EFFECTS OF EURYCOMA LONGIFOLIA JACK SUPPLEMENTATION ON RECREATIONAL ATHLETES' ENDURANCE RUNNING PERFORMANCE AND PHYSIOLOGICAL RESPONSES IN THE HEAT

by

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

KESAN PENGAMBILAN EURYCOMA LONGIFOLIA JACK TERHADAP PRESTASI LARIAN DAYA TAHAN DAN TINDAK BALAS FISIOLOGI ATLET REKREASI DALAM PERSEKITARAN YANG PANAS

ABSTRAK

Kajian ini mengkaji kesan pengambilan *Eurycoma longifolia Jack* terhadap prestasi larian daya tahan dan tindak balas fisiologi atlet rekreasi dalam persekitaran yang panas. Sembilan atlet rekreasi lelaki yang sihat (Umur: 23.3 ± 4.3 tahun; Berat badan: 69.2 ± 9.6 kg; VO_{2max}: 43.1 ± 6.6 $mL.kg^{-1}.min^{-1}$) telah menyertai kajian ini. Dalam kajian 'double blind, placebo-controlled cross-over' ini, subjek telah menyempurnakan 2 ujian larian daya tahan yang berlangsung pada hari yang berasingan, setelah mengambil sama ada kapsul *Eurycoma longifolia Jack* (75 mg *Eurycoma longifolia Jack* sekapsul) atau 'placebo' sebanyak dua kapsul sehari selama tujuh hari sebelum dan satu jam sebelum ujian. Pada hari ujian, selepas memanaskan badan pada 50% VO_{2max} selama 5 minit, subjek dikehendaki berlari pada 60% VO_{2max} selama 60 minit. Selepas itu, mereka melakukan ujian 'time trial' selama 20 minit untuk menentukan prestasi larian daya tahan. Kedua-dua ujian larian ini telah dijalankan di dalam makmal di mana suhu dan kelembapan relatif telah dikawal masing-masing pada ± 31°C dan ± 70%. Sampel darah telah diambil sebelum subjek memanaskan badan, selepas memanaskan badan, dan pada setiap 20 minit semasa ujian larian untuk menentukan kepekatan haemoglobin, paras haematokrit, dan kepekatan glukosa dalam darah. Pada setiap 20 minit semasa ujian larian, 3 $mL.kg^{-1}$ berat badan air sejuk (± 8°C) telah diberikan kepada subjek. Keputusan kajian ini menunjukkan

bahawa prestasi larian daya tahan adalah tidak berbeza secara statistik (p=0.139) antara ujian *Eurycoma longifolia Jack* (EL) dan placebo (P). Pada masa yang sama, pengambilan oksigen, denyutan jantung, tanggapan daya usaha, perubahan berat badan, suhu telinga, suhu kulit, kepekatan haemoglobin dalam darah, paras haematokrit, dan kepekatan glukosa dalam darah juga tidak berbeza secara statistik antara kedua-dua ujian. Maka, keputusan yang diperolehi dari kajian ini menunjukkan bahawa pengambilan *Eurycoma longifolia Jack* yang kronik selama 7 hari dengan dos sebanyak 150 mg sehari tidak dapat menghasilkan kesan bermanfaat ke atas prestasi larian daya tahan dan tindak balas fisiologi dalam persekitaran panas di kalangan atlet rekreasi.

EFFECTS OF EURYCOMA LONGIFOLIA JACK SUPPLEMENTATION ON RECREATIONAL ATHLETES' ENDURANCE RUNNING PERFORMANCE AND PHYSIOLOGICAL RESPONSES IN THE HEAT

ABSTRACT

This study investigated the effects of *Eurycoma longifolia Jack* supplementation on recreational athletes' endurance running performance and physiological responses in the heat. Nine healthy male recreational athletes (Age: 23.3 ± 4.3 years old; Body weight: 69.2 ± 9.6 kg; VO_{2max}: 43.1 ± 6.6 $mL.kg^{-1}.min^{-1}$) were recruited for this study. In this double blind, placebo-controlled cross-over study, subjects completed 2 endurance running trials, performed on separate days, after either *Eurycoma longifolia Jack* (75 mg of *Eurycoma longifolia Jack* per capsule) or placebo supplementation. Two capsules per day of either *Eurycoma longifolia Jack* or placebo were taken for 7 days before and one hour prior to the experimental trial. On the trial day, after 5 minutes warm-up at 50% VO_{2max}, subjects were requested to run at 60% VO_{2max} for 60 minutes. This was immediately followed by a 20 minutes time trial for determining endurance running performance. The experimental trials were carried out in the laboratory where the temperature and relative humidity were kept at approximately 31°C and 70% respectively. Blood samples were taken before warm-up, after warm-up, and every 20 minutes during the trial to determine haemoglobin concentration, haematocrit level, and plasma glucose concentration. At every 20 minutes during the trial, 3 $mL.kg^{-1}$ body weight of cool water was given to the subjects. Study results showed that endurance running performance was not different statistically (p=0.139)

