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Banana isotonic drink improves orthostatic tolerance in voluntary dehydration subject

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Abstract: This study was conducted to determine the effects of the banana isotonic drink that has been developed on orthostatic tolerance. Experimental research used cross-over design involved 16 subjects who passed the screening for voluntary dehydration and were divided into two groups. Each subject was administrated with 500 ml of fluid and subjected to schellong test for heart rate and blood pressure monitoring. Banana isotonic group had the higher cardiac activity than in plain water group to maintain blood circulation to meet the body volume and it showed a rapid tolerance to blood pressure when the subject provoked to upright position compared to plain water. Banana isotonic drink showed more improvement for the orthostatic tolerance in voluntary dehydration subject.

Keywords: Banana, isotonic drink, orthostatic, voluntary dehydration

Introduction

Tropical temperatures with its hot and humid conditions may lead to dehydration due to sweat excretion and its electrolytes content in large amount. About 48% of adults suffered from dehydration and 26% of them never realized it (Bennett *et al*., 2004). This hidden dehydration or known as voluntary dehydration can have serious consequences on a person's health and may increase the risk of some diseases and death (Wotton *et al*., 2008).

Consumption of isotonic beverage improves the condition of dehydration (Maughan, 2004; Wilson and Temple, 2004; Ramakhrisna, 2004; Wesley, 2006). Banana isotonic drink (BID) is a newly developed isotonic drink containing carbohydrate and electrolytes, however, it requires further improvement and clinical test for its effectiveness in rehydration (Penggalih, 2010). This drink meets the standard of isotonic beverages (Jamal and Eisenberg, 2004), having a mosm osmolarity value of 269. BID is able to improve hydration through the mechanism of maintaining body liquid by slowing down the urine formation (Penggalih, 2011). Orthostatic tolerance is a condition that is often associated with a person's state of hydration by monitoring the heart rate and blood pressure (Schroeder *et al*., 2002).This research aims to determine the effects of BID as an alternative treatment to improve orthostatic tolerance and provide benefits for cardiac health by lowering cardiac workload to regulate the blood volume through the response of heart rate and blood pressure in voluntary dehydration subjects.

Materials and Methods

This research was an experimental study with cross-over design. Subjects were divided into control group, plain water (PW) and treatment group with banana isotonic drink (BID). The sixteen subjects involved in this study passed the screening of voluntary dehydration characterized by the increasing of heart rate more of than 30 beats per minute after supine position, the increasing of heart rate up to 120 beats per minute during 7 minutes in upright position, and with or without the decreasing of 20 mmHg systolic and 10 mmHg diastolic blood pressure in an upright position.

Criteria of the subjects in this research were a maximum of 20-year-old man, non smoker, no history of chronic illnesses and in good health. Preparation of the subjects were conducted a day before treatments. Data collection begins with the provision of a standard diet and fluid compliance program. The experiments were conducted at 09.00 - 12.00 a.m. The subjects were asked not to be involved in excessive activity,

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not to consume caffeinated beverages, alcohol and refrain from taking vitamin or mineral supplements over the last 48 hours. Subjects were asked to fast overnight.

The schellong test procedure in monitoring orthostatic tolerance was conducted by monitoring their heart rate and blood pressure for 5 min during supine position and 7 min during upright position. The delta position between supine and upright position shows the orthostatic tolerance. Heart rate and blood pressure were assessed with an automatic blood pressure monitor OMRON SEM-1 Model according to the method described by Schroeder *et al*. (2002). Two experimental treatments were conducted separately within 7 days of washout periods and drinks were given and assigned randomly. This research experiment has been approved by the Ethics Committee for Health and Medical Research, Faculty of Medicine Gadjah Mada University.

Stata Version 10 was used for statistical analysis. Kolmogorov-Smirnov test was performed to determine the data distribution. If the data are normally distributed (P> 0.05), the data were further processed using ANOVA t-test to determine the differences among pre, post and 2h after intervention and independent t-test to determine the differences among treatments. Consideration of significant differences is p <0.05.

