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Provision of Coconut Water as Good as Packed Coconut Water and Isotonic Beverages on Hydration Status in Football Athlete

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Abstract

The purpose of this study was to analyze differences in the hydration status of subjects who used coconut water, packaged coconut water, and isotonic drinks like sports drinks. The research design used in this study was a cross-over design. The test was carried out 4 times a week with a washout period of 2x24 hours. In each test, athletes were asked to jog on a treadmill for 40 minutes at a 5.6 km/hour speed and a slope of 5%. Drinks were given as much as 150 ml in the 15th minute and 30th minute while jogging on the treadmill. Measurement of urine-specific gravity using a refractometer and urine color table was performed before and after jogging on a treadmill to assess the hydration status of the subject. Based on the results of this study, it can be concluded that coconut water is as good as packaged coconut water and isotonic drinks in maintaining the hydration status of athletes, as seen from the urine specific gravity and urine color table. However, coconut water contains antioxidants that isotonic drinks don't, therefore coconut water has the potential to be sports drink because it can maintain hydration status and minimize oxidative stress resulting from exercise if treated properly with the addition of sodium.

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INTRODUCTION

Athletes› performance is supported by many factors to be able to achieve achievements. In addition to implementing the right exercise program, proper nutritional intake must also be met to improve athlete performance. With the rapid development of the science and practice of sports nutrition, nutrition is increasingly being recognized as an important component of supporting optimal sports performance. In addition to supporting the athlete›s performance at the time of competition, nutrition also plays a role in recovery. One of the nutrients that must be met to improve athlete performance is water. Water is an essential nutrient element for humans (Santoso dkk., 2011). Maintain fluid balance or hydration status in athletes, it can be done by giving proper fluids before, during and after exercise. Fluid balance must be maintained because it can affect metabolic function and lack of fluid requirements will result in dehydration. However, water is often forgotten as an important nutrient for the body. Because of the importance of water for the body, athletes during exercise their fluid needs must be met. When exercising for a long period of time, athletes can excrete a lot of fluids through sweat and can lead to dehydration. Dehydration can refer to a lack of fluids in the body because the amount that comes out is greater than the amount that goes in. (Rismayanthi, 2015).

Dehydration conditions during exercise can reduce athlete performance. When exercising for a long time, athletes can lose 2% of their body weight from dehydration which can result in decreased aerobic performance in both hot and cold environments (Cheuvront dan Kenefick, 2014). Hillman dkk. (2011) it was found that as hydration status decreased in hot weather, the distance traveled for 90 minutes while static cycling decreased compared to when hydrated. In addition to aerobic ability, when dehydration occurs, anaerobic ability also decreases. In addition, dehydration during exercise has a negative effect on the cognitive function of athletes (Fortes dkk., 2018). Not properly hydrated dehydration will occur in athletes and decreased performance will occur. Decreased performance in sports due to dehydration is certainly very detrimental because it will affect the decline in athlete and team achievement

Many athletes consume isotonic drinks to improve training performance and compensate for dehydration and electrolyte loss (Demirhan dkk., 2015) (Galemore, 2011). Demirhan dkk., (2015) Regarding the effect of giving isotonic drinks and mineral water during exercise to professional wrestling athletes, it was found that there was no significant change between body weight before and after exercise in both the mineral water and isotonic drink sample groups (Demirhan dkk., 2015) (Baron dkk., 2015). Some athletes are starting to choose other alternatives to sports drinks. For some athletes coconut water can be considered as a viable alternative. Coconut water is believed to maintain hydration status, this is because coconut water is rich in potassium, chloride and carbohydrates (Naik dkk., 2020). In addition, compared to mineral water, coconut water does not cause nausea, bloating, and also does not cause stomach pain when consumed in large quantities (Naik dkk., 2020). Because the number of occurrences of dehydration and dehydration can have a negative effect during exercise, this research needs to be done to prove what kind of drink can properly hydrate the body while exercising by looking at the physiological parameters, namely urine specific gravity and urine color as a marker of hydration status.

