ACUTE EFFECT OF RED PITAYA JUICE SUPPLEMENTATION ON RUNNING PERFORMANCE AND MUSCLE DAMAGE AMONG CADETS

SITI MAIZURA BINTI MOHD DAUD

MASTER OF SCIENCE
(COACHING SCIENCE)

UNIVERSITI PERTAHANAN NASIONAL MALAYSIA

2022

ACUTE EFFECT OF RED PITAYA JUICE SUPPLEMENTATION ON RUNNING PERFORMANCE AND MUSCLE DAMAGE AMONG CADETS

SITI MAIZURA BINTI MOHD DAUD

Thesis submitted to the Centre for Graduate Studies, Universiti Pertahanan Nasional Malaysia, in fulfilment of the requirements for the Degree of Master of Science (Coaching Science)

2022

ABSTRACT

Red pitaya is naturally high in CHO and antioxidants that may help in improving performance and reducing delayed-onset muscle soreness (DOMS), making it a viable sports supplement option. This study investigated the acute effect of red pitaya juice (DRG) supplementation on running time-trial (TT) performance and muscle damage after a high-intensity exercise among cadets. In this randomised, single-blind, cross-over study, 11 male cadets completed two endurance running trials with either red pitaya juice (DRG; isocaloric to 6% of glucose concentration) or placebo (PLA; containing 6% glucose). Subjects consumed 350 ml of DRG or PLA 45 min before and immediately after the running trials. Then, they ran for 20 min at 75% VO_{2max} followed by a 5-km TT with *ad-libitum* access to plain water. Subjects have full access to monitor the distance and to adjust the speed but were blinded to the actual speed and heart rate. The rating of perceived exertion (RPE) was assessed every 5 min during the TT and the fluid sensation scale (FSS) was measured after consuming the supplements. The biomarker of muscle damage (creatine kinase; CK), total antioxidant capacity (TAC), blood glucose and lactate levels were measured at pre-, immediately, and 24h post-exercise. There were no significant differences in the running performance (26 sec; $p=0.166$) between both trials and no significant differences in speed ($p=0.330$), heart rate ($p=0.264$) and RPE levels ($p=0.449$). There were no significant differences in blood glucose ($p=0.357$) and lactate level ($p=0.901$) between trials. However, there were significant differences in blood glucose ($p=0.001$) and lactate ($p<0.001$) levels between pre and immediately after exercise in both trials. There were no significant differences in the CK level ($p=0.875$) and TAC plasma level

(*p=0.076*) between DRG and PLA trials at any time points. The FSS showed no significant differences in thirst (*p=0.611*), sweetness (*p=0.660*), nausea (*p=1.000*), fullness (*p=0.393*), and stomach upset (*p=0.796*) sensations between DRG and PLA trials. In conclusion, acute DRG supplementation elicited similar effects on running TT performance, blood glucose, lactate level, CK and TAC among cadets. Therefore, DRG can be considered as an alternative ergogenic aid in maintaining high-intensity endurance performance due to its similar effect with PLA.

ABSTRAK

Pitaya merah secara semula jadinya tinggi karbohidrat dan antioksidan yang boleh membantu dalam meningkatkan prestasi dan mengurangkan kecederaan otot tertunda (DOMS) menjadikannya sebagai pilihan makanan tambahan sukan yang baik. Kajian ini menyiasat kesan suplemen jus pitaya merah (DRG) pra-senaman terhadap prestasi ujian masa (TT) dan kerosakan otot selepas senaman berintensiti tinggi dalam kalangan kadet. Dalam kajian rawak, buta dan bersilang ini, 11 orang kadet lelaki menjalani dua ujian larian ketahanan dengan meminum sama ada jus pitaya merah (DRG; isokalori kepada 6% kepekatan glukosa) atau plasebo (PLA; mengandungi 6% glukosa). Sebanyak 350 ml DRG atau PLA diminum 45 minit sebelum dan sejurus selepas ujian. Kemudian, para peserta berlari selama 20 minit pada 75% VO_{2max} diikuti dengan TT 5-km bersama akses *ad-libitum* terhadap air kosong. Subjek mempunyai akses penuh untuk memantau jarak dan menukar kelajuan larian tetapi dibutakan dengan kelajuan sebenar dan kadar denyutan jantung. Skala penarafan tenaga yang digunakan (RPE) dinilai setiap 5 minit sepanjang TT dan skala sensasi bendalir (FSS) diukur setiap kali selepas pengambilan suplemen. Biomarker kerosakan otot (creatine kinase; CK), jumlah kapasiti antioksidan (TAC), paras glukosa darah dan laktat diukur pada pra, serta-merta dan 24 jam selepas senaman. Tiada perbezaan yang ketara dalam prestasi larian (26 saat; $p=0.166$), antara kedua-dua ujian dan tiada perbezaan ketara dalam kelajuan ($p=0.330$), kadar denyutan jantung ($p=0.264$) dan tahap RPE ($p=0.449$). Tiada perbezaan yang ketara pada tahap glukosa darah ($p=0.357$) dan paras laktat ($p=0.901$) antara ujian. Walau bagaimanapun, terdapat perbezaan yang ketara dalam paras glukosa darah ($p=0.001$) dan laktat ($p<0.001$) antara sebelum dan sejurus

