



## USAGE OF FRUIT-INFUSED WATER FOR PREVENTION OF DEHYDRATION DUE TO ENDURANCE EXERCISE

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### Abstract

This study aimed to extend previous investigation regarding its beneficial effects on changes of blood glucose. This experimental research was conducted from 06:00-12:00. Twenty-four young men (age 19-20 y.o.) were divided into three groups, Fasting-Exercise-Only (FEO), Fasting-Exercise-Water (FEW), and Fasting-Exercise with Fruit-Infused Water (FEF). Subjects underwent fasting for 12 h before the experimental day. The data of body weight (Kg) and macroscopic urine color were collected before and after exercise. Body weight in all experimental groups were decreased by 1% during endurance exercise. There were no differences in decrease of body weight between FEF and FEW groups compared to FEO group ( $p > .05$ ). The change in urine color was significantly different between pre-exercise and post-exercise data ( $p < .05$ ). The darkest urine color was observed in FEO group (4.75), followed by FEW group (4.25), while FEF group (3.63) did not reach dehydration level. In conclusion, fruit-infused water is suggested to be drink as a choice for fluid intake during exercise.

### Introduction

Exercise has many beneficial effects on the body for all ages as long as it is done correctly, properly, systematically, and regularly (exercise should be adjusted to physiological function). Exercise is able to improve the overall health status of an individual (Hagen, K.B. et al, 2012; Locks, R.R. et al, 2012). Yet, exercise is also known as physical stress which is able to affect physiological processes inside the body. One of consequences of exercise is dehydration (loss of water) which is caused by long-

duration exercise (typically aerobic exercise) such as jogging, cycling, swimming, hiking, etc. Indicators of dehydration are thirstiness, dizziness, exhaustion, muscle spasm, loss of body weight, change of urine color, and vomiting (Sawka, M.N., 2007; Simpson, M.R. and Howard, T., 2011).

Dehydration causes loss of mineral and electrolytes (potassium, sodium, chloride etc.), increase of body temperature, change in cardiovascular system, disturbance in nerve system, and eventually it will impair exercise

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performance (Murray, B., 2007). Previous studies reported that 2% loss of body weight could impair performance for about 7% - 29% (Goulet, E.D.B., 2012). Dehydration during exercise occurred in heat condition (Hackney, K.J. et al, 2012).

Techniques or substances which can be used in order to maintain exercise performance called as ergogenic aids. It is classified into nutrition (carbohydrate loading, drugs such as usage of anabolic-androgenic steroid), physiological condition, psychological condition, and technique. As part of ergogenic aids, the right nutrition is the essence of what the body needs to maintain or improve exercise performance, recovery from fatigue and injury prevention. Several nutrition which had been investigated and their effects were: 1) Caffeine could effectively improve body strength. It also could be used for recreational sport or sports which were related with resistance, 2) Supplements which contain protein, vitamin, mineral were recommended to be consumed for injury prevention and good performance, 3) Beverages which contain carbohydrate and electrolyte were able to increase or prevent the decline of performance when they were taken as fluid substitute (Hackney, K.J. et al, 2012; Higgins, J.P. et al, 2010; Jenkinson, D. M. and Harbet, A.J., 2008).

In previous study, fruit-infused water was able to elevate blood glucose approximately

45 minutes since its intake (Ali, M.A. et al, 2016). Therefore, the purpose of this study was to investigate the effects of fruit-infused water (combination of apple, banana and lemon) on body weight and urine color as the markers of dehydration caused by exercise.

**Methods**

This was an experimental research study. The independent variable in this study was fruit-infused water while the dependent variables were body weight and urine color as dehydration markers. It was conducted from 06:00 a.m. until 12:00 p.m.

Twenty-four young men (aged 19-20 years) were divided into three groups, 1) fasting-exercise-only (FEO), 2) fasting-exercise-water (FEW), and 3) fasting-exercise-fruit-infused water (FEF). The following procedure was implemented: 1) Subjects were examined a week before the experiment. 2) Informed consent was obtained from each subject. 3) One day before the experiment, all subjects received instructions regarding the study protocol (12 h fasting from food). 4) On the day of the experiment, the subjects were asked to sit and rest for 15 minutes. 5) Two hours before exercise, the treatment drink were administrated: 500 mL of either water or fruit-infused water. 6) Urine collection and body weight measurement (pre-exercise data) were then taken less than 5 minutes before exercise begun. 7) The exercise was then given.