METHOD

This study uses an experimental method with a cross-over design. This research has passed the ethical feasibility test of the Faculty of Medicine, University of Lampung. This research was conducted using the Lampung Football Academy population. All the core players of Lampung Football Academy were sampled, this was done because this study used saturated sampling. After that, the sample was selected according to the inclusion and exclusion criteria. After the sample was selected, 12 people who fit the criteria were selected, then the sample was divided into 4 groups using the single blind method, where the research subjects did not know which group they would be in and what drink they were given by dividing each group by random allocation.

Before the study began, the sample was explained in advance about this research. Samples were asked not to consume electrolyte drinks, caffeine, alcohol or stamina enhancing drinks in the last 24 hours, sleep enough for 7 to 8 hours and were asked to drink 240 ml of water before bed and in the morning. Samples were also asked to drink at regular intervals to maintain their hydration status. The sample was divided into 4 groups according to the drink given, the drink was given at the 15th minute and 30th minute while running on the treadmill as much as 150 ml (Benardot, 2020). In this study, the drinks provided were coconut water, packaged coconut water, isotonic drinks and bottled drinking water.

The coconut water used in this study was coconut water from young green coconuts aged 6 to 7 months, the isotonic drink in this study used the brand: P. On the first day group 1 was given isotonic drink, group 2 was given bottled coconut

water, group 3 was water coconut and group 4 bottled drinking water. After that, the sample was checked for urine specific gravity using a refractometer and also a urine color table to determine the hydration status before and after jogging on the treadmill. Urine specific gravity refractometer is used to determine the specific gravity of urine and is known as a valid and easy tool to determine hydration status. Then the sample was asked to jog on a treadmill. Jogging on a treadmill was carried out for 40 minutes at a speed of 5.6 km/hour, grade 5%, with a room temperature of 27.6±0.8oC. In the study of Ganio et al. (2011) this treatment without being given fluids while jogging on a treadmill was able to cause moderate dehydration (loss of 1.733% of body weight) in the sample and was also able to cause the pulse to increase to a level 2 exercise pulse with 65% (132 heart rate/min).) of the maximum pulse rate (Ganio et al., 2011). After jogging on the treadmill, the sample is checked for urine specific gravity using a refractometer and urine color table. After completing the research on the first day, a wash out was carried out for 2x24 hours to eliminate the carry out effect in the previous treatment. On the second, third and fourth days the samples were still in the same group but only the drinks were changed.

RESULTS AND DISCUSSION

To describe the research results in more detail and strengthen the interpretation of hypothesis testing, a description of the data in the form of the characteristics of the research sample is presented in tabular form. The following is a description of the sample consisting of age and BMI

Table 1. Sample Characteristics

Characteristics	Average Age ±SD	Mean IMT±SD
Group 1	17,67±0,33	20,15±0,55
Group 2	17,33±0,33	20,8 ±0,214
Group 3	17±0	20,12 ±0,318
Group 4	17,67 ±0,33	19,87 ±0,48
p value	0,363	0,47

Based on **Table 1** Characteristics of the sample, the results of data processing on the characteristics of age and BMI using the one way ANOVA test obtained p value = 0.363 (p>0.05). These results indicate that there is no significant difference in the characteristics of age and BMI between group 4 as a control group, group 1, group 2 and group 3.

Table 2. The results of the average difference in the hydration status of subjects before and after jogging

Variable	Before Exercise	After Exercise	Different Value	%	p
Urine specific gravity	1,017	1,019	0,002	0,19	0,148
Colour Urine	4,58	5,0833	0,5	10,9	0,058

Based on **Table 2**, where data processing in the isotonic drink group used the paired sample t-test on urine specific gravity and Wilcoxon on urine color. It was found in the isotonic drink group based on urine specific gravity with p value = 0.148 (p > 0.05) and based on urine color Asymp. Sig = 0.058 (p > 0.05) which means that there is no significant difference in urine specific gravity and urine color before and after being given jogging on a treadmill and using isotonic drinks.

