Laporan Akhir Geran Penyelidikan Jangka Pendek

Prof. Rabindarjeet Singh

Effect of a Herbal Drink on Cycling Endurance Performance

Semua laporan kemajuan dan laporan akhir yang dikemukakan kepada Bahagian Penyelidikan dan Pembangunan perlu terlebih dahulu disampaikan untuk penelitian dan perakuan Jawatankuasa Penyelidikan di Pusat Pengajian.

USM JP-06

BAHAGIAN PENYELIDIKAN
UNIVERSITI SAINS MALAYSIA

Laporan Akhir Projek Penyelidikan Jangka Pendek

1) **Nama Penyelidik:** Profesor Rabindarjeet Singh

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(*Jika berkaitan*) Assoc. Prof. Roland G. Sirisinghe

2) **Pusat Pengajian/Pusat/Unit:** Unit Sains Sukan, Pusat Pengajian Sains Perubatan,

3) **Tajuk Projek:** Effect of a Herbal Drink on Cycling Endurance Performance

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4. (a) **Penemuan Projek/Abstrak**

(Perlu disediakan makluman diantara 100-200 perkataan di dalam Bahasa Malaysia dan Bahasa Inggeris, ini kemudiannya akan dimuatkan ke dalam Laporan Tahunan Bahagian Penyelidikan & Pembangunan sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti.)

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk menilai kesan minuman herba 'AgroMas®' ke atas respons fisiologi serta prestasi dayatahan semasa mengayuh basikal. Dalam kajian ini, sembilan orang pelumba basikal telah mengayuh basikal ergometer pada 71.9 ± 0.7% daripada pengambilan oksigen maksimal (VO_{2max}) sehingga penat dalam bilik yang bersuhu 23.9±0.2^{0}C dan berkelembapan relatif 64.7±1.5 %. Para subjek menjalankan dua ujian yang diselang selama seminggu. Semasa ujian dijalankan, subjek diberi minuman herba (H) ataupun plasebo (P) semasa mengayuh. Isipadu minuman sebanyak 3ml.kg^{-1} berat badan telah diberi kepada subjek pada setiap 20 minit. Minuman adalah diberi secara buta dwipihak dan menimbal balas. Titik kelesuan dalam kajian ini didefinisikan sebagai masa di mana subjek tidak berkemampuan mengekalkan kelajuan mengayuh pada 40 RPM. Darah subjek diambil sebelum ujian bermula, iaitu ketika subjek dalam keadaan rehat dan semasa mengayuh setiap 20 minit. Dalam ujian ini, didapati masa mengayuh sehingga penat oleh subjek bagi H (83.7±4.6 min) adalah lebih lama daripda P (81.5±5.0 min), tetapi perbezaan masa ini adalah tidak signifikan dari segi statistik ($p>0.05$). Kajian ini juga tidak menunjukkan perbezaan dari segi perubahan berat badan, kadar pengambilan oksigen, isipadu plasma, suhu rektal, suhu kulit, kadar denyutan jantung, tanggapan tahap usaha, sensori minuman, nisbah pertukaran gas,

kepekatan glukosa dan kepekatan laktat darah apabila subjek menerima samada H atau P. Hasil kajian ini menunjukkan bahawa kedua-dua H dan P mendatangkan kesan yang sama ke atas prestasi senaman, pengawalatur suhu serta respons fisiologi dalam aktiviti mengayuh basikal secara berpanjangan. Sebagai kesimpulan, bolehlah dikatakan bahawa minuman herba 'AgroMas®' tidak dapat meningkatkan prestasi dayatahan berbasikal.

ABSTRACT

The aim of this study was to evaluate the effects of 'AgroMas®' herbal drink on physiological responses and endurance performance during cycling exercise. Nine cyclists cycled on a cycle ergometer at 71.9±0.7% of the maximal oxygen consumption (VO_{2max}) until exhaustion in a room maintained at 23.9±0.2^{0}C and 64.7±1.5 % relative humidity on two occasions with 1-week interval. The point of exhaustion was defined as the time when subjects could no longer maintain 40 RPM. Subjects ingested either a 'herbal drink' (H) or placebo (P). During each exercise bout, subjects received 3ml.kg^{-1} body weight of H or P every 20 minutes in a double-blind randomised study design. Blood samples were collected at rest and during exercise, every 20 min., for the determination of substances. Total cycling time to exhaustion was insignificantly ($p > 0.05$) longer with H (83.7 ± 4.6 min) than P (81.5 ± 5.0 min). Changes in body weight, oxygen uptake, plasma volume, core temperature, skin temperature, heart rate, perceived rate of exertion, fluid sensation, respiratory exchange ratio, blood glucose concentration and blood lactate concentration were similar with both H and P treatment. These results showed that the H and P treatment elicited similar exercise performance, thermoregularity and physiological responses during endurance cycling. Thus, it can be concluded that the 'AgroMas®'herbal drink could not enhance cycling endurance performance.

