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FULL LENGTH ARTICLE

The Comparison between Different types of Cold Fluid Ingestion towards Endurance Exercise in Hot and Humid Condition

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Abstract: The rise in body core temperature associated with continuous exercise in hot and humid environments is known to possess a particularly stressful challenge to the maintenance of normal body temperature and fluid homeostasis. Recent evidence has shown that internal cooling methods, such as drinking cold fluids, are able to lower core temperature and enhance endurance performance in the heat. Pre-cooling (before exercise) and per-cooling (during exercise) methods were use, as ingesting cold fluids is easily implemented on site and provides additional benefit of hydration for athletes. Therefore, this study examines the effectiveness of pre-cooling and per-cooling methods on endurance exercise towards heart rate, rectal temperature, sweat rate, and power output of athletes ingesting different types of cold fluids. 3 female high-performance cyclists were asked to complete a 30km time trial on a cycle ergometer. The familiarisation and experimental sessions were identical, however application of fluid ingestion at 4-5°C before and during exercise differs (plain water = PW, Guava juice = GJ, isotonic drink = ID). Fluid is ingested every 15 minutes during the exercise sessions. As different athletes possess different work intensities, results showed that there is no s ignificant difference on the effects of different types of cold fluid ingestion towards thermoregulation of the body as each fluid succeeded in enhancing athletes' performance. Therefore, it is suggested that the consumption of any types of fluid at cold temperature could help in body thermoregulation as well as enhancing continuous exercise performance.

Key words: Cold fluid ingestion, Thermoregulation, Endurance exercise

1. Introduction

Under adverse climate conditions, including high temperature and humidity, heat gained from the combination of physical exertion and the hot environment can exceed the body's capacity to remove heat through perspiration. During prolonged exercise in the heat, body fluids lost as sweat must be replaced as frequently as possible to avoid dehydration and subsequent thermal injury. According to a professor of Exercise Science, Physiology and Biophysics at the University of Iowa, there is little chance that under hot, humid weather conditions, thermal

injury will occur in competitive events lasting up to 10 minutes (the vastmajority of track events). But body temperature could rise to dangerous levels (e.g., 106 degrees Fahrenheit) under these conditions during exercise lasting 12 - 16 minutes or longer, especially if the competition is preceded by a vigorous warm-up that elevates the body temperature. In addition, he said liquids ingested during exercise should contain 5-8% carbohydrate and a small amount of electrolytes. Such beverages will provide a source of fuel for the working muscles, encourage drinking by enhancing taste, promote fluid retention, and will facilitate the absorption of water and glucose from the intestines. During heavy work or prolonged exercise, at least eight ounces (1 cup) of fluid should be consumed every 15-to-20 minutes [1].

This research tries to determine the difference between three different types of fluid (plain water = PW, Guava juice = GJ, isotonic drink = ID) to be ingested to enhance the performance of athletes in maintaining high-performance. Performance enhancement refers to the ability to maintain the body's core temperature, sweat rate and heart rate during prolonged exercise in hot and humid climate.

In sports, to emerge as the champion is always competitive. In world class competitions such as the Olympic Games or Commonwealth Games, a difference of 0.001 seconds in sprint events differentiates the champion and the runner up. Therefore, the aim of this research is to find a solution for athletes to maintain their exercise intensity enabling them to sustain prolonged exercise through precooling and per cooling method using fluid ingestion.

Literature Review

A research by Lee, Shirreffs and Maughan (2008) found that ingestion of fluid before and during exercise as a method to increase the body's thermoregulation abilities is influenced by the temperature of the liquid. This conclusion was achieved through the observation that during longer exercise session, lower heart rate and lesser sweat rate were obtained with the ingestion of cold drink compared to warm drink [2].

A research done by Wegmann, Faude, Poppendieck, Hecksteden, Fröhlich and Meyer (2012), suggested that pre-cooling can effectively enhance endurance performance, particularly in hot environments, however sprint activities is barely affected using this technique. This study analyses performance effects with regard to several test circumstances such as environmental temperature, test protocol, cooling method and aerobic capacity of the subjects. These studies found that pre-cooling had a larger effect on performance in hot than in moderate temperatures [4]. Performance enhancements were observed for intermittent sprints, whereby performance changes were smaller during short-term, high-intensity sprints. The most promising cooling methods are cold drinks, cooling packs and cooled room, whereas a cooling vest and water application showed only small effects.