between *Eurycoma longifolia Jack* (EL) and placebo (P) trials. Similarly, oxygen uptake, heart rate, rate of perceived exertion, body weight changes, tympanic temperature, mean skin temperature, haemoglobin concentration, haematocrit level, and plasma glucose concentration were not statistically different between trials. Thus, these findings indicated that chronic supplementation of *Eurycoma longifolia Jack* with a dosage of 150 $mg.day^{-1}$ for 7 days did not elicit beneficial effects on endurance running performance and physiological responses of recreational athletes in the heat.

CHAPTER 1

INTRODUCTION

Ergogenic aids are substances or devices that enhance energy production, use or recovery and provide athletes with a competitive advantage (Ahrendt, 2001). It is also known as external influences that can positively affect physical or mental performance especially by eliminating fatigue symptoms (Ang *et al.*, 2001). The term "ergogenic" means "tending to increase work" and, in the context of sports, includes techniques used to increase energy production and performance (Thein *et al.*, 1995).

Ergogenic aids can be divided into four categories; pharmacological aids, physiological aids, nutritional aids, and psychological aids. Some include mechanical aids as one of the ergogenic aids (Table 1.1). Nutritional ergogenic aids refer to substances that enhance performance and are either nutrients, metabolic by-products of nutrients, food (plant) extracts, or substances commonly found in foods that are provided in amounts more concentrated than commonly found in the natural food supply (Benardot, 2005). The most popular supplements or nutritional ergogenic aids among endurance athletes are caffeine, erythropoietin, and the dietary practice of carbohydrate loading (Juhn, 2002).

Table 1.1 Types of ergogenic aids (Coleman, 2008).

Category	Examples
Mechanical aids	Free weights to develop strength, lightweight racing shoes, and nasal strips to improve air flow to the lungs.
Pharmacological aids	Androgenic steroid hormones and their precursors, quasi-nutrient substances that impair a pharmacological effect (i.e. beyond the nutritional effect you would expect from a normal intake).
Physiological aids	Blood doping, sauna, massage, and other forms of physiotherapy.
Nutritional aids	Carbohydrate loading, sports drinks, caffeine intake, and the consumption of other substances commonly available in the food supply.
Psychological aids	Hypnosis, relaxation techniques, imagery techniques, and motivational techniques.

Attempts to enhance athletic performance are not new. Ancient Greek Olympians ate mushrooms while Aztec athletes ate human hearts to win. On the other hand, European cyclists took heroin, cocaine "speedballs," and ether-soaked sugar tablets in the late 1800s. In 1904, the winner of Olympic marathon, Tom Hicks, took strychnine and brandy during the race. The winner of the 1920 Olympic 100-m dash, Charlie Paddock, drank sherry with raw egg before the race. In the 1960 Olympics, Danish cyclist Knut Jensen and in the 1967 Tour de France, famed British cyclist Tommy Simpson died from taking amphetamine on the race road (Eichner, 1997).

In 1996, out of general population, approximately 50 percent of athletes have reported taking some form of dietary supplements while 76 to 100 percent of athletes in some sports are reported to use them (United States Department of Agriculture, 1999). Both amateur and professional athletes used ergogenic aids which claim to enhance sports performance. Other surveys have shown that 76 percent of college athletes, and 100 percent of body builders take supplements (Sobal and Marquart, 1994). Yet, some supplements are banned by certain bodies such as International Olympic Committee (IOC) and National Collegiate Athletic Association (NCAA), for certain reasons although they benefit the exercise performance (Table 1.2).

