

ORIGINAL ARTICLE

EFFECTS OF A HERBAL DRINK ON CYCLING ENDURANCE PERFORMANCE

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In this study, we examined the effects of acute ingestion of a herbal drink (H) or a coloured water placebo (P) on physiological responses and performance during cycling exercise. Eight healthy and trained male young cyclists (age: 16.0 ± 0.5 years) exercised on a cycle ergometer at $72.0 \pm 0.8\%$ of the maximal oxygen consumption (VO_{2max}) until exhaustion in a room maintained at 23.9 ± 0.2 °C and $64.2 \pm 1.6\%$ relative humidity on two occasions, 1-week apart. During each exercise bout, subjects received $3\text{ml}\cdot\text{kg}^{-1}$ body weight of H or P every 20 minutes in a double-blind randomised study design. There was no significant difference between H and P trials in the total work time to exhaustion (84.5 ± 5.1 and 82.3 ± 5.6 min respectively). Changes in heart rate, oxygen consumption, plasma glucose concentrations, plasma lactate concentrations, rectal temperature, respiratory exchange ratio and energy expenditure were similar with both type of drinks. Loss of plasma volume was also similar with both drinks. Herbal drink elicited similar physiological responses, thermoregulatory responses and exercise performances during endurance cycling when compared to the placebo ingestion. Thus, it can be concluded that the ingredient in the herbal drink did not provide any added advantage to cycling endurance performance.

Key words : Herbal drink, physiological responses, thermoregulatory responses, cycling performance, cyclist

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Introduction

During physical activity, heat is generated as a by-product of muscle activity and energy metabolism (1). This heat is dissipated through sweating, 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 heavy exercise in the heat may be as high as 2 to 3 L·h⁻¹ (3). Dehydration can partially disable the cardiovascular system and considerably reduce the performance (4-6). Thus, it is essential to replace the lost fluid and to maintain hydration for optimal performance (7).

Numerous studies regarding fluid intake during exercise have used carbohydrate-electrolyte solution as fluid replacement during exercise (8-13).

However, other drinks such as fruit drinks, 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 drink and in Malaysia, one such drink is the herbal drink, 'AgroMas[®]'. The studies on the effect of herbal drink as fluid replacement or as exercise enhancement drink has not been evaluated, it is therefore proposed that the effect of 'AgroMas[®]' herbal drink be investigated to evaluate the physiological effects of this drink on the cycling endurance performance.

Methodology

Subjects.

Eight well-trained male young cyclists

Table 1. Physical and physiological characteristics of the subjects (mean \pm SEM)

Parameter	(Mean \pm SEM)
Age (years)	16.0 \pm 0.5
Height (cm)	164.9 \pm 2.4
Weight (kg)	56.9 \pm 1.7
VO _{2max} (ml/kg ¹ min ⁻¹)	56.1 \pm 2.3

VO_{2max}, maximum oxygen uptake

participated in this study after giving their written, informed consent. Anthropometric and physiological characteristics of the subjects are shown in Table 1. 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}) (14) using an electromagnetically-braked cycle ergometer (Excalibur Sport, Lode, Gronigen, The Nederland). Based on the measured VO_{2max} and VO₂ values from steady-state exercise, exercise intensity for warm-up and experimental trial was established which elicited a VO₂ 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, 1 week apart. 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 \pm 0.2 °C and 64.2 \pm 1.6% relative humidity). A fan was directed 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 at every 20 minutes during the cycling performance. The composition of the herbal drink and the placebo used in this study are listed in Table 2. The coloured-water placebo used in the present study had similar taste as the herbal drink. The order of the two trials was randomised and a double blind cross-over design was used.

To produce a uniform homogenous physiological state among subjects, a 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

Table 2: Test drink composition per 100 ml

	Herbal Drink	Placebo
<i>Eurycoma Longifolia/ Tongkat Ali</i> (mg)	0.1	—
<i>Cinnamomum Cassia</i> (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

using nitrogen based calibration gases.

On each trial, the cyclists reported to the laboratory after fasted for 10 -12 hour. 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 $\pm 20g$). 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, $Tsk=0.3(Tch+Tbic)+ 0.2(Tth+Tcalf)$ (15). 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).