(b) **Senaraikan Kata Kunci yang digunakan di dalam abstrak:**

Bahasa Malaysia	**Bahasa Inggeris**
Minuman Herba	Herbal drink
Respons fisiologi	Physiological responses
Pengawalatur suhu	Thermoregularity responses
Prestasi mengayuh basikal	Cycling performance
Pelumba basikal	Cyclist

5. Output Dan Faedah Projek

(a) **Penerbitan** (*termasuk laporan/kertas seminar*)
(Sila nyatakan jenis, tajuk, pengarang, tahun terbitan dan di mana telah diterbitkan/dibentangkan)

i. The findings of this study was presented as poster at the 15th Scientific Meeting of The Malaysian Society of Pharmacology and Physiology held on the 8th to 9th May, 2000 at U.S.M., Kubang Kerian.

ii. The findings of this study was also presented as a poster at the International Conference for Physical Educators (ICPE 2000)—Innovation and Application of Physical Education and Sports Science in the New Millennium – An Asia –Pacific Perspective held on the 7th and 8th July, 2000 at The Hong Kong Institute of Education, Hong Kong. The paper has been accepted and published in the proceeding of the above conference.

iii. The manuscript for this study has been accepted by Malaysian Journal of Nutrition. Most probably will be published in 2002.

(b) **Faedah-Faedah Lain Seperti Perkembangan Produk, Prospek Komersialisasi Dan Pendaftaran Paten**

(Jika ada dan jika perlu, sila gunakan kertas berasingan)

Tiada

(c) **Latihan Gunatenaga Manusia**

i) *Pelajar Siswazah:MSc:* ***Ooi Foong Kiew***

ii) *Pelajar Prasiswazah:*

iii) *Lain-lain:*

6. **Peralatan Yang Telah Dibeli:**

Tiada

UNTUK KEGUNAAN JAWATANKUASA PENYELIDIKAN UNIVERSITI

14/12/05

TANDATANGAN PENGERUSI
JAWATANKUASA PENYELIDIKAN
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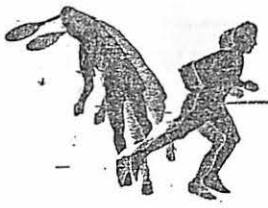

Titles of Poster Presentations

Raymond W. LEUNG, *University of Southern Indiana;* Michael J. GERMAIN, *Tuft University;* and Samuel A. HEADLEY and Tina M. MANOS, *Springfield College, USA*

Effect of Exercise During Dialysis on Urea Clearance

Ping LING, *Zhejiang University, China*

The Role of Physical Fitness Programs for Gifted Children in P.R. China

John LIU, *Springfield College;* Shihui CHEN, *University of Texas Pan American;* and Jiabei ZHANG, *Western Michigan University, USA*

Children's Learning of Motor Skills: The Acquisition and Development of Error-Detection Capability and Instructional Considerations

John LIU, Dee BROWN and Hugh MCCAULEY, *Springfield College;* Shihui CHEN, *University of Texas Pan American, USA*

The Effect of Active and Passive Selection of Performance Goals on the Performance Reproduction of a Motor Skill

Wen-Hao LIU, *University of Georgia, USA;* and Gang-Yan SI, *Wuhan Institute of Physical Education, China*

Field-Dependent Students' Limitations in Physical Education and the Solution

Wen-Hao LIU and Jepkorir R. CHEPYATOR-THOMSON, *University of Georgia, USA*

Improving Student Teaching Experience in Physical Education: An Analysis of Preservice Teachers' Perspective about Student Teaching

Duncan J. MACFARLANE and Kwok-Keung FONG, *The University of Hong Kong, Hong Kong-China*

The Effect of an External Nasal Dilator on the Athletic Performance of Active Chinese Male Adolescents

Chiaki MATSUO and Kazuhiko WATANABE, *Hiroshma University, Japan;* Di-Na PEI, Jian LIU and Jian-guo QI, *Beijing Normal University, China*

Research of the Motivation on Health and Exercise in Chinese and Japanese Women

Michael C MCNEILL, *National Institute of Education, Singapore;* Len ALMOND, *Loughborough University, UK;* and Peter A HORTON, *James Cook University, Australia*

Sport as a Curriculum Innovation in Singapore

Charles L. NIX, *Mississippi State University, USA;* and Shu-Ching WU, *Ling Tung College, Taiwan*

The Use of Imagery by Table Tennis Players

Foong-Kiew OOI, Rabindarjeet SINGH, Roland G. SIRISINGHE and Ang Boon SUEN, *Universiti Sains Malaysia, Malaysia*

Effects of 'Agromas©' Herbal Drink on Physiological Responses and Cycling Performance in Young Cyclists

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EFFECTS OF A HERBAL DRINK ON CYCLING ENDURANCE PERFORMANCE

Project Report

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EFFECTS OF A HERBAL DRINK ON CYCLING ENDURANCE PERFORMANCE

ABSTRACT

Intake of fluids during exercise becomes a paramount concern to an athlete to maintain hydration status as metabolic heat generated by exercise must be dissipated to maintain body temperature within narrow physiological limits. To maintain this hydration status, there are many types of drinks available and one such fluid that is available to our Malaysian athletes is a locally produced herbal drink (AgroMas® 'Air Minuman Herba') whose efficacy is yet to be proven in the physiological responses to physical exercise. The purpose of this study was, therefore, to evaluate the effects of acute ingestion of this herbal drink (H) or a coloured water placebo (P) on physiological responses and performance during cycling exercise.

