Clinical Trial Protocol
Iranian Registry of Clinical Trials

15 Jun 2026

The Effect of Acute and Chronic L-Citrulline and Citrulline Malate Supplementation on Resistance Training Performance, Muscle Soreness, Lactate and Nitric Oxide in Resistance-Trained Men

Protocol summary

Study aim

Investigating the effects of acute and chronic supplementation with L-citrulline compared to citrulline malate on resistance training performance, muscle contusion, lactate and nitric oxide

Design

In the acute phase, in a double-blind cross-over and counter-balanced placebo-controlled design, Each subject randomly receives one of the 3 supplement interventions. Blood sampling will be done before and after each session, and factors related to resistance training performance will also be recorded in each session. In the chronic phase, in the form of a randomized, double-blind, placebo-controlled design, 45 resistance trained male volunteers will be randomly divided into three groups of 15 (g 1: L-citrulline, g 2: citrulline malate, and g 3: placebo) and will follow a resistance training protocol for eight weeks, along with receiving the relevant supplement. Before and after the eight-week protocol, a one maximum repetition testing session for the hack squat and chest press exercises is performed in order to evaluate the effect of the supplement intervention on the lower and upper body strength.

Settings and conduct

Research sessions will be held in: Acute phase: Prime Cross Fit Club (Kermanshah, Iran) Chronic phase: Iran Fit gym (Kermanshah, Iran)

Participants/Inclusion and exclusion criteria

Inclusion criteria: History of resistance training at least 3 sessions per week in the last 6 months Body mass index 18.5 to 29.99 (kg/m2) Entry ban criteria: Smoking Current or past use of anabolic androgenic steroids Consuming performance-enhancing supplements affecting research results

Intervention groups

1. L-citrulline (8 grams of L-citrulline + 15 grams of maltodextrin) 2) Citrulline malate (12 grams of citrulline malate + 15 grams of maltodextrin) 3) Placebo (15 grams of maltodextrin)

Main outcome variables

Maximum strength; Muscular endurance; Nitric oxide; Lactate

General information

Reason for update

Acronym

IRCT registration information

IRCT registration number: **IRCT20221128056642N1**
Registration date: **2022-11-29, 1401/09/08**
Registration timing: **prospective**

Last update: **2022-11-29, 1401/09/08**
Update count: **0**

Registration date

2022-11-29, 1401/09/08

Registrant information

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Name of organization / entity

Razi university

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Recruitment status

Recruitment complete

Funding source

Expected recruitment start date

2023-02-09, 1401/11/20

Expected recruitment end date
2023-07-11, 1402/04/20
Actual recruitment start date
empty
Actual recruitment end date
empty
Trial completion date
empty

Scientific title
The Effect of Acute and Chronic L-Citrulline and Citrulline Malate Supplementation on Resistance Training Performance, Muscle Soreness, Lactate and Nitric Oxide in Resistance-Trained Men

Public title
The Effect of L-Citrulline and Citrulline Malate Supplementation on Resistance Training Performance
Purpose
Other
Inclusion/Exclusion criteria
Inclusion criteria:
Healthy men living in Kermanshah with an age range between 18 and 35 years History of resistance training at least 3 sessions per week in the last six months Body mass index 18.5 to 29.99 (kg/m2)
Exclusion criteria:
Smoking Current or past use of anabolic androgenic steroids Consuming performance-enhancing supplements affecting the research results (including creatine, HMB, beta-alanine and NO stimulants) in the four weeks leading up to the start of the research, or taking L-citrulline or citrulline malate supplements in the past year Suffering from musculoskeletal injuries affecting the process of performing resistance training exercises Having any acute or chronic disease
Age
From **18 years** old to **35 years** old
Gender
Male

