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## Effect of Fruit-Infused Water (Combination of Apple, Banana and Lemon) on Blood Glucose in Young Men

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**Abstract:** The purpose of this study was to investigate the effect of fruit-infused water (FIW) on blood glucose (BG) in young men. This study was conducted from 06:00 a.m. until 12:00 p.m. Twenty-four young men (19-20 year old) were divided into three groups: (1) fasting-only (FO), (2) fasting-water (FW) and (3) fasting-fruit-infused water (FF). All subjects fasted for 12 h before receiving treatment (water or fruit-infused water). Blood glucose was measured a total of 9 times before treatment and every 15 min after administration of treatment for 2 h. Fasting blood glucose indicated no significant differences among the 3 experimental groups: FO (100 mg/dL), FW (98 mg/dL) and FF (98 mg/dL). Interestingly, at the first 15 min, fruit-infused water appeared to elevate blood glucose [FF (107 mg/dL), FW (98 mg/dL) and FO (97 mg/dL)]. At the second 15 min, the elevation of BG in FF group was still elevated (115 mg/dL) compared with FW (96 mg/dL) and FO group (100 mg/dL). However, at the third 15 min, this elevation dropped slightly [FF (105 mg/dL), FW (94 mg/dL), FO (99 mg/dL)]. Beyond 60 min, following water/FIW intake there was no significant differences among the three groups. Fruit-infused water is able to elevate blood glucose. The elevation of BG from intake of FIW is maintained for approximately 45 min.

**Key words:** Fruit-infused water, blood glucose, hypoglycemic

### INTRODUCTION

Numerous articles report the beneficial effects of the recent trend of fruit-infused water. However, there is insufficient scientific evidence that provides support for those statements.

Fruit-infused water is a combination of any fruit, vegetable or herbal ingredients that is immersed in cold water, (Johns, 2015). When used as fluid replacement, fruit-infused water is recommended to be consumed at 15-22°C, (Convertino *et al.*, 1996). The nutritional value in fruit-infused water is similar to that of fruit juice. Fruit-infused water is customizable based on individual taste. Apple is a common fruits used to make a fruit-infused water, (Mitchell, 2013).

In Indonesia, apple and banana are non-seasonal fruits; they are easily found in many traditional markets and supermarkets. These fruit include, particularly, the local Indonesian apple (Malang apple, which is named after the city of its origin) and many varieties of banana. Apple and banana are consumed in salads, juice, cake and other forms of food. Lemon is generally used to provide an alternate flavor in food and beverage, (Murdock, 2002). The nutritional content of apples, bananas and lemons is presented in Table 1.

Sugar from fruit is also known as fructose. It is one of many types of simple sugars and is the sweetest type. In the human body, fructose is broken down from saccharose. Fructose is easily absorbed by the

circulation system and quickly increases blood glucose level, (Almatsier, 2009). Glucose is needed as the main fuel for the human body. Neurons and red blood cells use energy only in the form of adenosine triphosphate (ATP) from the glycolysis of glucose. The normal mean blood glucose level is approximately  $\pm 90$  (mg/dL). Homeostatis is regulated by the endocrine system using the hormones insulin and glucagon. These hormones are produced by alpha and beta cells in pancreas, (Goodwin, 2010; Almatsier, 2009).

The purpose of this study was to examine the effect of fruit-infused water (combination of apple, banana and lemon) on blood glucose in young men.

### MATERIALS AND METHODS

**Design, material and procedure:** This is an experimental research study. The independent variable in this study is fruit-infused water, while the dependent variable is blood glucose. It was conducted at 06:00 a.m. until 12:00 p.m. Twenty-four young men (aged 19-20 years) were divided into three groups, (1) fasting-only (FO), (2) fasting-water (FW) and (3) fasting-fruit-infused water (FF). The following procedure was implemented: (1) The subjects were examined a week before the experiment. (2) 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,

subjects were asked to sit and rest for 15 min. (5) The first measurement of blood glucose (fasting blood glucose) was then taken. (6) The treatment drink was administrated: 500 mL of either water or fruit-infused water. (7) The second measurement of blood glucose was performed 15 min after drinking. (8) Subsequent blood glucose measurements were performed at 15 min increments until 2 h had elapsed (9 times in total), (Fig. 1). The study procedures were approved by the Institutional Human Study Committee of Faculty of Sports Sciences, Semarang State University.

The fruit-infused water contained energy 212 Kcal/L of energy, which 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: The apple and lemon were washed. The banana was peeled and thinly sliced. (1) The fruits were muddled, (the juice and flavor ere extracted from the fruits by pressing and twisting them with a muddler in batches before and after adding the liquid). Muddled fruit adds flavor quickly. (2) The fruits were then crushed and herbs were pressed with a flavor wand to release their flavors. The fruits were crushed gently, as over-crushing, may cause a bitter taste. (3) Instant infusion was then performed. This process involves combining liquid with the muddled 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 drink. These techniques are adopted from primulaproducts.com with some modifications.

Blood Glucose Measurement, protocol of BG measurement performed is based on the instruction from GlucoDr™ Blood Glucose Test Meter.

Here are the specifications of GlucoDr™ Blood Glucose Test Meter:

- 1: Model: AGM-2100
- 2: Method of measurement: Electrochemical
- 3: Sample Volume: 4 µl (microliter)
- 4: Test Strip: GlucoDr™ Blood Glucose Test Strip
- 5: Test Range: 20-600 mg/dL
- 6: Test Time: 11 sec.
- 7: Calibration: Knob
- 9: Operational Range: 15-30°C (room temperature), humidity <85%

**Data analysis:** The data were expressed as the mean±standard errors of the mean (SEMs). The t-test was used to determine whether there were any effects of fruit-infused water on blood glucose. A level of  $p < 0.05$  was considered statistically significant.

