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Influence/effectiveness of carrot and orange mix juice on Vo_2max in soccer players

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ABSTRAK

Latar Belakang: *Daya tahan kardiorespirasi merupakan salah satu unsur penting dalam melakukan latihan fisik. Daya tahan kardiorespiratori dapat diketahui dengan mengukur konsumsi atau volume oksigen maksimal ($\tilde{V}O_2$maks). Suplementasi buah dan sayur tertentu telah dibuktikan dapat berperan terhadap daya tahan atlet. Buah dan sayur diduga mempengaruhi daya tahan dengan menunda kelelahan disebabkan zat gizi yang terkandung seperti karbohidrat, vitamin, mineral, dan zat fitokimia. Penelitian sebelumnya menyatakan buah-buahan sumber karbohidrat diketahui dapat memperbaiki $\tilde{V}O_2$maks. Beta carotene dan vitamin C telah teruji dapat meningkatkan daya tahan. Buah wortel dan jeruk merupakan buah-buahan dengan kandungan beta carotene dan vitamin C yang tinggi. Buah wortel dan jeruk juga mengandung mineral yang tinggi yaitu kalium. Kalium merupakan mineral utama yang sangat dibutuhkan pada latihan yang membutuhkan daya tahan (endurance) dan kalium diketahui juga berperan dalam metabolisme karbohidrat untuk mengubah glukosa menjadi glikogen yang disimpan dalam hati untuk energi. Efek dari kombinasi beta carotene, vitamin C dan kalium pada jus wortel dan jeruk terhadap daya tahan kardiorespirasi pada atlit perlu analisis lebih lanjut.*

Tujuan: *Penelitian ini bertujuan mengetahui pengaruh pemberian jus wortel-jeruk terhadap nilai $\tilde{V}O_2$maks pada atlet sepak bola.*

Metode: *Penelitian ini merupakan penelitian quasi eksperimental dengan rancangan pre-post test without control group. Jumlah subjek penelitian adalah sembilan atlet sepak bola yang memenuhi kriteria inklusi di Unit Kegiatan Mahasiswa (UKM) Sepak Bola Universitas Ahmad Dahlan Yogyakarta. Subjek penelitian menerima intervensi pemberian 250 ml jus wortel-jeruk selama 13 hari. Nilai $\tilde{V}O_2$maks diukur menggunakan yoyo intermittent recovery test I sebelum dan setelah intervensi. Perbedaan nilai $\tilde{V}O_2$maks sebelum dan setelah intervensi dianalisis menggunakan uji paired t-test.*

Hasil: *Hasil pengukuran nilai $\tilde{V}O_2$maks sebelum pemberian jus wortel-jeruk (44,02 ± 2,66) ml /kg /menit dan setelah pemberian jus wortel-jeruk (45,88 ± 3,11) ml /kg /menit. Terdapat perbedaan $\tilde{V}O_2$maks yang signifikan setelah pemberian jus wortel-jeruk pada atlet sepak bola (p= 0.003).*

Kesimpulan: *Pemberian jus wortel-jeruk efektif meningkatkan nilai $\tilde{V}O_2$maks atlet sepak bola.*

KATA KUNCI: jeruk, sepak bola, $\tilde{V}O_2$maks, wortel, *yoyo intermittent recovery test I.*

ABSTRACT

Background: *Cardiorespiratory endurance is one of the main factors for exercising. Cardiorespiratory endurance can be known by measuring $\tilde{V}O_2$max. Fruits and vegetables intake can give beneficial impact for endurance athletes. Fruits and vegetables are thought to affect endurance by delaying fatigue caused by nutrients contained such as carbohydrates, vitamins, minerals, and phytochemicals. Previous studies stated that fruit sources of carbohydrates are known to improve ṼO2maks. Beta carotene and vitamin C have been proven to increase endurance. Carrots and oranges are high in beta carotene and vitamin C. Carrot and orange also contain a high level of potassium. Potassium is one of the main mineral which is needed for endurance exercise and it also has the potential to help carbohydrates metabolism in converting glucose to glycogen which later saved by the liver as an energy source. The effect of the combination of beta carotene, vitamin C and potassium on carrot and orange juice on cardiorespiratory endurance in athletes requires further analysis.*