Phase
2-3
Groups that have been masked

- Participant
- Care provider
- Investigator
- Outcome assessor

Sample size
Target sample size: **45**
Randomization (investigator's opinion)
Randomized
Randomization description
For the acute phase, due to the inclusion of three conditions (L-Citrulline, Citrulline malate, and Placebo), there were six possible sequences in which participants could complete the study (i.e. ABC, ACB, BAC, BCA, CAB and CBA). Based on the sample size (n = 30), each sequence will be used exactly five times. The order in which the sequences is assigned to participants will be determined using Random Sequence Generator at WWW.RANDOM.ORG website. For the chronic phase, according to the existence of three groups (L-citrulline, citrulline malate, and placebo), all subjects (n=45) will be divided into three equal groups (15 subjects in each group) using a table of random numbers and will be placed in one of the groups in a simple random way.
Blinding (investigator's opinion)
Double blinded
Blinding description
In the acute phase, the main researchers and all the people involved in data collection will be blinded to the type of intervention (supplement) given to each subject in each of the three main research sessions. To achieve this, the random assignment of the subjects in the counter-balance table and the preparation of the supplements provided to the subjects in each session are done by a research assistant who will not be present at the time of taking the supplement intervention at the research site and will not be involved in any part of the data collection process. Also, in order to keep the subjects blind, the supplement consumed by each subject in each research session is prepared by one of the research assistants and given to the subject to consume in a dark colored shaker whose contents are not known. In addition, the subject should also use a nose clip while drinking this mixture. Similar to the acute phase, in the chronic phase, the main researchers and all the people involved in data collection are unaware of the type of intervention received by each subject during the eight weeks of exercise and supplementation protocol. To achieve this, random assignment of subjects to three groups is done by a research assistant who does not interfere in other stages of this research plan. Also, the supplement consumed by the subjects of all three groups is also prepared by the same research assistant. The supplement provided to the subjects of all three groups will be similar in terms of smell and taste.
Placebo
Used
Assignment
Other
Other design features
Since this research plan aims to evaluate and compare both acute and chronic effects of supplementation with L-citrulline and citrulline malate, it consists of two separate phases. In the acute phase, in the form of a double-blind cross-over and counter-balanced placebo-controlled design, 30 resistance-trained male volunteers between the ages of 18 and 35 years will be examined for the acute effects of supplementation with L-citrulline and citrulline malate on resistance exercise performance and blood factors. In the chronic phase, in the form of a randomized, double-blind, placebo-controlled design, 45 resistance-trained male volunteers between the ages of 18 and 35 will be randomly divided into three groups of 15 each (Group 1: L-citrulline, Group 2: Citrulline malate and Group 3: Placebo) and will perform a resistance training protocol for eight weeks in addition to receiving the corresponding supplement.

Secondary Ids

empty

Ethics committees

1

Ethics committee
Name of ethics committee
Research ethics committees of Razi University
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No. 142, 114 Alley, 17 Shahrivar Square, Kermanshah, Iran
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Approval date
2022-10-26, 1401/08/04
Ethics committee reference number
IR.RAZI.REC.1401.057

Health conditions studied

1

Description of health condition studied
Resistance training performance
ICD-10 code
ICD-10 code description

Primary outcomes

1

Description
Resistance training performance
Timepoint
Acute phase: three acute research sessions with an interval of one week from each other. Chronic phase: one research session before and one session at the end of the eight-week protocol.
Method of measurement
Recording the number of repetitions performed in each set of resistance training - recording the rate of perceived exertion using the Borg scale - measuring muscle soreness using a Visual Analog Scale (VAS) questionnaire

Secondary outcomes

1

Description
Blood factors (Lactate and Nitric Oxide)
Timepoint
Acute phase: three acute research sessions with an interval of one week from each other. Chronic phase: one research session before and one session at the end of the eight-week protocol.
Method of measurement
Blood sampling from each subject before and after each main research session

Intervention groups

1

Description
The first intervention group: supplementation with L-citrulline (8 grams of L-citrulline + 15 grams of maltodextrin) 60 minutes before the start of each main research session (resistance training)-In the acute phase, a single dose session and in the chronic phase, daily for eight weeks
Category
Other

2

Description
The second intervention group: supplementation with citrulline malate (12 grams of citrulline malate + 15 grams of maltodextrin) 60 minutes before the start of each main research session (resistance training); in the acute phase, a single dose session and in the chronic phase, daily for eight weeks
Category
Other

3

Description
Control group: The third group: supplementation with a placebo (15 grams of maltodextrin) 60 minutes before the start of each main research session (resistance exercise); in the acute phase, a single dose session and in the chronic phase, daily for eight weeks.
Category
Other

Recruitment centers

1

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Full name of responsible person
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Grant name
Grant code / Reference number
Is the source of funding the same sponsor organization/entity?
Yes
Title of funding source
Razi university
Proportion provided by this source
10
Public or private sector
Private
Domestic or foreign origin
Domestic
Category of foreign source of funding
empty
Country of origin
Type of organization providing the funding
Academic

Person responsible for general inquiries

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Sharing plan

Deidentified Individual Participant Data Set (IPD)
Undecided - It is not yet known if there will be a plan to

make this available

Study Protocol

Undecided - It is not yet known if there will be a plan to make this available

Statistical Analysis Plan

Undecided - It is not yet known if there will be a plan to make this available

Informed Consent Form

Undecided - It is not yet known if there will be a plan to make this available

Clinical Study Report

Undecided - It is not yet known if there will be a plan to make this available

Analytic Code

Undecided - It is not yet known if there will be a plan to make this available

Data Dictionary

Undecided - It is not yet known if there will be a plan to make this available