selepas bersenam dalam kedua-dua ujian. Tiada perbezaan yang ketara dalam tahap CK (*p=0.875*) dan tahap plasma TAC (*p=0.076*) antara ujian DRG dan PLA pada setiap poin masa. FSS tidak menunjukkan perbezaan ketara pada rasa dahaga (*p=0.611*), rasa manis (*p=0.660*), loya (*p=1.000*), rasa kenyang (*p=0.393*), dan sakit perut (*p=0.796*) antara ujian. Kesimpulannya, suplementasi DRG yang akut memberi kesan yang sama terhadap prestasi larian TT, glukosa darah, paras laktat, CK dan TAC dalam kalangan kadet. Oleh itu, DRG boleh dipertimbangkan sebagai bantuan ergogenik alternatif untuk mengekalkan prestasi daya tahan ketika senaman berintensiti tinggi kerana kesannya yang serupa jika dibandingkan dengan PLA.

ACKNOWLEDGEMENTS

Alhamdulillah, all praises and thanks to Allah, the Almighty, and His Merciful blessings had granted me strength and courage throughout my study. I had finally completed my master's study entitled 'Acute Effect of Red Pitaya Juice Supplementation on Running Performance and Muscle Damage among Cadets'.

First and foremost, I would like to express my deepest gratitude to my main supervisor, Dr Faizal Abdul Manaf, for all his guidance, constructive comments, valuable life advice, and motivation throughout this study. Thank you for your time and persistent effort given, which has helped a lot in the success of this study. I am deeply indebted to my co-supervisor, Dr Nursyuhada Mohd Sukri, for her constructive guidance, precious advice, and continuous support throughout this study, especially during the lab work. Her detailed and thorough checking and valuable comments have assisted so much in improving this thesis and in completing this study.

A special note of appreciation goes to Encik Mohamad Hanapi Johari, one of the research team members who had helped with the lab usage and valuable guidance for the equipment. A token of gratitude to all participants who contributed greatly to this study for their full commitment, cooperation, and time.

Finally, my heartiest appreciation goes to my beloved family, my mother, Siti Turiah Samirin, my father Mohd Daud Idris and my friends for their endless support and motivation throughout my journey.

Thank you so much, and may Allah bless you all.

APPROVAL

The Examination Committee has met on **17 May 2022** to conduct the final examination of **Siti Maizura binti Mohd Daud** on his degree thesis entitled **'Acute Effect of Red Pitaya Juice Supplementation on Running Performance and Muscle Damage among Cadets'.**

The committee recommends that the student be awarded the of **Master of Science (Coaching Science)**.

Members of the Examination Committee were as follows.

Lt Kdr Prof. Madya Ts. Dr. Mohd Norsyarizad bin Razali TLDM (Bersara)
Faculty of Defence Science and Technology
Universiti Pertahanan Nasional Malaysia
(Chairman)

Dr. Azimah binti Ahmad
Faculty of Medicine and Defence Health
Universiti Pertahanan Nasional Malaysia
(Internal Examiner)

Dr. Ayu Suzailiana Muhamad
School of Health Sciences
Universiti Sains Malaysia
(External Examiner)

APPROVAL

This thesis was submitted to the Senate of Universiti Pertahanan Nasional Malaysia and has been accepted as fulfilment of the requirements for the degree of **Master of Science (Coaching Science)**. The members of the Supervisory Committee were as follows.