Pre-cooling has become a popular strategy to improve performance over a variety of exercise modes and durations as evidence has shown it to be an effective method for lowering pre-exercise core temperature, increasing heat storage capacity and improving exercise performance in the heat. Therefore,) conducted a research to determine the effectiveness of ice slurry ingestion as a pre-cooling manoeuvre for improving submaximal exercise performance in the heat, as well as investigate the potential mechanisms behind the improvements observed [5]. The main findings from this research were that ice slurry ingestion was an effective and practical pre-

cooling method for prolonging submaximal running time in the heat and is able to prolong running time in the heat by increasing the rectal temperature tolerable before exercise termination. Finally, ice slurry ingestion may enhance exercise performance in conditions of heat strain via thermoreceptive sensory mechanisms. Due to its' practicality for use on the field, ice slurry ingestion may be a more preferred form of pre-cooling than traditionally used strategies.

Cramping after a heavily charged session of exercise is a direct result of loss of electrolyte such as potassium, sodium and chloride, through sweating. Deepak (2013) suggested that the high content of potassium in guava can restores the lost potassium reserve of the body, thereby maintaining a balance of this mineral in the electrolyte [6]. Due to high content of potassium and vitamin C in guava, the regulation of blood pressure can be optimised and the blood flow through the body can be normalised, as potassium helps in maintaining the rhythm of body muscles contractions, including the heart, and vitamin C in guava helps in growth and repair of body tissue and cartilage resulting in healthy blood vessels.

Better Health Channel (2012) in its article suggests that an intake of carbohydrate is needed during exercise lasting more than 60 minutes in order to top up blood glucose levels and delay fatigue [7]. Therefore, sports drinks, diluted fruit juice and water are suitable choices of drinks as during digestion processes, carbohydrates are broken down into glucose which later will be used as a key energy source to fuel exercising muscle tissue.

Methodology

A total of 3 subjects were chosen from high performance, very active female cyclists, whom participated in competitive and recreational sports and endurance exercises. These athletes have no previous history of heat illness and were without injuries and are readily heat-acclimated.

On their first visit to the laboratory, subjects' body density was measured and body fat per-centages were estimated using Siri's equation. Prior to the actual test, a cycling economy test on a cycle ergometer and familiarisation with the equipment used were conducted at room temperature (24.6 ± 1.9°C, 44.4 ± 8.2% RH) for the determination of maximal oxygen uptake (VO^2 max).

Throughout the study, subjects were asked to maintain their normal lifestyle activities, including physical activity and nutritional habits. In the 12hr period prior to the trials, subjects were asked to avoid strenuous exercise, as well as the consumption of alcohol, caffeine, non-steroidal anti-inflammatory drugs or nutritional supplements. Before beginning the experiment, the readily-acclimatised subjects were required to attend a familiarisation trial involving cycling for 30km time trial on cycle ergometer in the same hot and humid environment (33.7 ± 0.3°C, 69.7 ± 4.3 % RH) as the experiment session, and ingesting 200 ml of cold plain water at 4°C-5°C every 15min time interval. The temperature of 4°C were chosen for the control drink as this is the typical temperature of drinks found in conventional refrigeration units. For each trial, the subjects wore the same exercise clothing. The same protocol was used during experiment but each subjects was given different types of cold fluid (A = plain water, B = isotonic drink, C = Guava juice).

Time of completion, heart rate, rectal temperature, sweat rate, power output and intensity were observed, recorded, calculated and analysed.

Results and Discussion

Time of completion

Figure above shows athlete that drinks plain water has the shortest time of Completion, with the time of 44 minutes, followed by the athlete that drinks guava juice, which cycles in 56 minutes and lastly, the athlete that drinks isotonic drink, with the time travel of 58 minutes. The athlete that drinks isotonic drink has a longer time travel for the 5km start, which is 10 minutes than the athlete that drinks plain water and guava juice, with the difference of 5 minutes.