To date, herbs or plant products that have been investigated as ergogenic aids (nutritional aids) for enhancing endurance performance are such as caffeine, ginseng, mahuang, ephedrine and related alkaloids (Bucci, 2000). *Eurycoma longifolia Jack* is one of the famous herb found in Malaysia. It is commonly known as 'Tongkat Ali' in Malaysia and as 'Pasak Bumi' in Indonesia. It is also referred to as 'Malaysian ginseng' since it is well-known among various ethnic groups in Malaysia for treating various diseases and enhancing health (Jagananth and Ng, 2000).

Eurycoma longifolia Jack is a tall, single-stemmed (Husen *et al.*, 2004), slender shrubby, slow growing tree, found on sandy soil (Ang *et al.*, 2002). It belongs to the *Simaroubaceae* family and grows wildly in Southeast Asian countries, i.e. Malaysia, Indonesia, Thailand, Myanmar, Laos, and Cambodia

(Jagananth and Ng, 2000, Ang *et al.*, 2000, Osman *et al.*, 2003). Its active ingredients called quassinoids (Ang *et al.*, 2002) are concentrated in taproot and reach its reproductive age after five years or more (Husen *et al.*, 2004).

Table 1.2 Popular products and practices used during aerobic activities (Juhn, 2002).

Products	Ergogenic potential in aerobic activity	Adverse effects / safety	Banned by	Typical dosage
Caffeine	Yes	Dependency, withdrawal, CNS stimulation; although a diuretic, exercise eliminates the diuretic effect	IOC: maximum urine concentration of 12 $\mu g.mL^{-1}$; NCAA: maximum urine concentration of 15 $\mu g.mL^{-1}$	2 – 9 $g.kg^{-1}$ orally 1 hour prior to event
Antioxidants	No, but does help parameters of cellular damage triggered by exercise, although correlation with performance not yet established	None known	None	Megadoses of vitamin C, vitamin E, beta carotene, alpha-tocopherol, coenzymeQ, for 2 – 4 weeks; multiple antioxidants recommended by some
Carbohydrate loading	Yes, for events ≥ 90 min; possibly for shorter events	None known	None	Increase carbohydrate intake by 10% for 3 – 5 days prior to event; high carbohydrate meal 3 – 6 hours prior to event
Pyruvate	No	Unstudied	None	5 – 7 g daily
Erythropoietin	Yes	Hypertension, thromboembolic events	IOC, NCAA	Highly variable; studies done using 50 $IU.kg^{-1}$ rH-EPO IV or SC typically for 15 – 30 days; darbepoietin less often used due to longer half life

CNS – central nervous system; rH-EPO – recombinant human erythropoietin; IOC – International Olympic Committee; IV – intravenous; NCAA – National Collegiate Athletic Association; SC – subcutaneous.

To our knowledge, studies on *Eurycoma longifolia Jack* as an ergogenic aid for enhancing endurance performance in humans are lacking. However, in two previous studies (Ooi *et al.*, 2001, Ooi *et al.*, 2003), acute effects of low dosage of *Eurycoma longifolia Jack* on endurance cycling performance have been investigated. Nevertheless, the dosage used in these previous studies could be insufficient and the subjects were only given acute supplementation during the experimental trial. Thus the present study was proposed to investigate the chronic effects of *Eurycoma longifolia Jack* supplementation (higher dosage and given daily for 7 days before experimental trial) on recreational athletes' endurance running performance and physiological responses in the heat.

1.1 OBJECTIVES OF THE STUDY

1. To investigate the effectiveness of *Eurycoma longifolia Jack* supplementation in enhancing endurance running performance in the heat.

2. To investigate the effects of Eurycoma *longifolia Jack* supplementation on physiological responses during endurance running in the heat.

1.2 RESEARCH HYPOTHESIS

H_{A1}: There is a significant difference in endurance running performance with *Eurycoma longifolia Jack* supplementation compared to the placebo trial.

H_{A2}: There are significant differences in physiological responses with *Eurycoma longifolia Jack* supplementation compared to the placebo during endurance running in the heat.

1.3 OPERATIONAL DEFINITIONS

1.3.1 Endurance Running Performance (Time Trial):

Distance in kilometers (km) covered by the subjects in 20 minutes in the heat and humid environments (± 31°C, ± 70% relative humidity) following a 60 minutes run at 60% of their respective VO_{2max}.

1.3.2 Heat Environment:

The temperature and relative humidity of the Sports Science Laboratory were maintained at ± 31°C and ± 70% respectively throughout the experimental trials.

