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The Effect of Giving Palm Sap (*Borassus Flabellifer Linnaeus*) on Hydration Status After Aerobic Exercise

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ABSTRACT
Dehydration is a common physiological condition that occurs after physical activity, particularly aerobic exercise, due to increased core body temperature and fluid loss through sweat. Unreplaced fluid and electrolyte loss can disrupt the body's fluid balance and impair performance and recovery. Mineral water is often used as a rehydration fluid, but it does not contain the optimal amount of carbohydrates and electrolytes to support fluid absorption. Palm sap water (Borassus flabellifer L.) has the potential to be a natural rehydration alternative because it contains simple carbohydrates and electrolytes. This study aimed to analyze the effect of palm sap water on hydration status after aerobic exercise compared to mineral water. This study used a quasi-experimental design with a randomized pretest-posttest control group design. Thirty healthy male university students aged 18–20 years were divided into two groups: the palm sap water group and the mineral water group. All subjects performed aerobic exercise, consisting of running for 30 minutes at an intensity of 64–76% of HRmax. After the activity, each group was given 250 mL of fluid according to the treatment. Hydration status was measured using Bioelectrical Impedance Analysis (BIA) with Total Body Water (TBW) as the parameter before and after the intervention. Data analysis used paired sample t-tests and independent sample t-tests. The results showed an increase in TBW values in both groups, but this was not statistically significant (p>0.05). Furthermore, there was no significant difference between the palm sap water and mineral water groups in the post-test (p>0.05). This indicates that both fluids are equally effective in maintaining body fluid balance during moderate-intensity aerobic activity.Insert short English abstract here. The abstract should be in Cambri font style, 9 font size, and justified. It should not exceed 300 words. You can write your article’s abstract using this style and replacing with this information text.

Keywords: Siwalan Palm Sap, Hydration Status, Aerobic Exercise, BIA.

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Introduction

Dehydration is a physiological condition that occurs when fluid loss exceeds intake, disrupting fluid balance (Askew, 2013). During physical activity, particularly aerobic exercise, increased muscle metabolism generates body heat, which triggers thermoregulatory mechanisms through peripheral vasodilation and sweat production, leading to fluid and electrolyte loss (Surapongchai et al., 2021);(Sawka et al., 2015). A fluid loss of 1–2% of body weight is categorized as mild dehydration and can reduce physical performance, increase heart rate, and impair cognitive function (Sawka et al., 2015).

An effective rehydration strategy is crucial for restoring fluid balance after exercise. Ideal rehydration fluids not only replace fluid volume but also contain electrolytes and carbohydrates to enhance water absorption and energy recovery

(Gonzalez-Gil et al., 2019). However, commercial isotonic drinks generally contain additives such as sweeteners and preservatives, which can potentially cause negative effects if consumed excessively (Wanudya Kusumaningati, 2024). Therefore, alternative natural rehydration fluids are needed that are safe and have a physiological composition that supports the rehydration process.

Siwalan palm sap (Borassus flabellifer L.) is a traditional beverage rich in simple carbohydrates (±10 g/100 mL) and electrolytes such as sodium and potassium (Mubin & Zubaidah, 2016);(Susanti et al., 2021). This combination plays a role in the Sodium-Glucose Cotransporter 1 (SGLT1) mechanism in the small intestine, which can increase efficient water absorption (Song et al., 2017). Several studies have shown that siwalan palm sap has the potential to improve hydration status and increase physical endurance (Liana et al., 2015), thus theoretically possessing characteristics similar to isotonic drinks (Manzil & Pambudiarto, 2024).

However, research on the effectiveness of siwalan palm sap as a rehydration fluid in the context of aerobic exercise is still limited. Most previous studies have not used mineral water as a direct comparison and have relied on indirect indicators such as urine osmolality. Furthermore, objective methods such as *Bioelectrical Impedance Analysis* (BIA) to measure Total Body Water (TBW) are still rarely used (Malbrain et al., 2014). Therefore, this study aimed to analyze the effect of palm sap water on hydration status after aerobic exercise and compare it with mineral water using a more comprehensive TBW measurement.