Results

Subjects characteristic

Orthostatic condition, age, weight, height, nutritional status with body mass index (BMI) indicators, systolic, diastolic and heart rate of 16 subjects were homogeneous (p> 0.05) (Table 1).

The effect of plain water (PW) and banana isotonic drink (BID) in the supine position of heart rate, systolic and diastolic

The statistical analysis tests between pre, post and 2h rehydration showed that only heart rate during supine position (P <0.05) in the BID group were significant. Independent t-test analysis showed a significant different of heart rate during supine position (P <0.05), however there were no significant difference in systolic and diastolic between treatment groups (P> 0.05) (Table 2).

The effect of plain water (PW) and banana isotonic drink (BID) on the monitoring of heart rate, systolic and diastolic in upright position

The difference between pre, post and 2h rehydration were significantly different both in heart rate and diastolic in PW and BID group (P <0.05), whereas in systolic pressure only BID group showed a significant difference (P<0.05). Independent t-test results showed that there was no significant difference in heart rate, systolic, and diastolic in upright position between the BID and the PW group (P> 0.05) (Table. 3)

The effect of plain water (PW) and banana isotonic drink (BID) for delta heart rate, systolic and diastolic

Delta changes of heart rate in orthostatic position between pre, post and 2h rehydration were significantly different in all groups as well as the diastolic in plain water group (P<0.05). Systolic and diastolic in both groups were not significantly

Table 1. Subject Characteristic

Variables	Category	Group		Total	P-Value
		PW[1]	BID[2]		
Age (year)	18-19	6	7	13	0.522
	19.1-20	2	1	3	
Total		8	8	16	
Weight (kg)	45-59	5	5	10	1.000
	60-90	3	3	6	
Total		8	8	16	
Height (cm)	160-169	3	4	7	0.614
	170-200	5	4	9	
Total		8	8	16	
Body Mass Index (kg/m²)	<18.49	2	2	4	0.580
	18.5-25	6	5	11	
	25.1-30	0	1	1	
Total		8	8	16	
Systolic (mmHg)	100-117	5	6	11	0.590
	117.1-140	3	2	5	
Total		8	8	16	
Diastolic (mm/Hg)	58-65	3	5	8	0.317
	66-80	5	3	8	
Total		8	8	16	
Heart Rate (beats per	54-70	3	6	9	0.131
minute)	71-110	5	2	7	
Total		8	8	16	

[1]Plain water.
[2]Banana Isotonic Drink.

Table 2. Heart rate, systolic and diastolic in supine position between plain water and banana isotonic drink

Variables	Group	Pre	Post	2h rehydration	P-Value[1]	P-Value[2]
Heart Rate (beats	BID[3]	70	68	68	0.002[5]	*0.039*
per minute)	PW[4]	65	66	67	0.498	
Systolic (mmHg)	BID[3]	116	116	113	0.349	0.329
	PW[4]	115	117	115	0.351	
Diastolic (mmHg)	BID[3]	64	63	61	0.280	0.815
	PW[4]	64	64	61	0.173	

[1]Anova t-test between pre, post and 2h rehydration.
[2]Independent t-test between PW and BID.
[3]Banana Isotonic Drink.
[4]Plain water.
[5]Significant difference P<0,05

Table 3. Heart rate, systolic and diastolic in upright position between plain water and banana isotonic drink

Variables	Minute	Pre		Post		2h Rehydration		P-Value[1]	P-Value[2]
		BID[3]	PW[4]	BID[3]	PW[4]	BID[3]	PW[4]		
Heart Rate	1	90	86	96	94	96	97	0.044[3,5]	0.792
(beats per	3	94	90	94	96	98	100		
minute)	5	95	94	95	94	100	100	0.016[4,5]	
	7	96	96	98	98	98	100		
Systolic	1	118	118	117	117	112	116	0.002[3,5]	0.273
(mmHg)	3	114	117	116	117	113	116		
	5	114	116	118	118	112	117	0.227[4]	
	7	116	115	117	118	113	116		
Diastolic	1	78	75	76	77	72	77	0.017[3,5]	0.575
(mmHg)	3	76	75	77	79	76	77		
	5	77	77	80	80	74	76	0.005[4,5]	
	7	76	75	78	79	75	78		