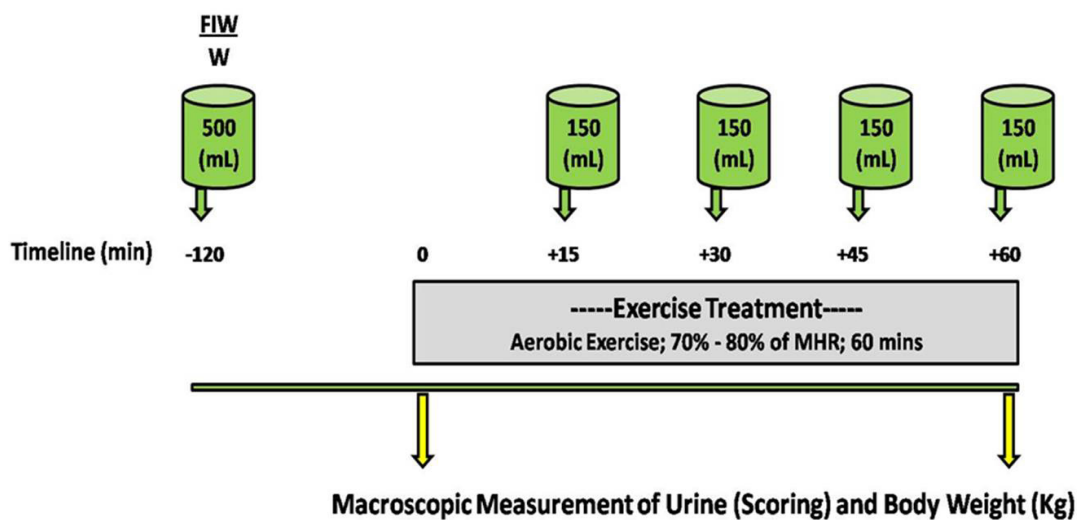


Figure 1. Study Design

8) The administration of treatment drink: 150 mL of either water or fruit-infused water during exercise every 15 minutes until 1 h had elapsed. 9) The second collection of urine and measurement of body weight (post-exercise data) were performed immediately after exercised had finished. The study procedures were approved by the Institutional Human Study Committee of Faculty of Sports Sciences, Semarang State University (Universitas Negeri Semarang).

Fruit-infused water, which contained 212 Kcal/L of energy, was obtained from 138 g of apple, 118 g of banana and 108 g of lemon. This recipe also contained 61 g/L of carbohydrates which is equal to 6% of a carbohydrate beverage (recommended for sport drink). Mineral water was used in this recipe. The following procedure was followed for the fruit-infused water: 1) The apple and lemon were washed. The banana was peeled and thinly sliced. 2) The fruits were mixed, (the juice and flavor were extracted from the fruits by pressing and twisting them with a mixer in batches before and after adding the liquid). Mixed fruit adds flavor quickly. 3) The fruits were then crushed and the herbs were pressed with a flavor wand to release their flavors. The fruits were crushed gently because over-crushing could cause bitter taste. 4) Instant infusion was then performed. This process involves combining liquid with mixed fruits and crushed herbs and pumping the beverage with a flavor wand. The wand was held vertically while pumping it up and down. The bottle/container was then closed and placed in the refrigerator for a minimum of 30 min until the temperature reached 15-22 °C. At this point it was ready to be drink (Ali, M.A. et al, 2016).

The exercise was designed based on FITT formula with some modifications. It consisted of running for 60 minutes with intensity of 70% - 80% of Maximum Heart Rate (MHR) on treadmill with 3° incline. Target intensity was monitored using indicators of: 1) awareness that breathing is harder, and 2) ability to talk but difficult to hold the conversation. In addition, the subjects were asked to wear sauna jacket during exercise in order to increase their body temperature and sweating (Murray, B., 2007).