Nine healthy and trained young male cyclists (age: 16.2±0.5years) exercised on a cycle ergometer at 71.9±0.7% of the maximal oxygen consumption (VO_{2max}) until exhaustion in a room maintained at 23.9±0.2°C and 64.7±1.5% relative humidity on two occasions with 1-week interval. During each exercise bout, subjects received 3ml.kg^{-1} body weight of H or P every 20 minutes in a double-blind randomised study design. Blood samples were collected at rest and during exercise for the determination of hematocrit level, hemoglobin concentration, plasma glucose concentration and plasma lactate concentration.

There was no significant difference between H and P trials in the total work time to exhaustion (83.7±4.6 and 81.5±5.0 min respectively). Changes in heart rate, oxygen consumption, plasma glucose concentration, plasma lactate concentration, rectal temperature, mean skin temperatures, respiratory exchange ratio and energy expenditure were similar with both types of drinks. Loss of plasma volume was also similar with both drinks. These results demonstrated that herbal drink elicited similar physiological responses, thermoregularity responses and exercise performance during endurance cycling when compared to the placebo. It is concluded that the AgroMas® herbal drink produced similar response to water ingestion and the herbal drink can, therefore, be used as an alternative choice for fluid replacement for activities shorter than 60 minutes.

Key words: **Herbal drink, physiological responses, thermoregularity responses, cycling performance, cyclist**

INTRODUCTION

During physical activity, heat is generated as a by-product of muscle activity and energy metabolism (1). This heat is dissipated through sweating, one of the many heat loss reflexes, where evaporation of 1 gram of water from the skin removes approximately 0.6 kilocalories of heat (2). However, sweating often results in dehydration, and sweat losses during hard exercise in the heat may be as high as 2 to 3 $L.h^{-1}$ (3). The loss of just 1 litre of water from the circulating blood volume can partially disable the cardiovascular system and considerably reduce the performance (4). Thus, it is essential to replace lost fluid and to maintain hydration for optimal performance (5).

Numerous studies regarding fluid intake during exercise have used carbohydrate-electrolyte solution as fluid replacement during exercise (6-11). However, other type of drinks such as fruit drink, caffeine free and nonalcoholic fluids have been used as fluid replacement during exercise. Over the years, a number of various types of drinks have been marketed as fluid replacement drinks and in Malaysia, one such drink is the herbal drink, 'AgroMas®'. Since the studies on the effect of herbal drink as fluid replacement or as exercise enhancement drink has not be evaluated, it is proposed that the effect of 'AgroMas®' herbal drink during exercise be investigated to evaluate the effects of this drink on physiological and endurance performance during cycling exercise.

METHODS

Subjects. Nine well-trained male young cyclists participated in this study after giving their written, informed consent. Their mean (± SEM) age, height, weight, and VO_{2max} were 16.2 ± 0.5 yr, 163.5 ± 2.5 cm, 56.2 ± 1.6 kg, and 56.9 ± 2.2 $ml.kg^{-1}.min^{-1}$ respectively. The study was approved by the Research and Ethical Committee of Universiti Sains Malaysia.

Preliminary testing. A progressive maximal exercise test was performed to obtain each subject's maximal oxygen uptake (VO_{2max}) using an electromagnetically-braked cycle ergometer (Excalibur Sport, Lode, Gronigen, The Nederland). Based on the measured

VO_{2max} and VO_2 values from steady-state exercise, exercise intensity for warm-up and experimental trial was established which elicited a VO_2 of 50% and 70% of VO_{2max}.

Endurance trial. The subjects cycled until volitional exhaustion on an electromagnetically-braked cycle ergometer at a workload requiring 70% VO_{2max} on two different occasions, separated by approximately 1 week. The subjects were instructed to cycle at 60 RPM, and exhaustion was defined as the point when they could no longer maintain 40 RPM despite verbal encouragement. Both trials were performed in the laboratory under similar experimental and environmental conditions (23.9 ± 0.2 ^{0}C and 64.7 ± 1.5% relative humidity). A fan directed air towards the subjects. On each occasion, the subjects were randomly assigned to consume either the herbal drink (H) or placebo solution (P) 3 ml.kg^{-1} body weight in a series of feedings at every 20 minutes during the cycling performance. The composition of the herbal drink and placebo used in this study are listed in Table 1. The order of the two trials was randomised and a double blind cross-over design was used.