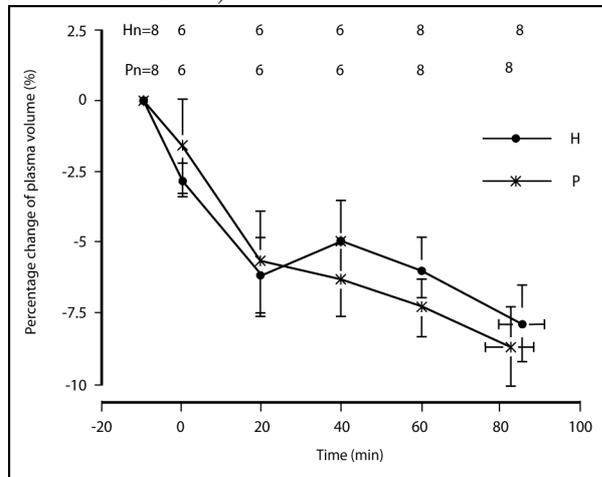
After sitting on the cycle ergometer for five minutes, a resting blood sample was collected and expired gas was measured. The subject was then asked to warm-up for five minutes by cycling at 50% VO_{2max} . Expired air was collected during the final minute of the warm-up. Immediately after the completion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

Table 3. Fluid sensation scale for thirst, sweetness, nausea, fullness and stomach upset (mean \pm 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	1.8 \pm 0.2	1.9 \pm 0.4	1.8 \pm 0.3	2.2 \pm 0.6	2.1 \pm 0.4
P	1.8 \pm 0.3	1.9 \pm 0.2	2.0 \pm 0.3	2.6 \pm 0.5	2.4 \pm 0.4
Sweetness (1=not sweet; 5=extremely sweet)					
H	1.1 \pm 0.1	1.0 \pm 0.0	1.1 \pm 0.1	1.2 \pm 0.2	1.1 \pm 0.1
P	1.1 \pm 0.1	1.1 \pm 0.1	1.1 \pm 0.1	1.0 \pm 0.0	1.1 \pm 0.1
Nausea (1=not nausea; 5=extremely nausea)					
H	1.0 \pm 0.0	1.3 \pm 0.2	1.3 \pm 0.3	1.2 \pm 0.2	1.2 \pm 0.2
P	1.0 \pm 0.0	1.1 \pm 0.1	1.2 \pm 0.2	1.2 \pm 0.2	1.2 \pm 0.2
Fullness (1=not full; 5=extremely full)					
H	1.4 \pm 0.2	1.3 \pm 0.2	1.4 \pm 0.2	1.2 \pm 0.2	1.2 \pm 0.2
P	1.4 \pm 0.3	1.1 \pm 0.1	1.3 \pm 0.2	1.2 \pm 0.2	1.2 \pm 0.2
Stomach upset (1=no upset; 5=extremely upset)					
H	1.0 \pm 0.0	1.4 \pm 0.2	1.4 \pm 0.3	1.4 \pm 0.4	1.3 \pm 0.2
P	1.1 \pm 0.1	1.1 \pm 0.1	1.1 \pm 0.1	1.2 \pm 0.2	1.1 \pm 0.1
Time point 'End' indicates at time of exhaustion in both the herbal (H) and placebo (P) trials					

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

Figure 1: Percentage change in plasma volume of the subjects during the herbal drink (H) and placebo (P) trials (mean \pm SEM)



and respiratory exchange ratio (RER) were measured at 10 minutes 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) were obtained every 20 minutes using the traditional Borg's Scale (16, 17). Fluid sensation such as thirst, sweetness, nausea, fullness and stomach upset were determined using a fluid sensation scale (18) 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) also in duplicate. The percent change in plasma volume was calculated as described by Beaumont *et.al.* (19). The other two ml of plasma was transferred into a tube anticoagulated with sodium fluoride (NaF). The plasma in the tube was separated by centrifugation (10 minutes, 4°C). Subsequently the plasma was divided into equal

portions, and stored at -20°C 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 \pm SEM.

Results

Cycling performance and fluid balance.

In both the herbal (H) drink and placebo (P) trials, time taken for exhaustion to occur were similar, and they were 84.5 ± 5.1 min and 82.3 ± 5.6 min respectively ($p > 0.05$). The total volume of fluid consumed during exercise was also similar in both drinks, 751.0 ± 49.6 ml and 727.6 ± 42.7 ml in the H and P trials respectively. As a result of exercise, subjects' body weight decreased 0.7 ± 0.2 kg ($2.6 \pm 0.5\%$) and 0.8 ± 0.2 kg ($2.8 \pm 0.5\%$) in the H and P trials respectively, and these values were corrected for the fluid ingested during cycling. The decrease in body weight as expressed both in kg and percentage change of body weight with P did not differ statistically from H.

