight was decreased in 15-pound increments. The procedure continued until the subject could no longer support 15 pounds of weight. This protocol followed recommendations from a study conducted by Lecomte et al. Use of this protocol required 7 to 10 sets and 6 to 15 repetitions per set in order to reach the endpoint of 15 pounds.

The research design was double blind. A Western Michigan University faculty member not associated with the study assisted in maintaining the double blind. Subjects, unaware of the exact treatment, administered emu oil, placebo, or no oil to

the right quadriceps muscle following the DOMS protocol. Approximately 1mL or fifteen drops of either emu oil or placebo was placed on the length of the quadriceps. Subjects manually administered the topical for 60 seconds at their own rate.

After completion of the DOMS exercises and oil application, subjects returned to Sindecuse Health Center to have two more blood samples collected, one at 24 hours and one at 48 hours post DOMS protocol. Each subject then evaluated his or her perceived level of soreness using a 10-point visual analog scale with 0 = no soreness and 10 = extreme soreness. Subjects circled the number on the scale that best indicated their level of perceived soreness. Perceived soreness was evaluated at 8, 12, 24, 36, and 72 hours post-exercise in all three conditions.

Statistical Analysis

A 3 x 3 (treatment x time) RM ANOVA was used to examine the difference among the creatine kinase levels ($\alpha = .05$). A 3 x 5 (treatment x time) RM ANOVA was used to assess perceived soreness. A post hoc tukey test was conducted in order to determine statistical significance. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS, Chicago, IL) version 11.0.

RESULTS

There were no significant differences found with time or treatment of the CK levels. Creatine kinase levels remained relatively unchanged with the exception of the control condition at the 48 hour blood draw.

Significance was found within the conditions over time for perceived pain ($F(1,11) = 8.19$, $p = .015$) (Table 2). Specifically, the perceived pain at the 36 hour mark was significantly lower for the emu oil condition compared to the control and placebo conditions. Trend analysis determined all treatments showed a significant quadratic trend meaning that soreness slightly increased over time but decreased at the 72 hour mark. Only the placebo treatment showed a significant cubic trend as well meaning that soreness increased and decreased on more than one occasion during this condition.

DISCUSSION

Numerous methods have been used to effectively induce DOMS such as isokinetic dynamometers (3,13,14), downhill running (1,19), and stepping (4). The eccentric exercise parameters chosen for this study were also effective in inducing DOMS. Muscle soreness was created in the quadriceps muscle through eccentric leg extension exercises in all subjects for each trial. Subjects experienced pain as early as 8-hours post-exercise, but all reported that the quadriceps were not painful after 72-hours post-exercise. Subjects experienced their peak amount of soreness between the 24 and 36 hour mark and decreased at 72 hours post-exercise which is consistent with other studies inducing DOMS (13, 14, 19).

CK levels were chosen as an indication of DOMS because it is a frequently used indicator of muscle damage. No significant changes in CK levels were found in our study. This could be attributed to a high rate of variability between CK levels, with some subjects experiencing very high levels of change in CK, while others remained relatively unchanged. For example the baseline mean CK level for the placebo treatment was 499.5 (IU/L) with a standard deviation of 812.9 (IU/L) (Table 1). Variability in CK levels is consistent with other studies (3,10,19). Lenn et al. found CK levels to range from extremely high (27,450 U/L^{-1} and 12,645 U/L^{-1}) to relatively unchanged (62-81 U/L^{-1}). Franklin et al. found a 15,315% elevation in CK levels from the baseline recordings in their research. The CK levels found by Schwane et al. indicated a 351% increase at 24 hours post-exercise and even a 141% increase at the 48 hour mark.

Due to extreme variability, CK may not have been the best physiological indicator for this study. The presence of CK can be indicative of increased permeability or breakdown of the muscle cell membranes that can occur anywhere in the body, not just the quadriceps muscle. CK reflects not only skeletal muscle damage but also brain, lung, and heart damage. CK delivers a generalized indication of muscle damage within the body whereas another marker such as troponin would specifically indicate damage to skeletal muscle because it is directly associated with that tissue type. CK levels also vary according to a person's muscle mass so individuals with larger musculature may generally have normal high ranging levels (7).