Body-Weight Scale Type ZT-120 was

used in this study. The subject step on it barefoot and wearing underwear. The specifications of Body-Weight Scale Type ZT-120 were: 1) Maximum weight which can be measured: 120 kg. 2) Height range: 70-190 cm. 3) Method of measurement: Automatic. 4) Accuracy: 0.1 mg.

The steps of urine collection were: 1) Collection of urine for about 2/3 of glass tube. 2) The color was then observed and matched with color in the urine chart, converted into number to determine the dehydration level (Simpson, M.R. and Howard, T., 2011).

The data were expressed as the means ± standard errors of the mean (SEMs). The t-test was used to determine whether there were any effects of fruit-infused water on body weight and urine color. A level of  $P < 0.05$  was considered statistically significant.

### Results and Discussion

Each of the experimental groups consisted of 8 subjects. The average ages of all subjects were 19 years old. The maximum heart rate of all subjects was 200 bpm, and 70 percent of the target heart rate (THR) was 140 bpm, while 80 percent of THR was 160 bpm.

The Body Weight (Kg), in all experimental groups were decreased by 1% during endurance exercise (FEO: -880 g; FEW: -560 g; FEF: -790 g), (Table 2). The treatment drinks, either water (FEW) or fruit-infused water (FEF), could not prevent the 1% loss of body weight compared with control group (FEO) ( $P > .05$ ).

One percent decrease in body weight during endurance exercise might lead to reduced performance. However it was not enough to impair the performance because loss of 2% in body weight caused performance impairment for about 7% - 29% (Goulet, E.D.B., 2012). Loss of body weight which occurred in this study was classified as modest/mild dehydration, which was commonly found in team-sport (Osterberg, K.L. et al, 2009). Moreover, previous studies confirmed that loss of 1% to 2% of body weight caused adverse effects on physiological function and muscular endurance which was correlated with change in cardiac output, and negatively affect performance, but the muscle strength was relatively unaffected (Goulet, E.D.B., 2012; Cengiz, A. and Demirhan, B., 2013).

1% to 2% loss of body weight could impair cognitive function, led to reduction

**Table 1. Characteristics of Subjects**

Experimental Groups	n	Age (years)	Maximum Heart Rate (bpm)	Target Heart Rate (bpm)	
				70%	80%
FEO	8	19,75	200,25	140,18	160,20
FEW	8	19,38	200,63	140,44	260,50
FEF	8	19,25	200,75	140,53	260,60

**Table 2. Change in Body Weight (Kg) after Exercise**

Experimental Groups	Body Weight (Kg)			
	Pre-Exercise	Post-Exercise	BW Change	Δ%
FEO	63,31	62,44	- 0,88	0,001
FEW	57,94	57,38	- 0,56	0,001
FEF	65,60	64,81	- 0,79	0,001

in subjective perception of alertness and ability to concentrate and increase in self-reported tiredness and headache. In addition, it also caused negative psychological effects on performance such as increased fatigue, anger, anxiety, decrease in mood and motivation, and increased confusion (Cengiz, A. and Demirhan, B., 2013).

Besides body weight, urine color also could be used to investigate whether individual was dehydrated or not (Simpson, M.R. and Howard, T., 2011). The change in urine color was clearly different between pre-exercise with post-exercise data ( $P < 0.05$ ). Before exercise treatment were given, subjects from all experimental groups were in good hydrated status as the urine score in each group were

2.63 in FEO group, 3.00 in FEW group, and 2.25 in FEF group. After exercise treatment, the darkest urine color was observed in FEO group (4.75), followed by FEW group (4.25) which were classified into dehydration. Interestingly, the change of urine color in FEF group (3.63) did not reached dehydration level (Figure 2).