Methodology

This study used a quasi-experimental design with a randomized pretest–posttest control group approach to evaluate the effect of palm sap water on hydration status after aerobic exercise. This design allows for comparison of changes in hydration status before and after the intervention in two different groups and controls for baseline variation between subjects.

The study subjects were 30 healthy male university students aged 18–20 years who were selected using a purposive sampling technique based on inclusion criteria: having a normal body mass index, no health problems, and not taking medications or supplements that affect body fluid balance. The subjects were then randomly divided into two groups: a control group (mineral water) and a treatment group (palm sap water), each consisting of 15 people.

The study procedure began with a pretest measurement of hydration status using a Beurer BF 100 *Bioelectrical Impedance Analysis* (BIA), with *Total Body Water* (TBW) as the primary parameter. Next, all subjects performed 30 minutes of aerobic exercise (running) at moderate intensity (64–76% HRmax), monitored using a heart rate monitor to ensure consistent exercise intensity. After the activity, each group received 250 mL of fluid, as indicated by the treatment. A repeat measurement (posttest) was performed after a 10-minute interval to evaluate changes in hydration status.

Data analysis was performed using parametric statistical tests after meeting the assumptions of normality and homogeneity. Normality was tested using the Shapiro–Wilk test, while homogeneity was tested using Levene's test. Differences before and after the intervention within each group were analyzed using a paired sample t-test, while differences between groups were analyzed using an independent sample t-test with a significance level of $\alpha = 0.05$.

Result

Table 1. Results of Statistical Analysis of Research Subject Characteristics

	N	Minimum	Maximum	Mean ± Std. Deviation
Usia (tahun)	30	18	20	18.47 ± 0.571
Berat Badan (kg)	30	46,2	75	59.190 ± 6.373
Tinggi badan (cm)	30	156	182	166.58 ± 6.446
Indeks Massa Tubuh (kg/m²)	30	18,4	24.5	21.343 ± 1.853

A total of 30 individuals participated in this study, with an average age of 18.47 ± 0.57 years, falling within the late adolescent stage, which is synonymous with physiological stability and good metabolic adaptability. The average weight was 59.19 ± 6.37 kg and height was 166.58 ± 6.44 cm, resulting in a BMI of 21.34 ± 1.85 kg/m^2, which is within the normal range according to the WHO classification. The average weight was 59.19 kg and height was 166.58 ± 6.45 cm, resulting in an average body mass index (BMI) of 21.34 ± 1.85, which is within the normal range according to the WHO classification (18.5–24.9).

The homogeneity of the subjects' physical characteristics is important because it indicates that the study group had a relatively uniform body composition, thus minimizing bias that could be caused by physiological variations. Thus, the observed changes in hydration status most likely stem from the influence of the type of rehydration fluid (mineral water vs. palm sap water), rather than from differences in individual body conditions.

Table 2. Descriptive Analysis of Variables

Variabel	Tes variabel	N	Minimum	maximum	Mean ± Std. Deviation (%)
Air Mineral	*Pretest*	15	58,1	70.0	63.34 ± 3.993
	Posttest	15	58.5	70.0	65.38 ± 3.793
Air Nira Siwalan	*Pretest*	15	57.9	69.2	64.233 ± 3.301
	Posttest	15	56.1	70.0	64.480 ± 4.264

Table 2 illustrates the results of a descriptive analysis of hydration status measured in two groups: the mineral water group and the palm sap water group, each consisting of 15 participants. In the mineral water group, the average score increased from 63.34 ± 3.99 in the pretest to 65.38 ± 3.79 after the intervention. Meanwhile, in the palm sap water group, the average score increased from 64.23 ± 3.30 to 64.48 ± 4.26 in the posttest.