Dr. Faizal Abdul Manaf
Defence Fitness Academy
Universiti Pertahanan Nasional Malaysia
(Main Supervisor)

Dr. Nursyuhada Mohd Sukri
Defence Fitness Academy
Universiti Pertahanan Nasional Malaysia
(Co-Supervisor)

UNIVERSITI PERTAHANAN NASIONAL MALAYSIA

DECLARATION OF THESIS

Student's full name : Siti Maizura binti Mohd Daud

Date of birth : 3rd October 1995

Title : Acute Effect of Red Pitaya Juice Supplementation on Running Performance and Muscle Damage in Cadets

Academic session : Sept 2019 – March 2022

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

I further declare that this thesis is classified as:

☐ **CONFIDENTIAL** (Contains confidential information under the official Secret Act 1972)*

☐ **RESTRICTED** (Contains restricted information as specified by the organisation where research was done)*

☐ **OPEN ACCESS** I agree that my thesis to be published as online open access (full text)

I acknowledge that Universiti Pertahanan Nasional Malaysia reserves the right as follows.

1. The thesis is the property of Universiti Pertahanan Nasional Malaysia.
2. The library of Universiti Pertahanan Nasional Malaysia has the right to make copies for the purpose of research only.
3. The library has the right to make copies of the thesis for academic exchange.

Signature	**Signature of Supervisor/Dean of CGS/ Chief Librarian
951003-10-5662	Dr. Faizal Abdul Manaf
IC/Passport No.	**Name of Supervisor/Dean of CGS/ Chief Librarian
Date:	Date:

*If the thesis is CONFIDENTAL OR RESTRICTED, please attach the letter from the organisation with period and reasons for confidentiality and restriction.
** Witness

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ALK	-	*Akademi Latihan Ketenteraan*
ANOVA	-	Analysis of variance
BCAA	-	Branched-chain amino acids
BMI	-	Body mass index
Ca^{+}/Ca^{2+}	-	Calcium ions
CEPS	-	Carbohydrate-electrolyte-protein solution
CES	-	Carbohydrate-electrolyte solution
CHO	-	Carbohydrate
CK	-	Creatine kinease
CMJ	-	Countermovement jumps
CPA	-	Carbohydrate with proteins and antioxidants
CRP	-	C-reactive protein
DOMS	-	Delayed-onset muscle soreness
DRG	-	Red pitaya fruit juice
ECC	-	Eccentric contractions
ELISA	-	Enzyme-linked immunosorbent one-step process assay
FDA	-	U.S. Food and Drug Administration
FSS	-	Fluid sensation scale
GAL	-	Galactose
GF	-	Glucose and fructose
GLU	-	Glucose
GTE	-	Green tea extract
GSH:GSSG	-	Oxidised glutathione ratio
HR	-	Heart rate
HRP	-	Horseradish peroxide
IL	-	Interleukin
LDH	-	Lactate dehydrogenase

LIST	-	Loughborough Intermittent Shuttle Test
LPO	-	Lipid peroxidation
Mb	-	Serum myoglobin
MD	-	Maltodextrin
MDA	-	Malondialdehyde oxidative stress
MHR	-	Maximal heart rate
MIVC	-	Maximal isometric voluntary contractions
MS	-	Muscle soreness
NaF	-	Sodium fluoride
NZBC	-	New Zealand Blackcurrant
OD	-	Optical density
ORAC	-	Oxygen radical absorption capacity
PIKT	-	Peak isokinetic torque
PIMT	-	Peak isometric torque
PLA	-	Placebo
PRO	-	Protein
RER	-	Respiratory exchange ratio
RH	-	Relative humidity
ROS	-	Reactive oxygen species
RPE	-	Rating of perceived exertion
RST	-	Repeat sprint test
RT	-	Room temperature
SD	-	Standard deviation
SJ	-	Squat jumps
TAC	-	Total antioxidant capacity
TTE	-	Time-to-exhaustion
VJ	-	Vertical jump test
VO_{2max}	-	Volume of maximal oxygen uptake
WHO	-	World Health Organisation
WIST	-	Water Polo Intermittent Shuttle Test
W_{max}	-	Maximal power output