[1]Anova t-test between pre, post and 2h rehydration.
[2]Independent t-test between PW and BID.
[3]Banana Isotonic Drink.
[4]Plain water.
[5]Significant difference P<0,05

Table 4. Delta position of heart rate, systolic and diastolic between plain water and banana isotonic drink

Variable	Minute	Pre		Post		2h Rehydration		P-Value[1]	P-Value[2]
		BID[3]	PW[4]	BID[3]	PW[4]	BID[3]	PW[4]		
Heart Rate	1	20	21	29	29	28	31	0.006[3,5]	0.403
(beats per	3	25	25	26	31	30	33		
minute)	5	25	29	28	28	32	34	0.038[4,5]	
	7	26	31	30	32	30	34		
Systolic	1	3	3	2	1	1	1	0.069	0.507
(mmHg)	3	1	1	0	0	1	1		
	5	2	1	2	1	1	2	0.394	
	7	0	1	2	0	1	1		
Diastolic	1	15	11	12	13	11	15	0.432[3]	0.665
(mmHg)	3	13	11	14	15	14	16		
	5	13	14	16	15	13	15	0.001[4,5]	
	7	12	12	15	14	13	16		

[1]Anova t-test between pre, post and 2h rehydration.
[2]Independent t-test between PW and BID.
[3]Banana Isotonic Drink.
[4]Plain water.
[5]Significant difference P<0,05

Table 5. Comparison of orthostatic tolerance in heart rate, systolic and diastolic pressure between plain water and banana isotonic drink

Variables	Prerequisite	Average Test Result	
		PW[1]	BID[2]
Heart Rate	Δ < 30 beats per minute	29 beats per minute	27 beats per minute
Systolic	Δ ± 8 mmHg	-1 up to 3 mmHg	-2 up to 3 mmHg
Diastolic	Δ ± 10 mmHg	14 mmHg	13 mmHg

[1]Plain water.
[2]Banana Isotonic Drink.

different (P>0.05). Heart rate, systolic and diastolic were not significantly different between groups (P>0.05) (Table. 4).

The effect of plain water (PW) and banana isotonic drink (BID) for orthostatic tolerance

Delta of heart rate, systolic and diastolic between the supine and upright position is a tool of monitoring orthostatic tolerance and orthostatic tolerance is useful to demonstrate the ability of beverages to repair the body's hydration status. Expected delta that indicates a good hydration status is when the heart rate does not exceed 30 beats per min; delta systolic is about ± 8 mmHg and delta diastolic blood pressure is about ± 10 mmHg (Medow *et al*, 2008). This suggests that treatments for both groups succeeded in getting their hydration status improved. However, the BID group had a better value in improving the body's hydration status through the response of orthostatic tolerance (Table 5).

Discussion

The conditions of the heart rate in supine position were significantly different between BID and PW group, and BID group was higher than the PW group. This suggests that the hydration status of the BID group was lower than in the PW group before being given any intervention. Cardiac load activity in the BID group was harder than in PW groups to stabilized blood pressure in order to supply blood to all parts of the body. This is related to the systolic and diastolic blood pressure in both groups that were not different significantly between pre, post and 2h rehydration.

Heart rate increased in upright position significantly up to 7 min monitoring both in the BID and the PW group but there were no difference between the groups. Heart rate is an indicator of the heart's ability to distribute the fluids in the whole body. It is often referred as predictors of a person's state of hydration. In normal conditions, heart rate increased while standing, but quickly returned to normal no more than 3 min while standing. This condition is highly dependent on the age and the respond is slower in older people (Medow *et al.*, 2008).