The increase in average scores in both groups indicates a positive change after the administration of rehydration fluids, although the difference was relatively small. These results demonstrate that both mineral water and palm sap water can help maintain body hydration status after moderate-duration aerobic physical activity. All data obtained were then tested for distribution to ensure the appropriateness of using parametric tests in the next stage of analysis.

Table 3. Normality Test (*Shapiro Wilk Test)*

Variabel		Sig.
Kadar hidrasi kelompok kontrol	*Pretest*	0.335*
(Air Mineral)	*Posttest*	0.273*
Kadar hidrasi kelompok perlakuan	*Pretest*	0.428*
(Air Nira Siwalan)	*Posttest*	0.281*

Based on Table 3, the significance value (Sig.) for the control group (mineral water) in the pretest was 0.335 ($p > 0.05$), and for the posttest it was 0.273 ($p > 0.05$). Meanwhile, for the treatment group (siwalan palm sap water), the significance value (Sig.) for the pretest was 0.428 ($p > 0.05$) and for the posttest it was 0.281 ($p > 0.05$).

All significance values ($p > 0.05$) indicate that the data from both groups were normally distributed, both before and after treatment. This fulfills one of the prerequisites for parametric analysis for the t-test, allowing for valid use of further tests such as the paired sample t-test and the independent sample t-test. The normal distribution of the data also indicates that changes in hydration status across subjects were relatively uniform, with no extreme values or outliers that could confound the analysis results.

The significance value of the Levene test is 0.203 ($p > 0.05$). The criteria can be said to be homogeneous if the significance level (Sig.) is greater than 0.05. Thus, it can be concluded that the variation in changes in values between groups is not significantly different. This homogeneity is important to ensure that the difference in results between the treatment and control groups is purely due to the type of fluid consumed, not due to variations in data distribution.

Table 4. *Paired Sample T-Test*

	(Sig.)
Pretest dan *posttest* kelompok kontrol (Air putih)	0.151
Pretest dan *posttest* kelompok perlakuan (Air Nira Siwalan)	0.179

Based on Table 4, the results of the paired sample t-test indicate no significant difference between the pretest and posttest measurements in the two treatment groups. In the control group consuming mineral water, the significance value was 0.151 (p >

0.05), and in the treatment group consuming palm sap water, the significance value was 0.179 ($p > 0.05$). Both values are greater than the 0.05 level of significance, thus concluding that there was no significant change between before and after treatment.

Descriptively, these results indicate that after the fluid administration process, either mineral water or palm sap water, the average hydration level experienced a slight increase, but the change was not large enough to indicate a statistically significant difference. Thus, these test results confirm that both groups exhibited a relatively stable pattern of change between the initial and final measurements in terms of body hydration status.

Table 6. *Independent Sample T-Test*

	Kadar Hidrasi
Sig. (2-tailed)	0.510

Based on Table 6, the Independent T-test results show a significance value (Sig.) of 0.510 ($p > 0.05$). This value is greater than the 0.05 significance level, thus concluding that there is no significant difference between the post-test results of the control group (given mineral water) and the treatment group (given palm sap water).

Descriptively, both groups showed relatively similar average hydration levels after the intervention, indicating that both types of fluids had a comparable effect on the hydration status of the study subjects. However, the difference in average values between the groups was not large enough to produce statistical significance.

Dicussion

The results of this study indicate that administering palm sap or mineral water after moderate-intensity aerobic exercise did not produce a statistically significant difference in changes in body hydration status ($p > 0.05$). However, both groups showed a trend toward increased Total Body Water (TBW) values, indicating that both fluids were able to maintain and restore body fluid balance without causing a fluid deficit.