LIST OF SYMBOLS

M	-	Molarity
V	-	Volume
↓	-	Decrease
↑	-	Increase
↔	-	No change
σ	-	Standard deviation
δ	-	Mean
%	-	Percentage
^{o}C	-	Celcius
e^{-}	-	electron

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Effective and fast recovery following strenuous physical activity either after training or during a competition is a crucial factor for an athlete's performance. Common training exercises include running, marching, callisthenics, climbing, hurdling, crawling, jumping, digging, and lifting. These physical demands of various movements in training will usually cause delayed-onset muscle soreness (DOMS), affecting recovery speed. The abrupt increase in physical stress and performance of unfamiliar training exercises during cadet basic training increases the likelihood of DOMS (Jones, 2015). As DOMS progresses, there may be a higher dependence on synergist muscles to relieve stress on the afflicted muscle groups that could affect a joint’s range of motion, reduce strength and power, disrupt movement techniques, and increase the risk of injury (Cheung et al., 2003).

Although there are no standardised definition of high-intensity exercise, a scientific review paper written by Bishop et al. (2019) has define high-intensity exercises as intervals performed above 75% of the maximal heart rate (MHR) for 10

minutes or more. In addition, metabolic equivalent of task (MET) value was often being used to classified physical activity level to measure body's expenditure of energy. According to the United State Department of Health and Human Services (2018), vigorous-intensity activity was defined as activities with 6.0 or more METs value such as jogging, carrying heavy loads and any intense activity that requires more breathing. These are among the routine exercises that are done during cadets' training and are considered as high intensity exercises. Given the high frequency of intensive physical training endured by newly enlisted cadets and the risk of injury, it is critical to implement recovery measures to reduce DOMS symptoms and improve muscular recovery (Scudamore et al., 2021). It has been hypothesised that antioxidant supplementation before the strenuous physical activity can boost the body's antioxidant defence mechanism and thus aid in faster recovery and performance of athletes or active individuals (Bailey et al., 2011). DRG is a good and natural source of antioxidants (Khalili et al., 2010; Tenore et al., 2012). Therefore, using DRG as a pre-exercise supplementation might help prevent delay-onset muscle soreness after strenuous training.

Exhaustive and strenuous exercise has been shown to cause skeletal muscle damage and has been implicated as one factor leading to delayed-onset muscle soreness (DOMS) (Owens et al., 2018; Ranchordas et al., 2018). Strenuous exercise might also increase the production of reactive oxygen species (ROS). The reduced antioxidant defence might affect the elimination of ROS, leading to DOMS (Tsai et al., 2001). DOMS following exercise depends on the type and the severity of exercise and usually peaks between 24 and 72h after exercise (Bleakley et al., 2012). This

becomes crucial for athletes or active populations, including cadets during training or competition when there is a limited duration for recovery (Ranchordas et al., 2018).

There are various supplementations for muscle injury and recovery in the marketplace. However, these supplements might contain dangerous substances that could cause unwanted side effects (FDA, 2017). In this light, there are limited studies investigating the effect of pre-exercise antioxidant-rich supplements derived from natural products on skeletal muscle damage and sports performance. Consumption of antioxidants or antioxidant-rich food could boost antioxidant defence and reduce oxidative stress by decreasing ROS production after strenuous exercise (Close et al., 2016). This might benefit athletes, cadets, and active populations as it could reduce DOMS incidence. The benefits of ingesting antioxidant-rich food such as honey, green tea and other types of fruits or berries concerning DOMS following exercise has been previously studied (Blando & Oomah, 2019; Murphy et al., 2017; de Lima Tavares Toscano et al., 2019; Hatchett et al., 2016; Machado et al., 2018). According to a study by Machado et al. (2018) on green tea extract (GTE) supplementation, it has been found that the antioxidative effect of GTE improved muscle recovery following strenuous exercise by the reduction of creatine kinase (CK). In another study by Hatchett et al. (2016), honey mixed with raw milk was compared with chocolate milk to investigate the beneficial role of honey in reducing DOMS following lower extremity DOMS protocol and concluded that ingestion of mixed raw milk with honey at post-exercise increased recovery rate compared to the commonly accepted recovery drink (chocolate milk). The DOMS protocol requires participants to finish 4 sets of 10 barbell back squat repetitions.