Table 3. The results of the average difference in the hydration status of subjects before and after jogging

Variable	Before Exercise	After Exercise	Different Value	%	p
Urine specific gravity	1,016	1,0178	0,0018	0,18	0,145
Colour Urine	4,33	4,75	0,42	9,70	0,96

Based on **Table 3** where data processing in the isotonic drink group uses the paired sample t-test on urine specific gravity and Wilcoxon on urine color. Obtained in the coconut water group based on urine specific gravity, the results were p value = 0.145 (p > 0.05) and based on urine color Asymp. Sig. = 0.96 (p > 0.05) which means that there is no significant difference in urine specific gravity and urine color before and after being given jogging on a treadmill and using coconut water

Table 4. The results of the average difference in the hydration status of subjects before and after jogging

Variable	Before Exercise	After Exercise	Different Value	%	Nilai p
Urine specific gravity	1,018	1,02	0,002	0,20	0,179
Colour Urine	4,916	5,333	0,417	8,48	0,96

Based on **Table 4**, where data processing in the isotonic drink group uses the paired sample t-test on urine specific gravity and Wilcoxon on

urine color. Obtained in the group of packaged coconut water based on urine specific gravity, the results were p value = 0.179 (p > 0.05) and based on urine color Asymp. Sig. = 0.96 (p > 0.05) which means that there is no significant difference in urine specific gravity and urine color before and after being given jogging on a treadmill and using packaged coconut water

Table 5. Comparative test results of urine specific gravity after jogging on a treadmill in the four groups of drinks

Variabel		Urine specific gravity		Warna urin	
Isotonic drink	Pre test	1,017	Minimal dehydration	4,58	Minimal dehydration
	Post test	1,019	Minimal dehydration	5,0833	Minimal dehydration
Coconut water	Pre test	1,016	Minimal dehydration	4,33	Minimal dehydration
	Post Test	1,0178	Minimal dehydration	4,75	Minimal dehydration
Packaged Coconut Water	Pre Test	1,018	Minimal dehydration	4,916	Minimal dehydration
	Post Test	1,02	Minimal dehydration	5,333	Minimal dehydration

Table 5 shows that the post-test urine specific gravity value data has a value of p=0.114 (p>0.05), which means that there is no significant difference between the administration of isotonic drinks, coconut water, packaged coconut water and bottled drinking water. When giving isotonic drinks, there is an average increase in urine specific gravity of 0.00158, when giving coconut water there is an average increase in urine specific gravity by 0.00175, when giving packaged coconut water an average increase in urine specific gravity is 0. 0.00225 and in the provision of bottled drinking water there was an average increase of 0.00167.

Table 6. The results of the comparison test of the subject's urine color after jogging on the treadmill in the four drink groups

Variable	Urine Color Post Average ±SD
Isotonic drink	5 x 10-1 ± 7,97724 x 10-1
Coconut water	4,1667 x 10-1 ± 7,9296 x 10-1
Packaged Coconut Water	4,1667 x 10-1 ± 7,9296 x 10-1
Bottled water	5 x 10-1 ± 7,97724 x 10-1
p value	0.574

Table 6 also shows that the urine color post test value data has an Asymp value. Sig. = 0.574 which means that there is no significant difference between the provision of isotonic drinks, coconut water, packaged coconut water and bottled drinking water. In the provision of isotonic drinks there was an average increase in urine color of 0.5, in the provision of coconut water there was an average increase in urine color of 0.416, in the provision of packaged coconut water there was an average increase in urine color of 0.416, in the provision of drinking water in packaging an average increase of 0.5.

Table 7. Classification of hydration status based on

Variable	Urine specific gravity±SD
Isotonic drink	1,58 x 10-3 ± 3,528 x 10-3
Coconut water	1,75 x 10-3 ± 3,864 x 10-3
Packaged Coconut Water	2,25 x 10-3 ± 5,429 x10-3
Bottled water	1,67 x 10-3 ± 2,902 x 10-3
p value	0.114

In this study, it was found that the administration of isotonic drinks, coconut water and packaged coconut water can maintain hydration status based on the parameters of urine specific gravity and urine color. The average hydration status of the sample at the time of the pre-test was in the minimal dehydration category and after jogging on the treadmill, the athlete's hydration status remained in the minimal dehydration category.