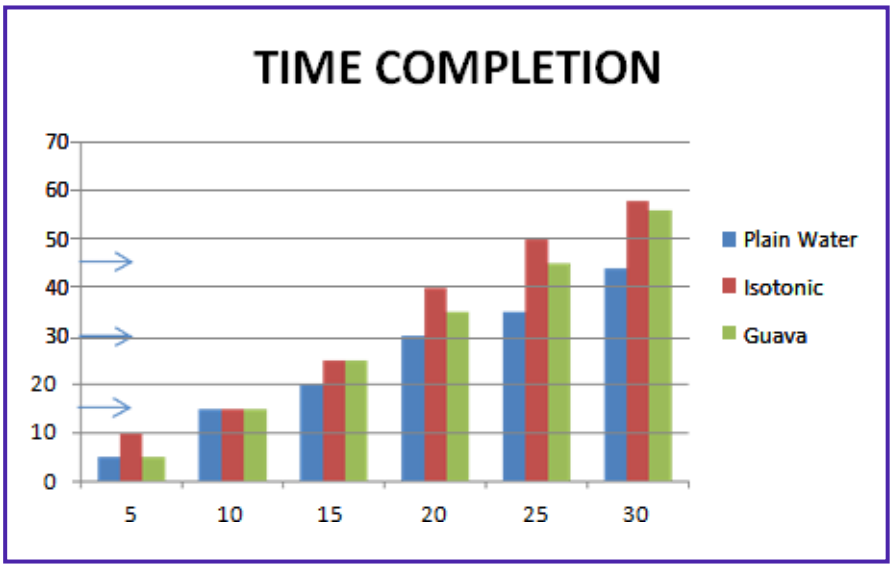

Figure 1. Time of exercise completion (min) against time trial distance (km). The arrow (⟶) denotes the time of cold water ingestion.

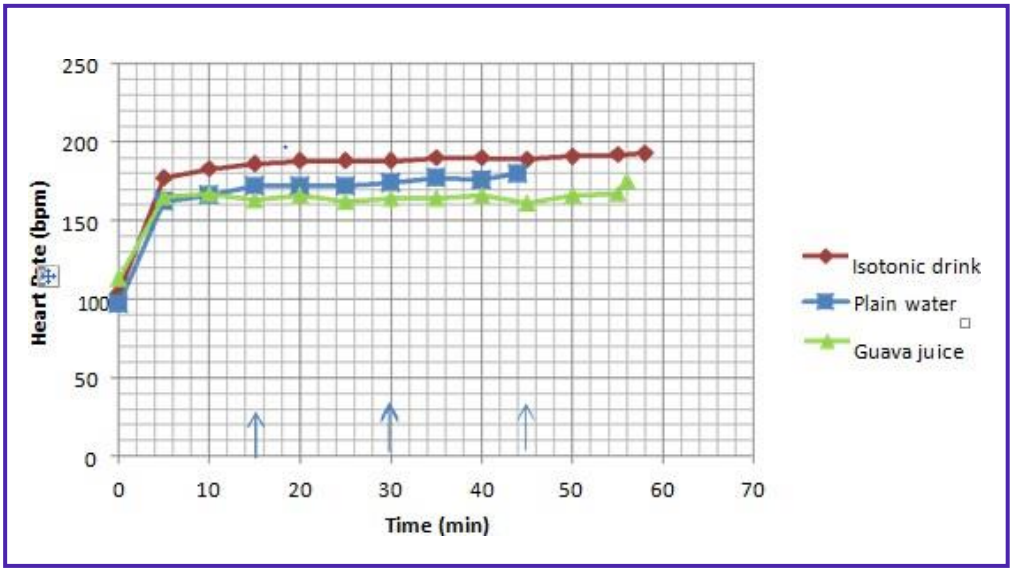

Figure 2. Heart rate (bpm) during 30km time trial. The arrow (↑) denotes the time of cold fluid ingestion.

Athlete that drinks isotonic has the least time taken for finishing the last 5km, which is 8 minutes, followed by the athlete that drinks plain water with the time of 10 minutes, and lastly, the athlete that drinks guava juice, with the time of 11 minutes.

Heart rate

Figure shows the heart rate response for every 5 min over the different types of cold fluid ingestion at every 15 min. During exercise, there is no significant difference between heart rate prior to drink ingestion since heart rate increased continuously and remain similar between every time interval. The first 5 min of the exercise shows that heart rate increases after the precooling session (drinking cold water 15 min before exercise).