CK variability may have been decreased in a few ways in this study. Subjects could have been trained individuals who were involved in accustomed physical activity as opposed to unaccustomed. Research conducted on trained versus untrained individuals found that CK levels were decreased in those who were trained in the eccentric activity (11). Training either prevents or minimizes the severity of muscle injury that occurs following eccentric exercises which means with less muscle damage there is a decrease in protein breakdown. Another study conducted by Evans et al. involving trained versus untrained individuals found that athletes had chronically elevated CK levels but had no consistent change upon completion of the study (2).

Another attempt at decreasing CK variability should include having subjects refrain from unaccustomed physical activity for a longer period of time. Since the

effects of DOMS lasts between 24 and 72 hours, subjects may have participated in strenuous activity up until 24-hours prior to participation.

Other muscle damage markers could have been used for this study that may have given a better physiological indication as to whether the emu oil had any effect. One such marker could have been troponin. Troponin is a regulatory protein found in striated muscles that regulates the force and velocity of a muscle contraction and can be used to indicate skeletal muscle damage. After muscle injury, there is an increase in plasma levels of skeletal troponin which can remain elevated for up to two days (7). However, the use of troponin as an inflammation marker is not as widely used as the CK marker due to the sensitivity in measuring the low values within the blood and because of it being a rather new form of technology in regards to measuring muscle soreness (7).

It may be possible that the amount of emu oil applied was insufficient due to the large musculature of the quadriceps. The amount of emu oil, 1mL, may not have been enough to penetrate far enough beyond the skin and adipose tissue in order to have an effect on the muscle. Repeated applications may have been necessary in order to effectively penetrate tissues surrounding the quadriceps. Penetration of the oil may have also been inhibited by manual application. More oil could have remained on the hands of subjects rather than penetrating into the quadriceps.

A supplementation process may have been more beneficial. Emu oil samples could have been given to the subjects to apply throughout the course of the study. Subjects could have started application of the emu oil prior to exercising and continued that application on a daily basis.

Significance was found in the visual analog scales (VAS) at 36 hours post-exercise for the emu oil condition. Subjects perceived less pain at the 36-hour marker after application of the emu oil. This may have been the time at which subjects started to feel diminished pain sensations in the quadriceps.

The reason for the decreased soreness during the emu oil condition is unknown. Physiologically, the emu oil did not change the damage that occurred to the quadriceps which was evident in the unchanged CK levels however, soreness was perceived as less severe during the emu oil condition. The decrease in soreness is possibly associated with a decrease in pain receptor sensitivity but that does not mean the damage that resulted from exercising completely resolved itself. The expectation of finding a decrease in perceived pain was met by findings from the study however the results of our two objectives cannot support the hypothesis that emu oil would have an effect on delayed onset muscle soreness.

CONCLUSION

In summary, this double-blind, randomized study demonstrated the following:

1. After eccentric exercise designed to produce DOMS, CK levels indicated no significant change in all three conditions (placebo, emu oil, and control).
2. After the development of muscle soreness, only at the 36-hour post-exercise mark of the emu oil condition (indicated by VAS scores) was there a significant decrease in perceived soreness by subjects.
3. Emu oil was ineffective at decreasing the CK levels produced following exercise however, it was effective in reducing perceived soreness. This may indicate that even though its use for this particular study was ineffective it may be useful in future research involving muscle soreness.

Further research involving emu oil needs to be conducted in order to determine its efficacy as a possible treatment for delayed onset muscle soreness. Future studies could involve physically trained individuals to reduce the variability in muscle damage markers. The amount and supplementation of emu oil could also be manipulated for further studies in order to determine if it could be used as a treatment for DOMS.