Giving Isotonic Drinks to Urine Specific Gravity and Urine Color to Athletes

This study shows that when jogging on a treadmill, giving isotonic drinks can maintain hydration status based on urine specific gravity and urine color table. The results of this study are in line with research by Demirhan dkk. (2015) on 18 elite wrestling athletes who performed 50 minutes of training. The isotonic drink is given 4x200ml 30 minutes before exercise and 3 times during exercise. The subjects in this study were weighed and 10 cc of blood was taken before and after conducting the study. The results of this study indicate that there is no difference between the levels of sodium (Na), potassium (K) and chlorine (CI). This indicates that isotonic drinks can prevent electrolyte loss during exercise. In addition to research Cebi (2015) on 20 soccer athletes who practice match for 90 minutes. The subjects of the study were given 1000ml (4x250ml) of isotonic drink starting 20 minutes before the practice match and during practice. Before and after exercise, 10 cc of blood sample to determine the

level of sodium (Na), potassium (K) and chlorine (CI). The results of this study indicate that the levels of Na, K and CI are not different before and after exercise, this indicates that isotonic drinks can prevent electrolyte loss during exercise. Geraldini dkk. (2017) on 10 karate athletes who did 90 minutes of exercise. Isotonic drinks were given at the start of the study, 25, 38, 48, 61, 73 and 90 minutes at the time of exercise. The results of this study are isotonic drinks can rehydrate karate athletes during one training session and reduce post-training proteinuria

The skin is the largest organ in the human body, accounting for 16% of the total body weight. The skin consists of two main layers, the epidermis which is derived from the ectoderm during embryonic development, and the dermis which is derived from the mesoderm (Kobielak dkk., 2015). Evaporation of sweat from the skin plays an important role in the regulation of human body temperature and sweating is most noticeable during strenuous physical activity or exposure to heat (Casa dkk., 2019). Physical activity plays a role in increasing metabolic rate and heat production. During physical activity, a large amount of heat is generated from muscle contraction as a by-product of metabolism. Furthermore, heat is transferred from the air to the body when the room temperature is higher than the skin temperature (Baker, 2019).

The mechanism of sweating occurs mostly in the sweat glands. Sweat glands are circular tubular structures that are important for regulating the temperature of the human body. Humans have three different types of sweat glands: eccrine, apocrine and apoeccrine. Temperature-sensitive nerves in the brain can detect internal body temperature and skin external temperature, then instruct sweat glands to respond to maintain core body temperature (Baker, 2019). Sweat is a dilute electrolyte solution consisting of 99% water, sodium, chloride, potassium, magnesium, lactate, ammonia and urea (Chen dkk., 2020).

Isotonic drinks are drinks that contain water, carbohydrates and electrolytes that have the same osmolality as blood, where normal blood osmolality is between 280 and 290 mOsm/kg. The presence of carbohydrates and these electrolytes plays an important role in maintaining hydration status. Because these electrolytes increase fluid retention in the extracellular space, restore fluid homeostasis and maintain plasma concentrations of vasopressin and aldosterone (Siow dkk., 2017). In addition to preventing dehydration, isotonic drinks can prevent post-training proteinuria (Geraldini dkk., 2017). Proteinuria is a condition of the presence of protein in human urine in abnormal amounts with a value more than normal, which is 150 mg/24 hours. (Tjiptaningrum & Hartanto, 2016).

Giving Coconut Water to Urine Specific Gravity and Urine Color to Athletes

This study shows that when jogging on a treadmill, giving coconut water can maintain hydration status based on urine specific gravity and urine color table. The results of this study are in line with Chagas dkk. (2017) on 13 subjects who did 3 exercise sessions on a bicycle ergometer and were given coconut water. Hydration status was assessed by the percentage of body mass lost and urine. In addition to hydration status, heart rate was also assessed to assess cardiovascular drift. The results in this study are coconut water can improve hydration status and reduce heart rate. Penelitian Chaubey dkk. (2017) in 8 male athletes aged 18 to 30 years who were given exercise running on a treadmill for 2x30 minutes at speeds of 2, 3, 4, 5, 6 and 7 miles per hour. Samples were given coconut water, isotonic drink and mineral water after exercise and were given 60 minutes to consume the drink. After 60 minutes, the subjects were given a performance test performed on a treadmill at a speed of 4.2 miles per hour with increasing incline.