Table 1: Test drink composition per 100 ml

	Herbal Drink	Placebo
Eurycoma Longifolia/Tongkat Ali (mg)	0.1	———
Cinnamomum Cassia (Presl) (mg)	2.0	———
Calcium (mg)	2.886	2.886
Sodium (mg)	1.056	1.056
Potassium (mg)	0.860	0.860
Phosphate (mg)	<0.003	<0.003

To produce a uniform homogenous physiological state among subjects, dietary and exercise restrictions were established. Each subject was instructed to record his diet for 72 hours prior to the first endurance trial session and to eat the same diet preceding the

second trial. In addition, they refrained from training or strenuous exercise 24 hours prior to the endurance trials but maintained similar training volume and intensity throughout the duration of the study.

For the preliminary tests and experimental trials, the subjects were fitted with a head gear which supported a one way non-rebreathing mouth piece (Vacummed 2700B). A paramagnetic oxygen analyser and an infra-red carbon dioxide analyser (SensorMedic 2900) were used to determine the percentages of oxygen and carbon dioxide, respectively in expired air sample taken during the investigation. Both analysers were calibrated daily using nitrogen based calibration gases.

On each trial, the cyclists reported to the laboratory after a 10 -12 hour fast. Subjects were encouraged to consume water during the fast. On reporting to the laboratory, after bladder emptying, subject's nude body weight was measured by an electronic weighing scale (Tanita Model, weighing accuracy ± 20g). Then a rectal probe (Yellow Spring Instrument) was inserted to a depth of 10 cm beyond the anal sphincter. Four skin electrodes were attached to different parts of the body: chest (ch), biceps (bic), thigh (th) and calf (calf) for the determination of mean skin temperature (Tsk) using the formula, Tsk = 0.3(Tch+Tbic)+ 0.2(Tth+Tcalf) (12). Core and skin temperatures were recorded by a temperature monitor (Libra Medical ET 300R). A heart rate monitor (Sport Tester PE3000, Polar Finland) was secured on the chest by attaching it onto an elastic belt. An indwelling cannula was inserted into a forearm vein and a 3 -way tap was attached to facilitate repeated blood samplings. The patency of the cannula was maintained with a heparinised saline solution (10 IU in 1 ml).

After sitting on the cycle ergometer for five minutes, a resting blood sample was collected and expired gas was measured. The subject was then asked to warm-up for five minutes by cycling at 50% VO_{2max}. Expired air was collected during the final minute of the warm-up. Immediately after the completion of the warm-up, the intensity of cycling was increased to 70% VO_{2max} and the clock started. At intervals of 20 minutes subsequent to

the warm-up and immediately after completion of the warm-up, 3 $ml.kg^{-1}$ body weight of the assigned cooled fluid (8^0C) was consumed by the subjects via plastic volumetric syringes. Expired air samples, heart rate, skin and core temperature, room temperature and humidity were taken at intervals of 10 minutes. VO_2 and respiratory exchange ratio (RER) were measured at 10 minute intervals using a computerised gas analysis spirometry system (SensorMedics 2900). Three ml of venous blood samples were collected at 20-minute intervals during exercise. Immediately after blood sampling, the assigned fluid was ingested by the subjects. Subjective ratings of perceived exertion (PRE) was obtained every 20 minutes using the traditional Borg's Scale (13, 14). Fluid sensation such as thirst, sweetness, nausea, fullness and stomach upset were determined using a fluid sensation scale (15) at the same time interval. Post-exercise nude body weight was obtained after the subjects had towel-dried themselves.

Blood measurement and analysis. Three ml of venous blood was drawn while the subject was seated on the cycle ergometer, immediately after warm-up, at every 20-minute interval thereafter and when the subject became exhausted while cycling on the ergometer. One ml of the blood was transferred into an EDTA (Ethylenediamine tetra-acetic acid) tube and was used to measure hematocrit and hemoglobin levels. Hematocrit was determined by micro-hematocrit centrifuge and Hawksley Reader (Hawksley England) in duplicate. Hemoglobin was analysed by the cyanmethemoglobin method (Drabkin's reagent) in duplicate. The percent change in plasma volume was calculated as described by Beaumont *et.al.* (16). The other two ml of blood was transferred into a tube anticoagulated with natrium flouride (NaF). The plasma in the tube was separated by centrifugation (10 minutes, 4^0C). Subsequently the plasma was divided into equal portions, and stored at -20^oC for analysis of glucose and lactate. Plasma was analysed for glucose concentration using glucose kits (Boehringer Mannheim Diagnostic), and plasma lactate was measured using a lactate analyser (YSI Model 2900).

Statistical analysis. Changes of physiological responses, hematology and cycling time with herbal drink and placebo were analysed using a one way analysis of variance (ANOVA) and paired-t test. The Statistical Package for Social Sciences (SPSS) programme was used for statistical analysis. Differences was considered significant at $p< 0.05$. Results were presented as mean ± SEM.