1.3.3 Double Blind, Placebo-Controlled Cross-Over Study:

Both subjects and researchers did not know the content of the capsules (*Eurycoma longifolia Jack* or placebo) that were given 7 days before and 1 hour prior to the experimental trial. The subjects are on their own control as they have to repeat the same experimental trial after a wash-out period of 1 week.

1.3.4 *Eurycoma longifolia Jack* Supplementation

The supplement was in a capsule, taken 2 capsules per day after breakfast by the subjects for 7 days before and 1 hour prior to the experimental trial. The supplement was prepared via good manufacturing practice and is approved by the Ministry of Health, Malaysia.

1.3.5 Placebo

White flour was inserted into the empty capsules as a placebo. These capsules were similar in size and colour as the *Eurycoma longifolia Jack* capsules. Its supplementation regimen was also the same as the *Eurycoma longifolia Jack.*

1.3.6 Recreational Athletes

Individuals who exercise for at least 30 minutes per session and at least 2 times per week prior to the study.

1.4 SIGNIFICANCE OF THE STUDY

Study to investigate the effects of *Eurycoma longifolia Jack* supplementation on endurance running performance in the heat is warranted as there is a scarcity of data in this area. If the present study finds that *Eurycoma longifolia Jack* supplementation can help to improve the endurance performance of runners in the heat, this may imply that *Eurycoma longifolia Jack* supplementation has potential to be used as an ergogenic aid for athletes to enhance their running performance in the heat. To our knowledge, this is the first study in Malaysia that uses *Eurycoma longifolia Jack* supplementation in a research related to endurance running performance in the heat.

CHAPTER 2

LITERATURE REVIEW

2.1 HERBS IN EXERCISE AND SPORT

Using herbs as ergogenic aids in exercise and sport is not novel. Ginseng, caffeine, ephedrine, and combination of both caffeine and ephedrine are the most popular herbs used in exercise and sports. People believe that these herbs can help to improve their performance, thus having an ergogenic effect. In recent years, numerous studies have been conducted to scientifically prove and investigate the effects of these herbs on exercise performance (Graham and Spriet, 1991, Ahuja *et al.*, 1992, Bell and McLellan, 2003, David and Andrew, 2003, Kim *et al.*, 2005, Schneiker *et al.*, 2006).

Ginseng is a general name for the plant genus *Panax.* Some of the members of this genus are *Panax ginseng, Panax quinquefolius, Panax notoginseng, and Panax japonicus*. Among these plants, *Panax ginseng* is the most widely used (David and Andrew, 2003). In exercise and sports, ginseng is believed to be a physical performance enhancer (David and Andrew, 2003). Its chronic use was believed to improve cardiorespiratory function and lower lactate concentration in the blood besides improving the physical performance (Kim *et al.*, 2005). However, it was reported that its benefits was only best seen in poor physically-conditioned individuals (Bahrke and Morgan, 1994).

Many studies found that ginseng can increase exercise duration until exhaustion during forced exercise trials (Bahrke and Morgan, 1994, Kim *et al.*, 2005). This was believed to be due to stress adaptation via ginseng supplementation (Ahuja *et al.*, 1992) and this adaptation to stress may increase time to exhaustion (David and Andrew, 2003). Triterpenoid glycosides or saponins, which are also called ginsenosides (David and Andrew, 2003) are compounds in ginseng which are responsible for the stimulant effect, alertness against fatigue, and stress (Ahuja *et al.*, 1992).

Liang *et al.* (2005) found that in untrained adults, consumption of 1,350 mg *Panax notoginseng* capsule per day for 30 days improved their endurance time more than 7 minutes and lowered their maximal mean blood pressure and oxygen consumption at 24^{th} minute during endurance cycle exercise. This further support use of ginseng as physical performance enhancer.

Studies on caffeine revealed that it can improve performance at varying intensities and modalities of exercise (Schneiker *et al.*, 2006) and evidence of its effects on sub-maximal exercise was well documented (Bell and McLellan, 2003). However, its effect on intermittent sprint performance is still lacking (Schneiker *et al.*, 2006). It has been reported that plasma concentration of caffeine is maximal after 1 hour ingestion and back to normal after 6 hours ingestion (Costill *et al.*, 1978). Thus, for ergogenic purposes, an effective dose for caffeine ranging from 2 $mg.kg^{-1}$ to 9 $mg.kg^{-1}$ body mass and should be taken at least 1 hour prior to exercise or competition (Kovacs *et al.*, 1998).