Coconut is one of the most important commodities especially in tropical countries. The largest producers of coconut include Indonesia, the Philippines and India which contribute 75% of the world's coconut production (Halim dkk., 2018). Coconut fruit consists of coconut skin, coconut husk, coconut shell, coconut meat and coconut water (Mühlbauer & Müller, 2020). All parts of the coconut fruit can be used, coconut coir is usually processed into rope, carpet and also planting media. Coconut shells can be used as charcoal with very high quality. The inside of the coconut can be divided into 2 parts that can be consumed, namely coconut meat and coconut water (Prades dkk., 2012). Coconut water is a liquid with a sweet and refreshing taste that is taken directly from the coconut fruit (Reddy & Lakshmi, 2014). Not only delicious and refreshing, coconut water is also rich in macronutrients and micronutrients, for example, carbohydrates, potassium, magnesium and chloride (Waziri dkk., 2013). Another composition of coconut water is sugar which is dominated by glucose, sucrose and fructose (Mahayothee dkk., 2016).

In addition to sugar content, coconut water also contains good electrolytes to maintain hydration status during exercise. Electrolytes are charged minerals that are needed in small amounts (micronutrients) that play an important role in increasing energy production in humans (Halim dkk., 2018). The body's electrolytes include sodium (Na+), potassium (K+), calcium

(Ca2+) and magnesium (Mg2+). During exercise, athletes lose water and electrolytes through sweat (Orrù dkk., 2018). However, due to the lack of sodium content in coconut water and the large amount of sodium released in sweat, this can cause exercise-associated hyponatremia (EAH). EAH refers to a low blood sodium concentration (below 135 mmol/L) that decreases during or immediately after physical activity or exercise (Rosner, 2019). ES can cause behavioral changes, seizures to edema. When the sodium concentration decreases to <110-115 mmol/L, symptoms such as muscle twitching, disorientation, coma and epileptic seizures occur. (Knechtle dkk., 2019). Therefore, in sports with a long duration, the use of coconut water needs to consider the addition of sodium.

Besides having content that can overcome dehydration, coconut water also has anti-oxidants (Zulaikhah, 2019). Oxidative stress can occur in muscle tissue that is overworked during exercise, therefore it is beneficial for an athlete to consume rehydration fluids that contain antioxidants. Coconut water contains L-arginine, cytokines and vitamin C. L-arginine found in coconut water can significantly suppress oxidative stress (Liang dkk., 2018).

Giving Packaged Coconut Water to Urine Specific Gravity and Urine Color to Athletes

This study shows that when jogging on a treadmill, giving packaged coconut water can maintain hydration status based on urine specific gravity and urine color table. The results of this study are in line with research by Kalman dkk. (2012) on 12 subjects who were given exercise running on a treadmill for 2x30 minutes at a speed of 2, 3, 4, 5, 6 and 7 miles per hour with a rest of 10 minutes in between sessions. Packaged coconut water was given as much as 2220 ± 367 ml after doing the exercise. The result of this study is that packaged coconut water can rehydrate the subject when exercising in terms of body weight, fluid retention, plasma osmolality and urine specific gravity

Coconut water is naturally low in fat and calories, without cholesterol and the balance of sodium, potassium, calcium and magnesium makes coconut water a healthy natural electrolyte drink (Pathiranage dkk., 2017). Coconut water is naturally sterile while in the coconut shell but coconut water is difficult to serve for a long time due to physicochemical changes if left for a long time. (Ekasari & Widyarti, 2019). So that many companies process coconut water in various forms, one of which is packaged coconut water (Prades dkk., 2012). Zulekha dkk. (2018) who found that coconut water processed at high temperatures reduced the content of tyrosol, one of the most important simple phenols that have been used for medical purposes with antioxidant activity, immune stimulant and antibiotic properties. Ekasari & Widyarti (2019) found that the pasteurization process at high temperature did not affect the physicochemical content of coconut water. Despite the reduced nutritional content of coconut water, pasteurized coconut water can be used as a sports drink and can last up to 1 month at room temperature and 1 year in the refrigerator (Pathiranage dkk., 2017).