RESULTS

Time to exhaustion with the herbal (H) drink was 83.7± 4.6 min, but it was not significantly different from that with the placebo (P) 81.5± 5.0 min ($p>0.05$). The total volume of fluid consumed during exercise were similar in both drinks, 734.2± 46.9 ml and 713.4 ± 40.3 ml in the H and P trials respectively. The average decrease in body weight, as a result of exercise, was 0.7 ± 0.2 kg and 0.8 ± 0.2 kg in the H and P trials respectively. These values were corrected for the fluid ingested during cycling. These decreases represented body weight changes of 2.7 ± 0.4% and 2.9 ± 0.4% for H and P trials respectively. The decrease in body weight as expressed both in kg and percentage change of body weight with P did not differ statistically from H.

No significant differences in hemoglobin concentrations and hematocrit were noted at any time point during the H trial when compared with P trial. Hemoglobin concentration changes and hematocrit levels during exercise with both H and P were also not statistically significant ($p>0.05$).

The percentage change of plasma volume relative to the preexercise level is shown in Figure 1. Plasma volume declined significantly ($p<0.01$) throughout the test with both H and P. However, no significant differences were found between the H and P trials at any time. Percentage change of plasma volume at exhaustion for H and P were -7.6 ± 1.2% and -8.3 ± 1.2% respectively (Figure 1).

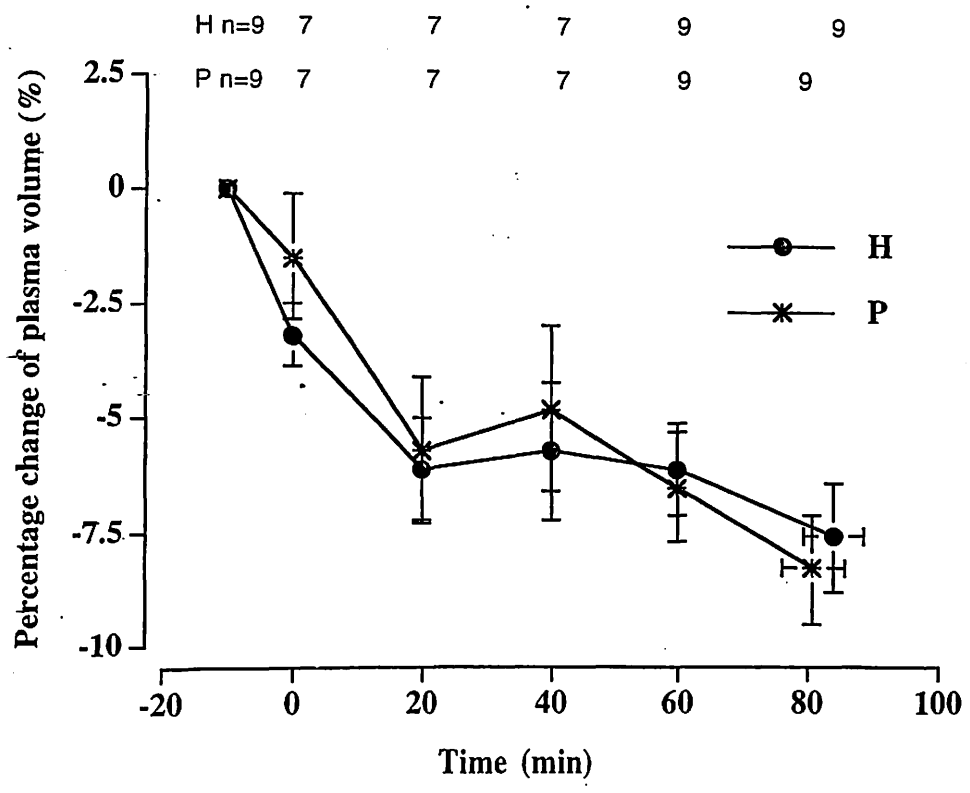

Figure 1: Percentage change of plasma volume (%) of the subjects during the herbal drink (H) and placebo (P) trials (Mean ± SEM)

Core temperature increased significantly during exercise in both the H and P trials ($p<0.001$). Core temperature increased from 36.9 ± 0.1°C to 38.3 ± 0.2°C at exhaustion in both the H and P trials. There was no significant difference in core temperature between the trials ($p>0.05$). Skin temperatures decreased significantly during exercise in the P trial ($p<0.05$) but not in the H trial. In the P trial, skin temperature decreased from 31.6 ± 0.1°C to 29.4 ± 0.7°C, whereas in the H trial, it decreased from 31.9 ± 0.2°C to 31.1± 1.5°C. However, the difference between skin temperatures in both the H and P trials were not statistically significant ($p>0.05$).