Figure 2: Plasma glucose concentrations (mmol.l^{-1}) at each time point in the subjects during the herbal drink (H) and placebo (P) trials (mean \pm SEM)

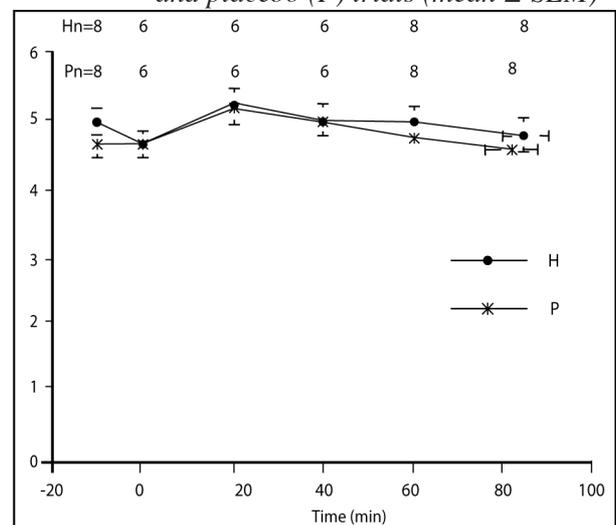
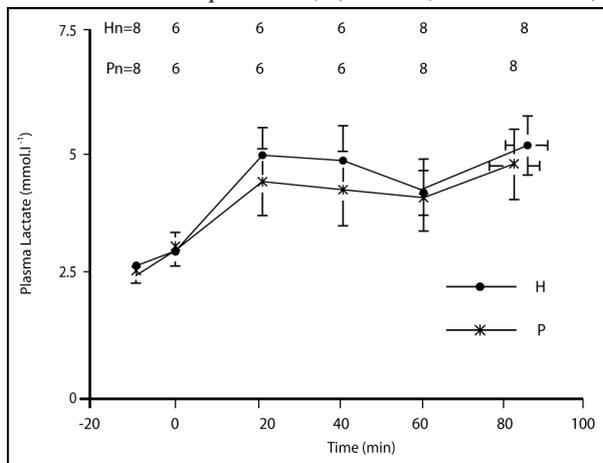


Figure 3: Plasma lactate concentrations (mmol.l⁻¹) at each time point in the subjects during the herbal drink (H) and placebo (P) trials (mean ± SEM)



Similar hemoglobin concentrations and hematocrit were noted at each time point during the H trial when compared with P trial. 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 trials. However, no significant differences were found between the H and P trials at each time point, and the percentage change of plasma volume at exhaustion time for both the H and P were $-7.6 \pm 1.3\%$ and $-8.6 \pm 1.4\%$ respectively (Figure 1).

Body temperature.

Core temperature increased significantly during exercise in both the H and P trials ($p < 0.001$). Subjects’ core temperature increased from $36.9 \pm 0.1^\circ\text{C}$ to $38.2 \pm 0.2^\circ\text{C}$ at exhaustion in the H trials, and increased from $36.9 \pm 0.0^\circ\text{C}$ to $38.3 \pm 0.2^\circ\text{C}$ at exhaustion in the P trials. There was no significant difference in core temperature between the trials ($p > 0.05$). On the other hand, 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 $31.6 \pm 0.2^\circ\text{C}$ to $29.3 \pm 0.7^\circ\text{C}$. Whereas in the H trial, it decreased from $31.9 \pm 0.2^\circ\text{C}$ to $31.1 \pm 0.2^\circ\text{C}$.

Oxygen uptake, heart rate, perceived rate of exertion and fluid sensation scale.

Oxygen uptake (VO_2) during the endurance trial was similar between the H and P trials, averaging $41.2 \pm 0.8 \text{ ml.kg}^{-1}.\text{min}^{-1}$ and $40.8 \pm 0.8 \text{ ml.kg}^{-1}.\text{min}^{-1}$ respectively. No significant difference in $\% \text{VO}_{2\text{max}}$ between the H and P trials ($p > 0.05$) was observed during exercise, where the mean $\% \text{VO}_{2\text{max}}$

sustained during the H and P trials were $72.5 \pm 1.5\%$ and $71.5 \pm 0.5\%$ respectively. There was also no significant difference in the heart rate responses between the H and P trials (mean: H: $157 \pm 2 \text{ b. min}^{-1}$ vs P: $156 \pm 2 \text{ b. min}^{-1}$). The perceived rate of exertion (PRE) were also similar in both the H and P trials. During each trial, PRE rose from ~ 12 to ~ 19 Borg units. Similarly, there were also no significant differences for thirst, sweetness, nausea, fullness and stomach upset ($p > 0.05$) at each time point during exercise in the H and the P trials (Table 3).

Respiratory exchange ratio and energy expenditure.

In both the H and P trials, respiratory exchange ratio (RER) did not differ at each time point. RER increased from 0.86 ± 0.03 at the beginning of the test to 1.00 ± 0.04 at 40 min and thereafter declined until end of the test in the H trial. In the P trial, RER increased from 0.92 ± 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, $46.8 \pm 2.1 \text{ kJ.min}^{-1}$ and $46.1 \pm 1.5 \text{ kJ.min}^{-1}$ for the H and P trials respectively.