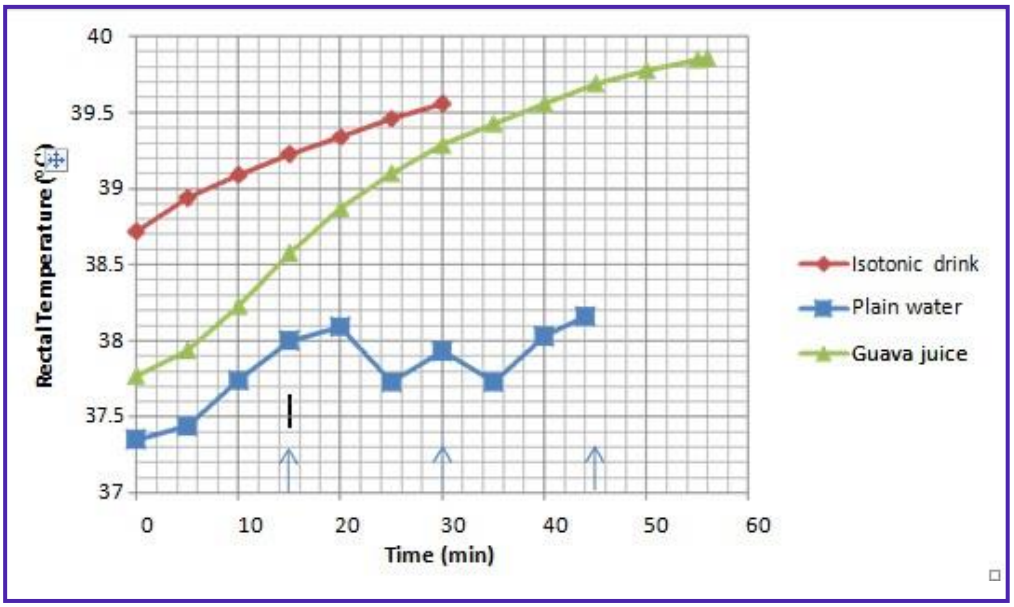

Figure 3. Tre (°C) during 30km time trial. The arrow (↑) denotes the time of cold fluid ingestion.

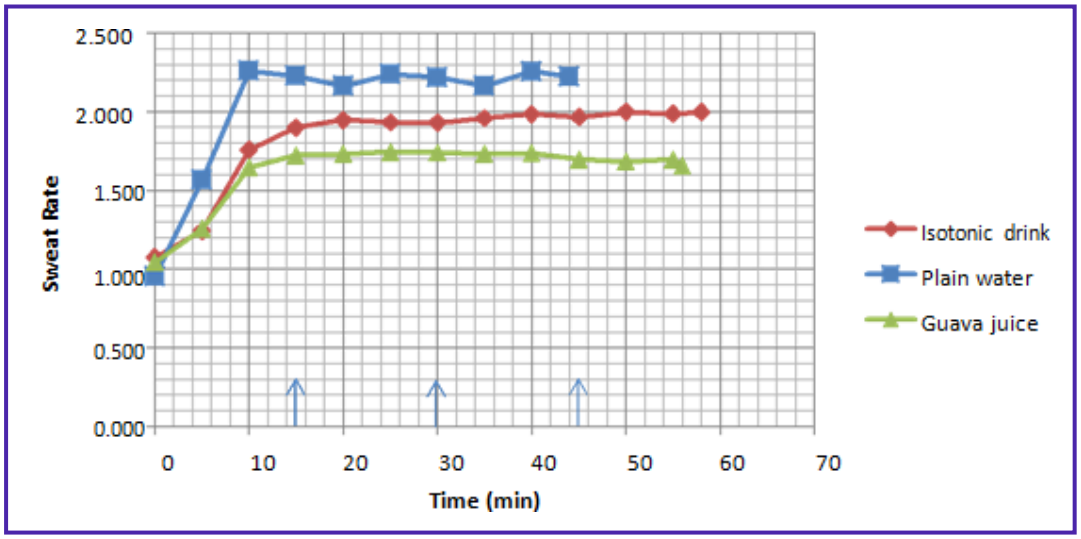

Figure 4. Sweat rate across 30km time trial. The arrow (↑) denotes the time of cold fluid ingestion.

During the second drinking period at the 15th min, heart rate slightly increases then remain constant after ingesting isotonic drink, remain constant after ingesting plain water until 25th min during exercise and increases then decreases after ingesting guava juice. Reaching the third and fourth drinking period at the 30th min and 45th min respectively, heart rate slightly increases until the end of the 30km time trial after ingesting isotonic drink and plain water, slightly increase then decrease 5 min before the fourth drinking period and increase until the end of the trial.