Oxygen uptake (VO_2) during the endurance trial was similar between the H and P trials, averaging 41.5 ± 0.7 $ml.kg^{-1}.min^{-1}$ and 41.2 ± 0.7$ml.kg^{-1}.min^{-1}$ respectively. The mean $\%VO_{2max}$ sustained during the H and P trials were 72.2 ± 1.3% and 71.6 ± 0.5% respectively. No significant difference in $\%VO_{2max}$ between the H and P trials were noted ($p>0.05$) during exercise. There was no significant difference in the heart rate responses

between the H and P trials (Mean: H: 156± 2 $b.min^{-1}$ vs P: 155 ± 2 $b.min^{-1}$). Heart rates at time of exhaustion for the H and P trials were 166 ± 3 $b.min^{-1}$ and 165 ± 4 $b.min^{-1}$ respectively. The perceived rate of exertion (PRE) increased significantly ($p<0.001$) from min 20 to the end of the test in both the H and P trials. In the H trial, PRE increased from 12.00 ± 0.37 Borg units at 20 min of exercise to 18.89 ± 0.26 Borg units at exhaustion, whereas in the P trial, PRE increased from 11.44 ± 0.29 Borg units at 20 min of exercise to 18.67 ± 0.24 Borg units at exhaustion. There were no significant differences in PRE during exercise at any time point between the H and P trials. There were also no significant differences for thirst, sweetness, nausea, fullness and stomach upset ($p>0.05$) at any time point during exercise between the H and P trials (Table 2).

Respiratory exchange ratio (RER) did not differ at any time point between the H and P trials. The changes of RER during exercise in both the H and P trials were not significant ($p>0.05$). RER increased from 0.86 ± 0.03 at the beginning of the test to 1.00 ± 0.03 at 40 min and thereafter declined until end of the test in the H trial. Meanwhile in the P trial, RER increased from 0.91 ± 0.04 at the beginning of the test to 1.00 ± 0.03 at 30 min and maintained at 40 min, and thereafter declined until end of the test.

The mean energy expenditure during exercise were similar, 46.5 ± 1.9 $kJ.min^{-1}$ and 46.3 ± 1.3 $kJ.min^{-1}$ for the H and P trials respectively.

Plasma glucose concentrations at rest in the H and P trials was 5.0 ± 0.2 $mmol.l^{-1}$ and 4.7 ± 0.2 $mmol.l^{-1}$ respectively (NS) (Figure 2). The plasma glucose concentrations increased at 20 min and decreased thereafter to the end of the test in both the H and P trials, but these changes were not significant. No differences were found in plasma at any time point during exercise in both the H and P trials. At the end of the test, glucose concentrations were 4.8± 0.2 $mmol.l^{-1}$ and 4.6 ± 0.1 $mmol.l^{-1}$ for H and P respectively.

Table 2. Fluid sensation scale for thirst, sweetness, nausea, fullness and stomach upset. (Mean ± SEM) of the subjects during the herbal drink (H) and placebo (P) trials.

Drink	Time (min)				
	20	40	60	80	End
Thirst (1=not thirsty; 5=extremely thirsty)					
H	1.9 ± 0.2	2.0 ± 0.3	1.9 ± 0.3	2.2 ± 0.6	2.1 ± 0.4
P	1.9 ± 0.3	2.1 ± 0.3	2.2 ± 0.3	2.6 ± 0.5	2.4 ± 0.4
Sweetness (1=not sweet; 5=extremely sweet)					
H	1.1 ± 0.1	1.0 ± 0.0	1.1 ± 0.1	1.2 ± 0.2	1.1 ± 0.1
P	1.1 ± 0.1	1.1 ± 0.1	1.1 ± 0.1	1.0 ± 0.0	1.1 ± 0.1
Nausea (1=no nausea; 5=extreme nausea)					
H	1.0 ± 0.0	1.2 ± 0.2	1.3 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
P	1.0 ± 0.0	1.1 ± 0.1	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
Fullness (1=not full; 5=extremely full)					
H	1.3 ± 0.2	1.2 ± 0.2	1.3 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
P	1.3 ± 0.2	1.1 ± 0.1	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2
Stomach upset (1=not upset; 5=extremely upset)					
H	1.0 ± 0.0	1.3 ± 0.2	1.3 ± 0.2	1.4 ± 0.4	1.3 ± 0.2
P	1.1 ± 0.1	1.1 ± 0.1	1.1 ± 0.1	1.2 ± 0.2	1.1 ± 0.1

Time point 'End' indicates exhaustion time in both the herbal (H) and placebo (P) trials

Plasma lactate concentrations at rest in H trial was similar to that in the P trial; 2.6± 0.2 mmol.l^{-1} and 2.4± 0.2 mmol.l^{-1} respectively (Figure 3). Plasma lactate concentrations increased significantly ($p<0.05$) during the endurance trial in both the H and P trials. No difference was found in plasma lactate concentration at any time point in the two trials, and the plasma lactate concentration at exhaustion was 5.1± 0.5 mmol.l^{-1} for H and 4.6 ± 0.7 mmol.l^{-1} for P trial.