## RESULTS AND DISCUSSION

Twenty-four young men (19-20 year old) were divided into three groups (Table 2).

The fasting blood glucose indicated that there is no significant difference among the 3 experimental groups [FO (100 mg/dL), FW (98 mg/dL) and FF (98 mg/dL)]. Interestingly, within the first 15 minutes, the fruit-infused water appeared to increase blood glucose in the FF group significantly compared to the FW and FO groups ( $p < 0.05$ ). Within the second 15 min, the elevation of BG in the FF group was maintained compared to the other two groups ( $p < 0.01$ ). However, within the third 15 minutes, the BG was elevated in comparison to the FW group ( $p < 0.02$ ) but not the FO group ( $p > 0.05$ ). Beyond 60 minutes, there was no statistically significant difference among all three groups, (Fig. 2).

Increased blood glucose in the FF group, may indicate that fruit-infused water has enough of a glycemic index to allow rise in the blood glucose level. The studied ingredients in this research are apple and banana. Both of the fruits are well known as high caloric fruit. Lemon was used in this study to provide a fresh taste, (Murdock, 2002). In addition, fructose which is contained in fruits, is more easily absorbed and influences blood glucose levels in a short period of time compared to complex sugars (Almatsier, 2009). In line with a study conducted by Nieman *et al.* (2012), which used banana, (banana in the fruit-infused water seems capable to increase

Table 1: Nutrition content of apple, banana and lemon, (Murdock, 2002)

Nutrition	Apple (138 g)	Banana (118 g)	Lemon (108 g)
Energy (Kcal)	81	109	22
Carbohydrate (g)	21	28	12
Protein (g)	0	1	1
Fat (g)	0	1	0
Water (%)	84	74	87
Fiber (g)	4	3	5

Table 2: Characteristics of subject

Group	N	Age (years)	Body weight (kg)
FO (Fasting-only)	8	19.75 (±0.70)	63.31 (±6.35)
FW (Fasting-water)	8	19.37 (±0.74)	57.93 (±6.16)
FF (Fasting-fruit infused water)	8	19.25 (±0.46)	65.60 (±9.24)

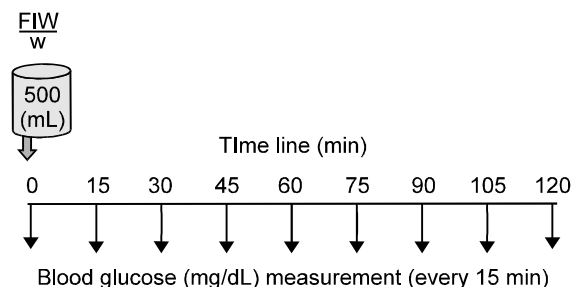


Fig. 1: Study design

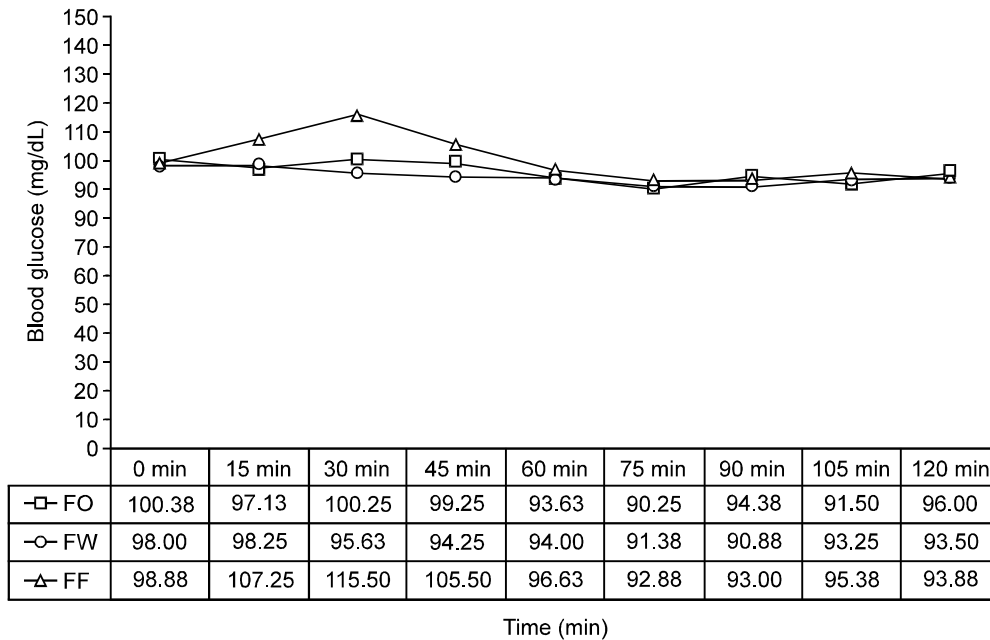


Fig. 2: Response of blood glucose from administration of treatment

blood glucose) stated that banana was able to maintain blood glucose during physical exercise. Moreover, consumption of banana was suggested as capable of maintaining exercise performance, (Nieman *et al.*, 2012). Decreased blood glucose at 60 minutes after treatment indicated that it was probably absorbed into the body's cells.

**Conclusion:** Fruit-infused water is able to elevate blood glucose. The elevation of BG caused by intake of FIW can be maintained for approximately 45 min.

**Suggestion:** Fruit-infused water can be used to maintain blood glucose and avoid hypoglycemic conditions.

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