Rectal temperature and sweat rate

Figures show the relationship between rectal temperatures and sweat rate across 30km time trial. Rectal temperature for the isotonic drink trial was not significantly different to the guava juice trial, where temperature increased continuously throughout both trials. Although core temperature increased after every ingestion of isotonic drink and guava juice trials, their Sweat rates indicated a continuous rise, showing that there is a fluid balance process throughout the athletes' bodies. For the plain water trial, rectal temperature showed a drop on 10th min and 35th min of the exercises that matched with the sweat rates readings which demonstrated a slight drop after 5 min of second and third ingestion.

Intensity

Figure shows the percent of intensity of each athlete consuming different types of cold water for precooling and percooling every 15 minutes recorded every 5 km distance. During the cycling session, there were no significant differences between the types of cold water ingested towards the intensity of the athletes. There are slight decrease in the intensity for the first 15 km and small improvement in the 20th km. From the 25th km, the athletes are able to increase their intensity up to 120% to reach the 30th km. Based on the graph, we can conclude that there is no difference between types of cold fluid ingested towards athletes' intensity.

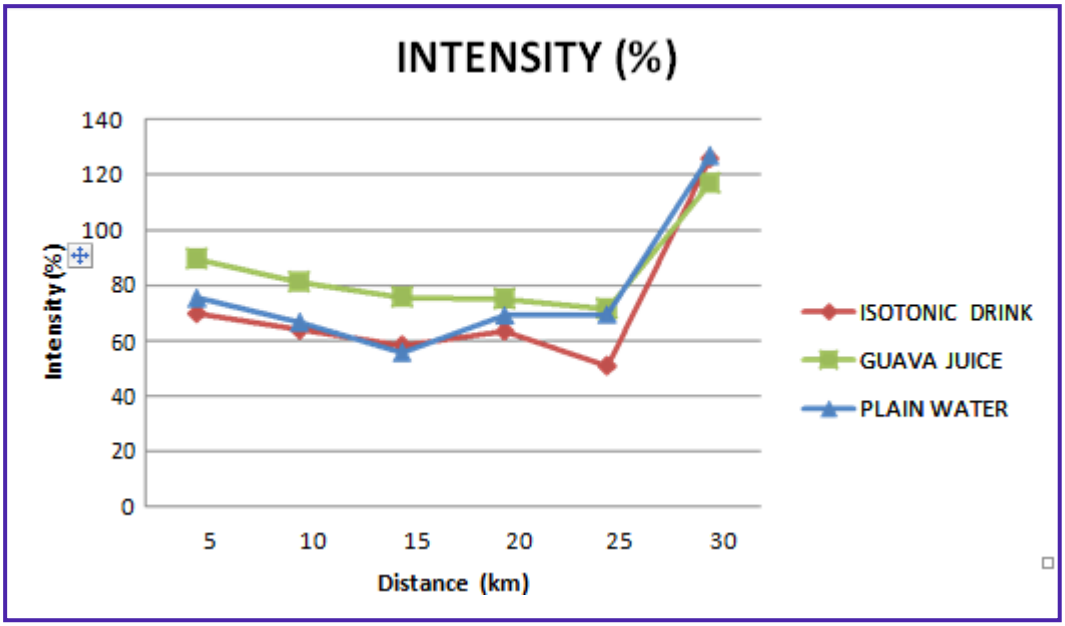

Figure5. Intensity (%) across 30km time trial.