Plasma glucose and lactate concentrations.

Plasma glucose concentrations at rest in the H and P trials were $5.0 \pm 0.2 \text{ mmol.l}^{-1}$ and $4.7 \pm 0.2 \text{ mmol.l}^{-1}$ respectively (NS) (Figure 2). The plasma glucose concentrations increased at 20 min and decreased thereafter to the end of the test, and no statistical difference was noted in plasma glucose at each time point during exercise in both the H and P trials. At the end of the test, glucose concentrations were $4.8 \pm 0.2 \text{ mmol.l}^{-1}$ for H and $4.6 \pm 0.1 \text{ mmol.l}^{-1}$ for P respectively.

Plasma lactate concentrations at rest in H trial were similar to that in the P trial ; $2.7 \pm 0.2 \text{ mmol.l}^{-1}$ and $2.5 \pm 0.2 \text{ mmol.l}^{-1}$ respectively (Figure 3). Plasma lactate concentrations increased significantly ($p < 0.05$) during the endurance trial in the H trial, however the increase in the P trial was insignificant. No difference was found in plasma lactate concentration at each time point in both the trials, and the plasma lactate concentrations at the end of the test were $5.2 \pm 0.6 \text{ mmol.l}^{-1}$ for H and $4.8 \pm 0.7 \text{ mmol.l}^{-1}$ for P trial.

Discussion

The findings of this study showed that the

time taken for exhaustion to occur was similar in both the herbal drink and placebo. 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 calorie or energy replacement during prolonged exercise. Numerous studies have shown evidence that 6 - 8% of carbohydrate in sports drinks help to enhance endurance performance (9, 20-24). The performance-enhancing effect of carbohydrate feeding has been attributed to a sparing of muscle and liver glycogen stores and maintenance of blood glucose level (24). Since the herbal drink 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 (25). In this study, subjects lost $2.6 \pm 0.5\%$ and $2.8 \pm 0.5\%$ body weight as a result of exercise with H and P trials respectively, which would have affected their performance. These values indicated that both H and P drinks produced the same effect on body weight loss and hence similar performance effects.

In addition, excessive sweating during exercise leads to more serious fluid loss and reduction in plasma volume (26). The loss of just 1 litre of water from the circulating blood volume can partially disable the cardiovascular system and considerably reduce performance (5). Thus the prime aim of fluid replacement is to maintain plasma volume, so that circulation and sweating can progress at optimal levels (26). In this study, similar plasma volume changes during exercise were observed with the herbal drink and placebo trials. The plasma volume declined significantly throughout the H and P trials ($p < 0.01$), where at exhaustion, the change in plasma volume was similar, $-7.6 \pm 1.3\%$ and $-8.6 \pm 1.4\%$ respectively. Similar changes in plasma volume were also observed in other studies (18, 27, 28). In the present study, the plasma shifts were approximately -8.1% 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 ingredients have no effect on thermoregulation. The increase in core temperature and a decrease in skin temperature during exercise are in agreement with other studies (19, 25, 29). The thermal gradient between the skin and the core facilitate heat loss, as evaporation is the principal heat loss mechanism (30).

As oxygen uptake and heart rate are indicators of exercise intensity (26), the present findings showed that the exercise intensity were similar in the H and P trials, averaging $41.2 \pm 0.8 \text{ ml.kg}^{-1} \cdot \text{min}^{-1}$ and $40.8 \pm 0.8 \text{ ml.kg}^{-1} \cdot \text{min}^{-1}$ respectively, which was equivalent to an intensity of approximately 72% of $\text{VO}_{2\text{max}}$. As heart rates were similar between the H and P trials (mean: $157 \pm 2 \text{ b.min}^{-1}$ and mean: $156 \pm 2 \text{ b.min}^{-1}$ in H and P respectively), it again showed that exercise intensity was similar in both the trials. This was also supported by the perceived rate of exertion in both trials.

As gastrointestinal discomfort is known to affect the mental drive for motor performance (31), this study showed that herbal drink did not cause any discomfort during the cycling endurance trial. The 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 throughout the exercise (Table 3).

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 with similar energy expenditure in the H and P trials ($46.8 \pm 2.1 \text{ kJ.min}^{-1}$ and $46.1 \pm 1.5 \text{ kJ.min}^{-1}$) respectively.

The similarities in blood glucose and blood lactate concentrations during exercise with both type of drinks indicated that muscle metabolism were similar and that the subjects exercised 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, 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. This indicated that the herbal drink and placebo elicited similar exercise performance, thermoregulatory responses and physiological responses during endurance cycling. Thus, it can be concluded that the ingredient in the herbal drink did not provide any added advantage to cycling endurance performance.

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