Table 1. Values for Creatine Kinase Levels for Conditions over Time

	Baseline	24hr	48hr
Control	187.9 ± 342.6	181.7 ± 236.8	160.0 ± 111.8
Emu Oil	138.8 ± 94.1	131.8 ± 40.9	252.3 ± 496.1
Placebo	86.2 ± 26.1	145.8 ± 116.9	499.5 ± 812.9

Table 2. Perceived Pain Means Following Control, Placebo, and Emu Oil Conditions

Time	Control	Emu	Placebo
	M ± SD	**M ± SD**	**M ± SD**
8 hours	2.16 ± .55	1.41 ± .40	1.91 ± .58
12 hours	3.50 ± .70	2.00 ± .58	2.91 ± .57
24 hours	4.41 ± .60	3.33 ± .51	3.91 ± .54
36 hours	4.83 ± .44	3.75 ± .57*	5.00 ± .76
72 hours	2.75 ± .58	3.16 ± .75	3.33 ± .78

Muscle soreness was assessed using a 10-point visual analog scale, 0 being no soreness and 10 being extremely sore.

*Indicates Significance over time among all three conditions

Appendix A

Research Protocol Approval

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Centennial 1903-2003 Celebration

Date: August 5, 2003

To: Michael Miller, Principal Investigator
Michaelyn Sebold, Student Investigator for Thesis

From: Mary Lagerwey, Ph.D., Chair Mary Lagerwey

Re: HSIRB Project Number 03-06-18

This letter will serve as confirmation that your research project entitled "Effects of EMU Oil on Delayed Onset Muscle Soreness of the Quadriceps Muscle" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: July 16, 2004

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

Appendix B

Informed Consent Document

Western Michigan University
Department of Health, Physical Education, and Recreation

1. **STUDY TITLE:** Effects of Emu Oil on Delayed Onset Muscle Soreness of the Quadriceps Muscle.

2. **INVESTIGATOR (S):** Michael G. Miller, EdD, ATC, CSCS
Michaelyn Sebold, ATC

3. **SUBJECTS:** Twelve undergraduate/graduate students or faculty volunteers from Western Michigan University.

4. **PURPOSE OF THIS STUDY:** The purpose of this study is to examine the effects of emu oil on delayed onset muscle soreness (DOMS) in the quadriceps muscle.

5. **WHAT YOU WILL BE ASKED TO DO IF YOU PARTICIPATE IN THIS STUDY:**

You will be asked to attend three sessions (approximately 1 hour each) with Michaelyn in the exercise physiology lab in the Student Recreation Center at Western Michigan University. This study should last no longer than 5 weeks. You will also be asked to go to Sindecuse Health Center for a total of 9 blood draws consisting of 8mLs of blood with each draw (approximately 2 teaspoons) throughout the course of this study. Blood will be taken from the arm at the bend in the elbow. Mr. Brien Leonard from Sindecuse will be performing the draws in the examination rooms. The student investigator will meet you for the first blood draw in order to familiarize you with Sindecuse Health Center. You will be asked to refrain from any unaccustomed, physical activity 24 hours prior to each session. The student investigator will call you 48 hours prior to participation to remind you about refraining from activity and to attend the baseline blood draw appointment.
Then you will be asked to go through the following list of events after the baseline blood draw:

a. You will be asked to meet in the exercise lab at Western Michigan University to perform a one repetition maximum test (1RM) on the right thigh during the orientation session. This test is performed on a leg extension machine. You will be asked to slowly flex your knee from an extended position with the largest amount of weight that you can tolerate. This determines the start weight for the test.

b. You will then be randomly assigned to one of three trials:
1) Soreness protocol and emu oil application
2) Soreness protocol and placebo application
3) Only the soreness protocol

This random assigning will also be used for the second session. The third session will be the trial you have not already participated in. By the end of the study, you will have participated in all three trials.

c. You will then go to Sindecuse Health Center to have a baseline blood draw. Upon completion of that first draw you will be asked to return to the exercise lab in the Student Recreation Center to perform the soreness protocol. This is done in order to fatigue the right thigh muscle. The 1RM weight will be used as the starting weight. You will slowly flex your knee from an extended position for each repetition. As you fatigue, the weight is lowered until you can no longer support 15 pounds. Each repetition will last 4 seconds.

d. Fifteen drops of either emu oil or placebo will be placed on the entire length of the right thigh. You will be asked to rub the substance in for one minute.

e. You will then be asked to return to Sindecuse for two of the three blood draws. The second draw is 24 hours after exercise and the third is 48 hours after exercise. The student investigator will call you 2 hours prior to these times in order to remind you about these draws.

f. You will be given a packet to take home after each of the three sessions. This packet contains 5 sheets of paper which contain soreness scales. There are 5 hours post-exercise where you will be asked to record your level of soreness (hours: 8, 12, 24, 36, 72).

g. You will be asked NOT to refer back to previous recordings when filling out each scale. Please bring your packet to the next trial session. The student investigator will collect the third packet at the final blood draw at Sindecuse.