The lack of a significant difference between the two groups indicates that the fluid loss during aerobic activity in this study was relatively mild. During aerobic exercise, an increase in core body temperature triggers thermoregulatory mechanisms through peripheral vasodilation and increased sweat production, which leads to fluid and electrolyte loss (Larsen et al., 2016). However, in conditions of mild dehydration (<2% of body weight), the body is still able to maintain fluid balance through efficient homeostatic mechanisms, so hydration recovery is more determined by adequate fluid volume than fluid composition (Sawka et al., 2015).

Physiologically, palm sap water has potential advantages as a rehydration fluid because it contains natural electrolytes such as sodium, potassium, and magnesium, as well as simple carbohydrates (Dwi et al., 2023). These compounds play a role in the fluid absorption mechanism in the small intestine through Sodium-Glucose Cotransporter 1 (SGLT1), where sodium and glucose absorption is followed by osmotic water movement, thereby increasing rehydration efficiency (Song et al., 2017). Furthermore, potassium plays a role in maintaining intracellular fluid balance, while magnesium supports cell membrane stability and metabolic enzyme activity. Based on these mechanisms, palm sap water theoretically has characteristics similar to natural isotonic drinks.

However, these physiological advantages were not significantly apparent in this study. This is likely due to several factors, including the subjects' low level of dehydration, which meant that the need for additional electrolytes was not a limiting factor in the rehydration process. Furthermore, the volume of fluid administered (250 mL) was likely insufficient to replace all fluids lost during physical activity. The American College of Sports Medicine recommends consuming 1.2–1.5 times the amount of fluid lost to achieve optimal rehydration, so a relatively small volume may limit differences between groups.

On the other hand, using TBW as an indicator of hydration status provides a comprehensive picture of body fluid distribution (Kyle et al., 2004), but is limited in detecting small changes over a short period of time. This may contribute to the lack of significant differences between groups, despite physiological differences in fluid absorption mechanisms.

The findings of this study align with previous research showing that the combination of electrolytes and carbohydrates in rehydration fluids is more effective in increasing body fluid retention than plain water, especially in conditions of greater dehydration (Maughan & Shirreffs, 2010). Therefore, the insignificant results in this study do not indicate the ineffectiveness of palm sap water, but rather reflect that the study conditions did not create enough physiological stress to optimize the role of electrolytes in the rehydration process.

Conclusions

This study showed that administering palm sap water and mineral water after aerobic activity did not significantly improve the body's hydration status. Nevertheless, both fluids contributed to post-exercise rehydration. This indicates that in cases of mild fluid loss, the volume of fluid consumed is more important than its composition. However, the electrolyte and natural carbohydrate content of palm sap water still shows potential as a natural rehydration drink beneficial for higher-intensity and longer-duration physical activities.

References:

Askew, E. A. S. (2013). *Physiological Functions of Water*. *2*, 1–9. https://doi.org/10.1016/B978-0-12-375083-9.00068-4

Dwi, S., Sari, P., Hartati, F. K., Sucahyo, B. S., & Rahmiati, R. (2023). *Nutrition , Antioxidant And Organoleptic Activities Of Legen Drink (Borassus flabellifer L .) at Different Temperature And Storage Time*. *1*(1), 23–29.

Gonzalez-Gil, A. M., Peschard-Franco, M., Castillo, E. C., Gutierrez-Delbosque, G., Treviño, V., Silva-Platas, C., Perez-Villarreal, L., Garcia-Rivas, G., & Elizondo-Montemayor, L. (2019). Myokine-adipokine cross-talk: Potential mechanisms for the association between plasma irisin and adipokines and cardiometabolic risk factors in Mexican children with obesity and the metabolic syndrome. *Diabetology and Metabolic Syndrome*, *11*(1), 1–16. https://doi.org/10.1186/s13098-019-0458-2

Kyle, U. G., Bosaeus, I., Lorenzo, A. D. De, Manuel, G., Lilienthal, B., Kent-smith, L., Melchior, J., Pichard, C., & Group, W. (2004). *Bioelectrical impedance analysis F part I : review of principles and methods*. 1226–1243. https://doi.org/10.1016/j.clnu.2004.06.004