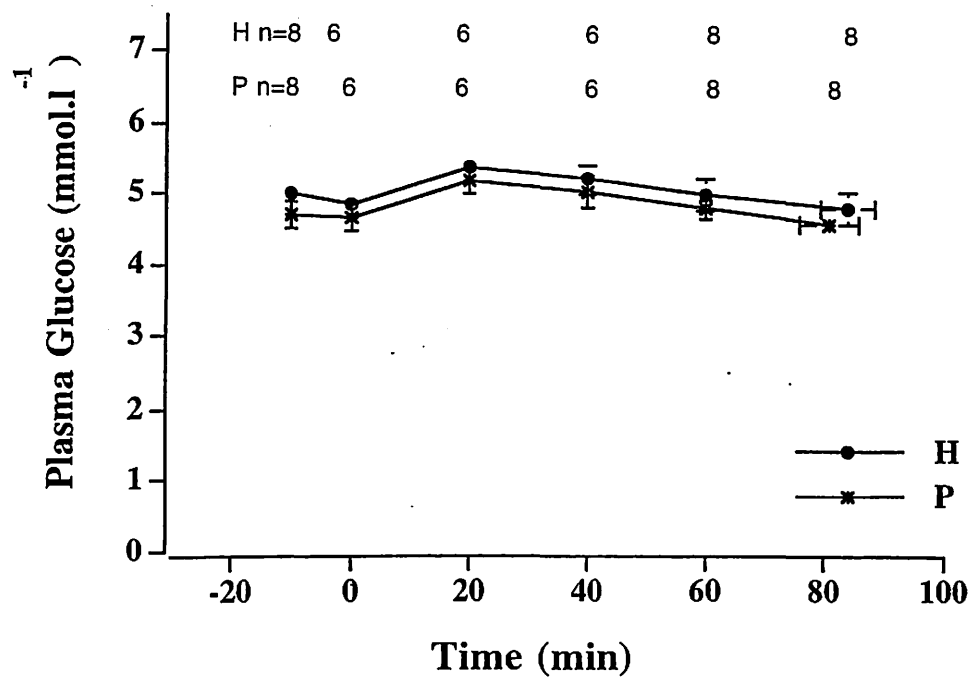

Figure 2: Plasma glucose concentrations ($mmol.l^{-1}$) of the subjects during the herbal drink (H) and placebo (P) trials (Mean ± SEM)

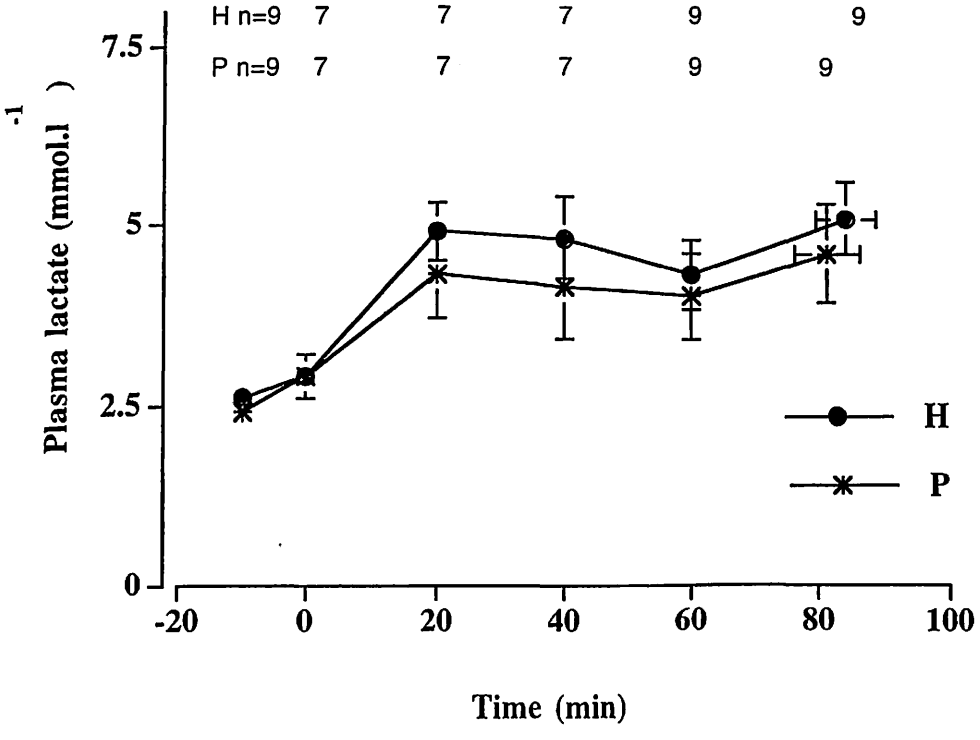

Figure 3: Plasma lactate concentrations ($mmol.l^{-1}$) of the subjects during the herbal drink (H) and placebo (P) trials (Mean ± SEM)

DISCUSSION

The findings of this study showed that both the herbal drink and placebo elicited similar exercise time to exhaustion. One possible reason for the non-significant difference in cycling time could be due to the absence of carbohydrate in the herbal drink. In the present study, the 'herbal drink' did not contain any carbohydrate, thereby making it less suitable as a drink for fluid replacement during prolonged exercise. Numerous studies have shown evidence that 6 - 8 % carbohydrate in sports drinks helps to enhance endurance performance (7, 17-21). The performance-enhancing effect of carbohydrate feeding has been attributed to a sparing of muscle and liver glycogen stores and maintenance of blood glucose levels (21). Since the 'herbal drink' in the present study did not contain any carbohydrate, the contribution of carbohydrate to enhance cycling time could not be seen.