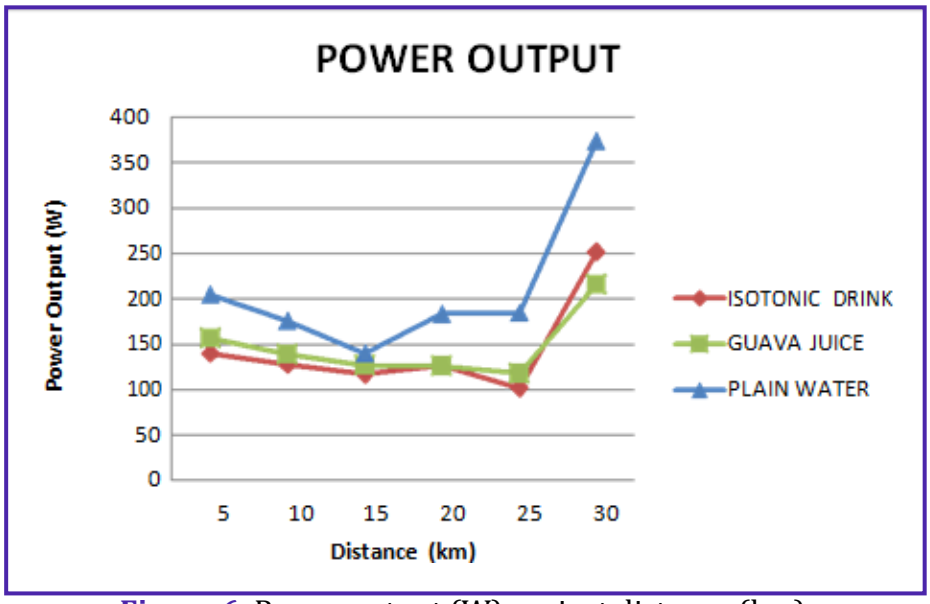

Figure 6. Power output (W) against distance (km)

We can conclude that cold fluid ingestion helps in maintaining the intensity of athletes along the exercise and helps in pacing up their intensity to accelerate in completing the 30km cycling.

Power Output

Figure illustrates the data recorded over different types of cold fluid ingestion towards the power output of the athletes. It shows some difference between the types of cold water. But, by referring to the data tabulated above, there is not much difference between the intensity even when the power output differs slightly. These are because the ability of someone in doing something that involved workload is different. So, we cannot compare the data of power output of the athletes directly. So, actually we can analyse these data according to the pattern of the graph. Based on the graph above, we can conclude that by ingesting cold water, athletes are able to maintain their power output and boost their energy to sprint up through the last 5 km.

Conclusion

After analysing the results obtained in this research, there is no effect of different types of cold fluid ingestion towards thermoregulation of the body. We found out that the three different types of cold fluid ingested helps in maintaining the heart rate and sweat rate of the athletes as well as enhancing their performances. Hence, they are able to maintain body temperature and complete their tasks in such hot and humid condition. This is due to few factors where each individual has different needs of water intake during exercise based on weight, sweat rate, and how hard they are working (work intensity). Apart from that, other factors also affect the speed at which fluid from a drink gets into the body such as the speed at which it is emptied from the stomach and the rate at which it is absorbed through the walls of the small intestine [8]. As different type of cold fluid is used in the experiment, therefore each drink has different nutrition content and fluid concentration. However, it can be concluded that pre-cooling (drinking before exercise) and per-cooling (drinking during exercise) methods are very effective in keeping the thermoregulation of the body thus, helping athletes perform better during an endurance event in hot and humid condition.

References

[1] C.V. Gisolfi, Preparing Your Athletes for Competition in Hot Weather, *Sports Engine Community*, (2014).

[2] J. K. Lee, S. M. Shirreffs, R. J. Maughan, (2008) Cold Drink Ingestion Improves Exercise Endurance Capacity in the Heat, *Medicine & Science in Sports & Exercise,* 40 (2008)1637-1644.

[3] Coen C. W. G. Bongers, Dick H. J. Thijssen, Matthijs T. W. Veltmeijer, Maria T. E. Hopman, Thijs M. H. Eijsvogels, Precooling and percooling (cooling during exercise) both improve performance in the heat: a meta-analytical review, *British Journal of Sports Medicine,* 49 (2015) 377-384.

[4] M. Wegmann, O. Faude, W. Poppendieck, A. Hecksteden, M. Fröhlich, T. Meyer, Pre-cooling and sports performance: a meta-analytical review, *Sports Medicine*, 42 (2012) 545-564.

[5] Rodney Siegel, 2011. Thermoregulatory and exercise performance: responses to cooling with ice slurry ingestion, *Edith Cowan University Research Online*, (2011)1-184

[6] Deepak Kevat, Guava Fruit 8 Health Benefits and Nutrition Facts You Will Love It, *Fitness World*, (2013).

[7] Better Health Channel. 2012. *Sporting performance and food.* Deakin University –A.School of Exercise and Nutrition Sciences. State of Victoria, Victorian Minister for Health.1999/2015.

[8] The Effect of Different Forms of Fluid Provision on Exercise Performance, *International Journal of Sports Medicine*, 14 (1993) 298.

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