You will be asked NOT to do or take anything that will relieve your discomfort in the thigh for the first 48 hours following exercise. You will be given TWO WEEKS between each session in order for your thigh to recover. The same steps will be followed for each session.

6. **POSSIBLE RISKS OF YOUR PARTICIPATION IN THIS STUDY:**

There are possible foreseeable discomforts if you participate in this study. Foreseeable discomforts include soreness and weakness to the right quadriceps muscle. Delayed onset muscle soreness usually appears approximately 24 hours after exercise. It lasts between 5 and 7 days. There may also be possible discomfort from the blood draws. Bleeding, bruising, or swelling may occur at the site of the draw. As

in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or additional treatment will be made available to you except as otherwise stated in this consent form.

There are no benefits to participants in this study. You will NOT be compensated for participating in this study.

7. **OTHER:**

Creatine kinase (CK) is the chosen soreness marker for this study. The blood draws determine the levels of CK in your blood stream. CK is the ONLY element that will be analyzed in this study.

In order to maintain confidentiality the study will be focused on group data and an identification number (rather than the subject's name) will be used to record data. Following the study, the primary investigator and the research committee will have access to the original data. The original data will be retained in a locked cabinet for a minimum of three years after the completion of the study in the department of Health, Physical Education, and Recreation at Western Michigan University and then destroyed.

The results of the research may be published but your name and identity will not be revealed. In order to maintain confidentiality of your records only aggregated data will be used. Following the study, only the primary investigator will have access to the original data. The original data will be retained in a locked cabinet for a minimum of three years after the completion of the study in the department of Health, Physical Education, and Recreation at Western Michigan University and then destroyed.

The conditions that must be met in order for you to participate in this study include an injury-free right thigh for the previous one-month. You must be of ages 18-40. You must not be involved in unaccustomed, physical activity for more than 10 hours per week or involved in competitive sports. You must not be taking non-steroidal anti-inflammatory medications.

You may withdraw from this study at any time without prejudice, penalty, or risk of loss of service you would otherwise receive. You will experience NO consequences both academically or personally if you choose to withdraw from this study. Should you have any questions prior to or during the study, you can contact the student investigator, Michaelyn Sebold, at 269-353-9967, or the primary investigator, Dr. Michael Miller at 269-387-2728. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

Appendix C

Visual Analog Scale

VAS Scales (Hours 8, 12, 24, 36, 72)

Please Indicate Your Subject ID Number: _____

Please Indicate the Corresponding Hour: _____
(Only indicate one of the five hour choices listed---8, 12, 24, 36, 72)

Perceived Soreness Rating

Please circle the number that best corresponds to the level of pain you are experiencing at the time of measurement. Consider all options! You may choose any number that corresponds to your experience. The key below is just to help you understand what the numbers represent.

0 1 2 3 4 5 6 7 8 9 10

0 = No Soreness
2 = Minimal Soreness
4 = Mild Soreness
6 = Moderate Soreness
8 = Severe Soreness
10 = Extreme or Unbearable Soreness

Appendix D

Par-Q Questionnaire

Par-Q Questionnaire

Please read the questions carefully and answer each one honestly. Check YES or NO.

YES	NO	
☐	☐	1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?
☐	☐	2. Do you feel pain in your chest when you do physical activity?
☐	☐	3. In the past month, have you had chest pain when you were not doing physical activity?
☐	☐	4. Do you lose your balance because of dizziness or do you ever lose consciousness?
☐	☐	5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
☐	☐	6. Is your doctor currently prescribing drugs for your blood pressure or heart condition?
☐	☐	7. Do you know of any other reason you should not do physical activity?

I have read, understood, and completed this questionnaire. Any questions I had were answered to my full satisfaction.

Name_____ Date_____

Signature_____Witness_____

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