Exercise performance in the heat has been shown to decline when the level of dehydration during exercise reaches as little as two percent of the body weight loss (22). In this study, subjects lost 0.7± 0.2 kg and 0.8± 0.2 kg as a result of exercise with H and P trials respectively. These decrease represented 2.7± 0.4% and 2.9 ± 0.4% change in body weight with the H and P trials respectively, which would have affected their performance. Since H and P drinks produced the same effect on body weight loss hence similar endurance performance.

In addition, excessive sweating during exercise leads to more serious fluid loss and accompanying reduction in plasma volume (23). The loss of just 1 litre of water from the circulating blood volume can partially disable the cardiovascular system and considerably reduce performance (4). Thus the prime aim of fluid replacement is to maintain plasma volume, so that circulation and sweating can progress at optimal levels (23). During bouts of acute exercise, plasma volume changes are caused by increased capillary hydrostatic pressure, rising intramuscular osmotic pressure and dehydration (1). In this study, similar plasma volume changes during exercise were observed in the 'herbal drink' (H) and

placebo (P) trials. The plasma volume declined significantly throughout the H and P trials ($p < 0.01$), where at exhaustion, the changes in plasma volume was similar; -7.6±1.2% and -8.3± 1.2% respectively. Similar changes in plasma volume were also observed in other studies (16, 24, 25). In the present study, the plasma shifts were approximately -7.95% between rest and time of exhaustion (Figure 1), with almost half of this shift occurring within the first 20 minutes of exercise. This implies that the fluid shift between compartment in the body were similar in both the H and P trials.

The absence of differences in core temperature and skin temperatures between the H and P trials indicated that the herbal drink (H) did not give any different effect on thermoregulation compared to placebo (P). The increase in core temperature and a decrease in skin temperature during exercise are in agreement with other studies (17, 22, 26). The thermal gradient between the skin and the core facilitate heat loss, in addition to the sweat evaporation being the principal active heat loss mechanism (27).

As oxygen uptake and heart rate are indicators of exercise intensity (23), the present findings showed that the exercise intensity were similar between the 'herbal drink' (H) and placebo (P) trials, averaging 41.5 ± 0.7 $ml.kg^{-1}.min^{-1}$ and 41.2 ± 0.7 $ml.kg^{-1}.min^{-1}$ respectively, which was equivalent to an intensity of approximately 70% of VO_{2max}. As heart rate, an indicator of exercise intensity, was similar between the H and P trials (mean: 156 ± 2 $b.min^{-1}$ and mean:155 ± 2 $b.min^{-1}$ in H and P respectively), it showed that exercise intensity was similar in both the trials. This was also seen in the perceived rate of exertion.

It is known that gastrointestinal discomfort may affect the mental drive for motor performance (28). In our study, subjects tolerated both the herbal and placebo drinks with no significant difference between trials for the sensation of thirst, sweetness, nausea, fullness and stomach upset at any time point during exercise.

At the exercise intensity chosen, the RER values in this study revealed little evidence of a shift from carbohydrate metabolism to FFA oxidation with both the H and P

ingestions. The mean energy expenditure were also similar, 46.5 ± 1.9 $kJ.min^{-1}$ and 46.3 ± 1.3 $kJ.min^{-1}$ in the H and P trials respectively.

The similarity in blood glucose concentrations and blood lactate concentrations during exercise with both type of drinks indicated that muscle metabolism were similar and that the subjects were exercising at the same intensity during the endurance trial.

The results of the present study showed that changes in body weight, oxygen uptake, plasma volume, core temperature, skin temperature, heart rate, perceived rate of exertion, respiratory exchange ratio, energy expenditure, plasma glucose concentrations and plasma lactate concentrations were similar with both 'AgroMas®' herbal drink and placebo treatment. These indicated that the 'AgroMas®' herbal drink and placebo treatment elicited similar exercise performance, thermoregularity responses and physiological responses during endurance cycling. Thus, it can be concluded that the herbal drink did not enhance cycling endurance performance. As it has been suggested that plain water be consumed as fluid replacement for physical activity lasting less than one hour (29), and since the herbal drink provided similar responses to water (placebo) ingestion, that the herbal drink can therefore be used as an alternative choice for fluid replacement for activities shorter than 60 minutes.

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