Exercise-induced dehydration was observed. The loss of body weight led to decrease in total body water, extracellular water, blood volume and plasma volume (Relic, D. et al, 2013). Dehydration during exercise is primarily caused by the process of evaporation (one mechanism of heat dissipation). Once the temperature is increased, the sweat gland helps the body to stabilize the core temperature. Sweating caused loss of valuable fluids from

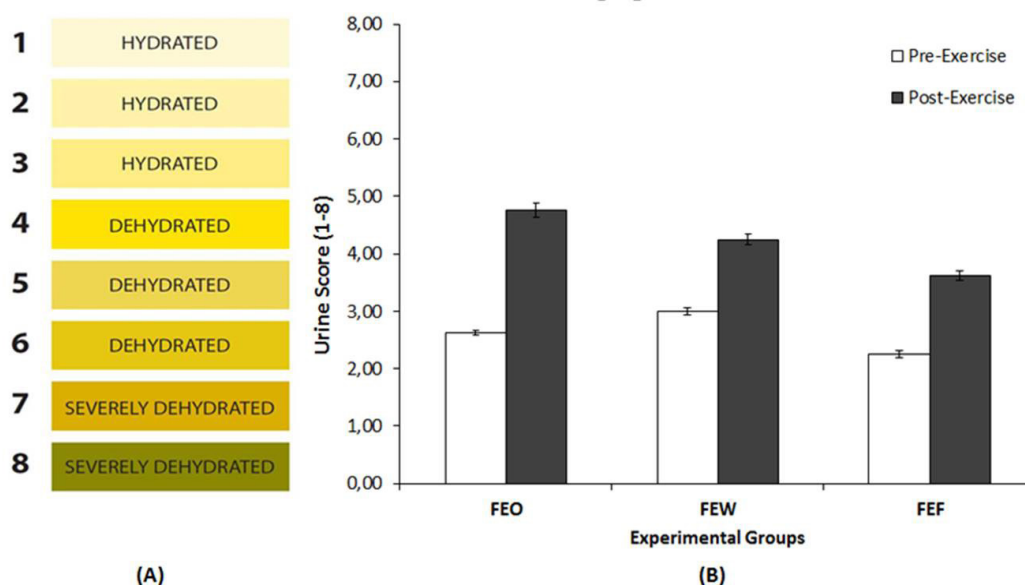


Figure 2. A. Urine Chart (Adopted from Simpson, M.R. and Howard, T., 2011), and B. Change in Urine Color after Exercise

the body. The rate is dependent to individual differences, intensity of exercise, conditions of environment, clothing, acclimatization state, and hydration status. Individual with excess sweat who undertakes intense exercise can become dehydrated. Modest dehydration carries few risks and can usually be treated by replacement of lost salts and fluids. Basically, drinking water as an effort to prevent dehydration is better than nothing. But drinking formulated liquid which content substances which are appropriate for physiological function is expected to be better.

Investigation about the usage of juice and juice-like water (fruit infused water) on health or athlete's performance had been conducted (Ali, M.A. et al, 2016; Januardi R. I., 2017). In the study which was conducted by Januardi about the effectiveness of fruit juice consumption as pain reliever for bruise trauma in *pencak silat* athletes, he discovered that the fruit juice was effective to reduce muscle pain. Furthermore, *jamu cekok* (Javanese herbal) also had been studied regarding its stimulatory effect on increasing the appetite and weight of toddler, especially the usage of *Curcuma aeruginosa*, *Curcuma xanthorrhiza* robx, *Kaempferla galanga* L, *Meniran phyllanthus niruri*, *Zingiber americans*, *Carica papaya* l, *Curcuma domestica* val, bitter and rotten tempoh (Marni & Retno

Ambarwati, 2015).

Endurance exercise in this study successfully caused dehydration by decrease of 1% of body weight. Unfortunately, the intake fluid either water or fruit-infused water could not prevent the loss of body weight. Furthermore, the change of urine color was suppressed only by drinking fruit-infused water. Fruit-infused water is suggested to be drink as a choice for fluid intake during endurance exercise.

### Conclusion

Body weight in all experimental groups were decreased by 1% during endurance exercise. This loss could not be prevented either using fruit-infused water or water compared with FEO group ( $p > .05$ ). The change in urine color was clearly different between pre-exercise and post-exercise data ( $p < .05$ ). The darkest urine color was observed in FEO group (4.75), followed by FEW group (4.25), while FEF group (3.63) did not reached dehydration level. Fruit-infused water is suggested to be drink as a choice for fluid intake during exercise.

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