Larsen, B. R., Stoica, A., & Macaulay, N. (2016). *Managing Brain Extracellular K + during Neuronal Activity : The Physiological Role of the Na + / K + - ATPase Subunit Isoforms*. *7*(April), 1–10. https://doi.org/10.3389/fphys.2016.00141

Liana, N. O., Sofro, Z. M., Titis, M. H. S., & Penggalih. (2015). *PENGARUH PEMBERIAN AIR SIWALAN (Borassus flabellifer L.) KEMASAN DAN AIR KELAPA (Cocos nucifera L.) KEMASAN TERHADAP REHIDRASI DENGAN INDIKATOR OSMOLALITAS URIN NOVRISKA OKY LIANA, Dr. dr. Zaenal M. Sofro AIFM, Sports&Circ.Med; Mirza Hapsari S.T.P., S*. 2–3.

Malbrain, M. L. N. G., Huygh, J., Dabrowski, W., De Waele, J. J., Staelens, A., & Wauters, J. (2014). The use of bio-electrical impedance analysis (BIA) to guide fluid management, resuscitation and deresuscitation in critically ill patients: A bench-to-bedside review. *Anaesthesiology Intensive Therapy*, *46*(5), 381–391. https://doi.org/10.5603/AIT.2014.0061

Manzil, L. D., & Pambudiarto, B. A. (2024). Studi Reaksi Fermentasi pada Minuman Legen Study of Fermentation Reactions in Legen Drinks. *Jurnal Integrasi Proses Dan Lingkungan*, *2*(1), 80–86. https://journal.umg.ac.id/index.php/jipl

Maughan, R. J., & Shirreffs, S. M. (2010). *Journal of Sports Sciences Recovery from prolonged exercise : Restoration of water and electrolyte balance Recovery from prolonged exercise : Restoration of water and electrolyte balance*. *December 2014*, 37–41. https://doi.org/10.1080/026404197367308

Mubin, M. F., & Zubaidah, E. (2016). *(PENGARUH PENGENCERAN NIRA SIWALAN DAN METODE INKUBASI) Study of Making Palm (Borassus flabellifer L .) Sap Kefir (Palm Dilution and Incubation Methods Effect)*. *4*(1), 291–301.

Sawka, M. N., Cheuvront, S. N., & Kenefick, R. W. (2015). Hypohydration and Human Performance: Impact of Environment and Physiological Mechanisms. *Sports Medicine*, *45*(1), 51–60. https://doi.org/10.1007/s40279-015-0395-7

Song, P., Onishi, A., Koepsell, H., Vallon, V., Jolla, L., Diego, S., Hospital, S. X., Biology, C., & Jolla, L. (2017). *Sodium glucose cotransporter SGLT1 as a therapeutic target in diabetes mellitus*. *20*(9), 1109–1125. https://doi.org/10.1517/14728222.2016.1168808.Sodium

Surapongchai, J., Saengsirisuwan, V., Rollo, I., Randell, R. K., Nithitsuttibuta, K., Sainiyom, P., Hong, C., Leow, W., Kai, J., & Lee, W. (2021). *Hydration Status, Fluid Intake, Sweat Rate, and Sweat Sodium Concentration in Recreational Tropical Native Runners*. 1–12.

Susanti, S. F., Arifin, M. S., Nugini, P., Tenggara, A., & Pohon, T. (2021). *IDENTIFIKASI BAKTERI KOLIFORM PADA MINUMAN LEGEN DI KECAMATAN BANYUGLUGUR KABUPATEN SITUBONDO*. *13*(2), 6–13.

Wanudya Kusumaningati, M. M. (2024). *PENGARUH PEMBERIAN CAIRAN AIR NIRA SIWALAN (Borassus flabellifer L .) DAN AIR KELAPA MUDA (Cocos*. *4*(2), 33–39.