Subjects in this study were 17-20 years old, in excellent health conditions and able to restore the heart rate faster and all were subjected to voluntary dehydration. Orthostatic hypotension is associated with dehydration which can be restored with fluid consumptions; however the provision of 500 ml for a young age will have no effect on the improvement of orthostatic (Mathias and Young, 2004). This effect will be very effective in older people and person who suffer from autonomic failure. Furthermore, the comparison of the effect of this BID and amount of fluid required in healthy people who are not suffering from dehydration needs to be further evaluated.

The results of the systolic in upright position showed that the BID group improved better after the intervention compared to the PW group, although the actual difference between groups was not significant. The analysis of diastolic both in PW and BID group also changed significantly between pre, post and 2h rehydration, although there is no different between groups. However, systolic pressure is more sensitive than diastolic pressure to response heart rate as a

compensation of cardiac activity. Therefore, BID is more effective to improve the orthostatic status compare to PW.

Orthostatic measurement is described as the body's response to gravity changes. Blood is pooling in the lower extremities after upright position resulting in decreased of cardiac output and arterial pressure. People will lose about 700 ml of blood from the chest cavity in upright position resulting in the decreasing of systolic and diastolic pressure. The overall effect is insufficiency of blood perfusion in the upper body. However, blood pressure usually does not decrease drastically, because it immediately triggers a vasoconstriction through the bar receptor reflex, pumping the blood back up into the body through the increasing of heart rate activity. Therefore, the provision of BID drinks is able to accelerate the process of blood perfusion in the upper body without aggravating the heart. Blood pressure are depends on many factors, together with the sympathetic nervous system reacts in stages at any rate through the bar receptor reflex. The factors such as cardiac output, the tone of vascular resistance, intravascular volume and body fluid status, determine the blood pressure and heart rate. The mechanisms that regulate the function of heart rate and blood pressure also conducted through the nerves and hormones system. Sympathetic nervous system plays an important role in daily life. Sympathetic nerve response is very important for simple tasks such as in changing body position. The change from supine position and upright position requires complex adjustments in blood flow and blood pressure, and the adjustment is being coordinated by the sympathetic nerves along with the parasympathetic (Charkoudian and Rabbitts, 2009). Without this adjustment, the blood flow to the brain will drop below the auto regulatory limit, and person with syncope or autonomic failure will faint after standing. Various researches on the accuracy of a fluid volume in order to give effect or response to orthostatic improvements are still being developed.

The real difference in terms of their contents between plain water and banana isotonic drink are the sugar and electrolyte. Sugar can accelerate the absorption in the small intestine so that it can bring the electrolyte into the cell faster. Sugar and electrolytes influence the osmolarity value of the beverage. Isotonic drink, include banana isotonic drink has the same value with plasma osmolarity and it should be quickly absorbed into the cell after the drink were consumed.

The ability of these beverages is also associated with the kidneys function, with rapid correction of plasma volume and electrolytes it will lead to the delay of urine formation (Penggalih, 2011). Dehydration will lower the total body fluids and will activate pre-absorptive factor characterized by dry mouth. If such a condition is not treated, it will activate osmoreceptor and result in the increase of plasma osmolarity. Plasma osmolarity increase because the level of sodium and sugar is interrupted or are not in equilibrium point. Therefore by giving BID are expected to give faster effect in plasma osmolarity. Since the concentration of plasma osmolarity meet the balance point, bar receptors effect does not need to work harder to correct it by raising extracellular plasma volume, increasing heart rate and blood pressure. Therefore banana isotonic administration in this research seems more effective to improve the orthostatic compared to plain water.

Conclusion

Banana isotonic group has higher cardiac load than plain water group to maintain blood circulation to meet the body volume, showed a rapid effect to blood pressure and showed more improvement for the orthostatic tolerance in voluntary dehydration subject.

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