Comparison of giving isotonic drinks, coconut water, packaged coconut water and bottled drinking water on urine specific gravity and urine color in athletes

Athletes' hydration status was as good when given coconut water, packaged coconut water, and isotonic drinks as sports drinks when jogging on a treadmill. The results of this study are in line with research by Kalman dkk. (2012) The result of this study is that there is no significant difference between bottled drinking water, concentrated coconut water, packaged coconut water and isotonic drinks on hydration status in terms of body weight, fluid retention, plasma osmolality and urine specific gravity. In addition to research Zehr (2019) on 1 male basketball athlete and 5 female basketball athletes who were given 40 minutes of match practice. Bottled drinking water, coconut water in keamsan and isotonic drinks. The results of this study are that there are no significant differences in all specific performances, both in skills (total incoming shots, shooting opportunities and dribbling performance) and fitness (total running distance, average sprint time, etc.) in basketball.

During exercise, athletes lose fluids and electrolytes through sweating as a consequence of increasing body temperature (Sawka dkk., 2011). Sweating is the body's mechanism for lowering the temperature. An increase in core body temperature is sensed by thermoreceptors in the brain and in the skin, this information is processed by the preoptic hypothalamic area of the brain to stimulate sweating and vasodilation in the skin to dissipate heat (Baker, 2017). When sweating, heat is transferred from the body to the sweat in the skin. When sweat on the surface of the skin has sufficient heat, it turns into water vapour, thereby removing heat from the body (for every 1 kg of sweat that is evaporated, 580 kcal of heat is released). (Nuccio dkk., 2017). In some situations, especially when exercising for long periods of time, at high intensity and/or in a hot environment, excessive sweating can result in fluid/electrolyte imbalance (Cheuvront & Kenefick, 2014). Dehydration has a negative effect on strength, self-esteem, short-term memory, attenti-

on and reactions (Zhang dkk., 2019).

In this study, it was found that coconut water, packaged coconut water, isotonic drinks can maintain hydration status, therefore all drinks in this study can be an option to maintain hydration status depending on the availability and preferences of athletes. However, coconut water has its own advantages, namely it contains antioxidants such as L-arginine and vitamin C. The content of antioxidants such as L-arginine in coconut water can also significantly suppress the occurrence of oxidative stress (Liang dkk., 2018). Of course, the antioxidant content in coconut water makes coconut water a potential sports drink that can overcome dehydration and also minimize oxidative stress. Coconut water also contains sugar which is dominated by glucose, sucrose and fructose (Mahayothee dkk., 2016). Besides being able to overcome dehydration, coconut water has macronutrients and micronutrients such as carbohydrates, potassium, magnesium and chloride (Ekasari & Widyarti, 2019). Pathiranage dkk., (2017) found that the mineral content (magnesium, potassium, calcium and iron) was lower when processed at high temperatures, but there was no significant difference in sugar and vitamin content. Packaged coconut water is processed using pasteurization at high temperatures. This technique not only eliminates the risk of bacteria, but also eliminates some of the nutrients of coconut water and almost all flavors of coconut water. However, in this study it was found that the hydration status of athletes was as good as when given coconut water, packaged coconut water, isotonic drinks and bottled drinking water as sports drinks.

CONCLUSION

The hydration status of athletes was as good as when given coconut water, bottled coconut water, isotonic drinks and bottled drinking water on jogging on a treadmill for 40 minutes with light to moderate intensity. However, coconut water contains antioxidants that isotonic drinks do not have, therefore coconut water has the potential to be a potential sports drink because it can maintain hydration status and minimize oxidative stress resulting from exercise if treated properly with the addition of sodium.

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