Previous studies have identified the benefits of New Zealand blackcurrant on exercise performance. It was found that ingestion of New Zealand blackcurrant improves 16.1-km time-trial performance (David et al., 2015), is beneficial in repeated short-distance 2 x 4-km cycling time-trials (Murphy et al., 2017), and enhances exercise performance in intermittent high-intensity sports (Perkins et al., 2013) as well as team sports with repeated maximal sprints (Willems et al., 2016). Studies also hypothesized that this enhancement in performance could be due to the blackcurrant's high antioxidant content, which reduces the oxidative stress developed during strenuous exercise (Lyall et al., 2009). Antioxidant supplementation was also shown to reduce exercise-induced oxidative stress by attenuating the ROS-induced inhibition of sodium-potassium pump activity (McKenna et al., 2006). These findings showed that antioxidant supplementation before strenuous exercise could aid in faster recovery and reduced DOMS.

Dragon fruit, also known as pitaya or pitahaya, is one of the popular exotic fruits in Malaysia. It is commercially grown extensively in Malaysia and available in many local markets (Halimoon & Hasan, 2010). It is usually consumed directly processed into ready-to-consume juice and other products such as jam. Pitaya is highly nutritious and rich in antioxidants (Halimoon & Hasan, 2010; Nur'Aliaa et al., 2009). Red pitaya has a higher antioxidant activity than white pitaya (Mahattanatawee et al., 2006; Nur'Aliaa et al., 2011). Thus, DRG extract from a natural source could be a good candidate for an antioxidant supplement.

Besides antioxidants, advocating high CHO is also included in nutritional recommendations, especially for endurance athletes to replenish glycogen stores post-exercise (Thomas et al., 2016). The primary aim of CHO beverages supplementation during endurance training is to replace fluid loss and maintain a high level of plasma glucose (Thomas et al., 2016). Therefore, as a natural fruit rich in antioxidants and CHO, DRG shows potential as a supplement to aid recovery and enhance sports performance.

Theoretically, it could be hypothesized that supplementation of DRG before strenuous exercise could have an ergogenic effect on exercise performance and might aid in better muscle recovery and delay the onset of muscle soreness. Although the antioxidative properties of DRG on general health have been researched worldwide, there are still limited studies conducted on the antioxidative effect and mixed carbohydrate content in red pitaya on athletes' running performance and muscle damage. Thus, this research will study the benefits of DRG in improving exercise performance and reducing skeletal muscle damage among cadets.

1.2 Problem Statement

Delayed-onset muscle soreness (DOMS) is a common problem faced by athletes, active individuals and cadets who have undergone strenuous endurance training. It is also one of the factors which can affect faster recovery due to the increase in production of ROS, creating an imbalance between ROS and antioxidants (Tsai et al., 2001). This may affect their performance and limit their potential during events or training since they only have a limited duration for recovery.

DRG is easily found in tropical climates and readily accessible in the market. The rationale behind the choice of making DRG as antioxidant supplement in this study is based on a finding that it is highly nutritious containing multiple bioactive compounds that offer various health benefits such as protection against liver damage, cancer, inflammation, reduce stiffness of the heart by breaking the free radical chain reaction and form stable intermediates (Halimoon et al., 2010; Ramli et al., 2014). Therefore, DRG supplementation might provide a solution to boost antioxidant defence and reduce oxidative stress by either decreasing or preventing ROS production after strenuous training.

In the marketplace, various supplementation options were readily available for muscle damage and recovery. According to U.S. Food and Drug Administration (FDA) (2017), these supplements may contain fraudulent substances and might have other adverse side effects on health. According to previous studies, about 38-99% of athletes or active individuals consume sports supplements despite the lack of scientific evidence supporting the effectiveness of supplementation in boosting sports

performance and aid recovery (Duvenage et al., 2015; Outram et al., 2015; Tawfik et al., 2016). Thus, this study is significant as it investigates the potential of DRG fruit as an alternative food that provides an ergogenic effect to help prevent DOMS after a strenuous training regime.

Other than that, although there are studies on the antioxidative properties of DRG on general health, there are still limited studies on the antioxidative effect and mixed CHO content in DRG on running performance and muscle damage of athletes or active population. Therefore, this study investigates the effectiveness of DRG supplementation on skeletal muscle damage and running performance among cadets. This study could generate new knowledge on supplementation and sports nutrition for future references.