Objectives: *The purpose of this study was to assess the effect of carrot-orange juice on $\tilde{V}O_2$max in soccer players.*

Methods: *This study was a quasi-experimental with pre-post test without control group design. There were nine soccer players from Universitas Ahmad Dahlan Yogyakarta that were taken by using purposive sampling which is match with criteria. The subject had been given 250 ml of carrot-orange juice for 13 days. $\tilde{V}O_2$max was measured by using a yoyo intermittent recovery test I. All data were analyzed by paired T-test.*

Results: *The mean of $\tilde{V}O_2$max in soccer players before consuming carrot-orange juice is 44.02 ± 2.66 ml /kg /min and after consuming carrot-orange juice is 45.88 ± 3.11 66 ml /kg /min. There was significant $\tilde{V}O_2$max difference after carrot-orange (p= 0.003).*

Conclusion: *Consumption of carrot-orange juice for 13 days effectively increase $\tilde{V}O_2$max level of soccer players.*

KEYWORDS: *carrot, orange, soccer, $\tilde{V}O_2$max, yoyo intermittent recovery test I.*

INTRODUCTION

High-intensity training that is done continuously can result in the increased of radical production resulting in oxidative stress which then triggers the gain of fatigue and causing the endurance to drop (1). Fatigue can also be caused by the reduction of muscle glycogen and blood glucose. Moreover, during the game athletes also tend to sweat which causes the risk of dehydration and electrolyte imbalance (2).

Cardiorespiratory endurance and body strength are essential in physical activity, workout, and exercise (3). Cardiorespiratory endurance can be known by measuring the maximum oxygen volume. The maximum oxygen volume which commonly called $\tilde{V}O_2$max can be defined as the maximum capacity in taking, transporting, and using oxygen during exercise (4). The low value of $\tilde{V}O_2$max in athlete will affect the endurance and performance while competing. Therefore, the ideal value of $\tilde{V}O_2$max will indirectly affect soccer achievement (5).

The average score of athlete's $\tilde{V}O_2$max at the Semarang State University Football Club was 41.7 ml/kg/ minute which depicted through with the Multistage fitness test (MFT) (6). The score of the stamina of the Undip Tembalang Football School athletes described by measuring $\tilde{V}O_2$max with Queen's College Step Test is 49.67 ml/kg/ minute (7). These results are still below the standard of international soccer athletes in which the average world soccer player has a high $\tilde{V}O_2$max which is around 60.5 ml/kg/ minute (8).

Carrots and oranges are natural sources of carbohydrates and electrolytes. Carrots are a type of vegetable that is high in carbohydrates, potassium, and antioxidants. The kind of simple carbohydrates in citrus fruits are fructose, glucose, and sucrose which can provide energy source quickly (9). The high content of beta-carotene from carrots and high vitamin C content in orange have the potential as antioxidants to help oxidative inhibition that can occur during endurance exercise thus preventing fatigue and improving cardiorespiratory endurance.

Potassium in carrots and oranges works for fluid balance of the body and is responsible for delivering nerve impulses and muscle contractions. A study states thatincreased activity of Na +, K +, and ATPase during exercise can stabilize the concentration of sodium and potassium in the membrane so that it can prevent fatigue (10). Potassium also influences the uptake and transport of glucose in the small intestine for it to can be used as an energy source (11).

UKM bola UAD (Universitas Ahmad Dahlan) has a training schedule for four times a week with 90 minutes duration in each timeline. The endurance training program carried out in the form of jogging, zig-zag running, hurdles, and twisting which done for 40 minutes every three times a week. On the average, the Members of UKM have an excellent nutritional status which is around 77.27% of the population. According to the last $\tilde{V}O_2$max records which were measured by using bleep test, it shows the mean of $\tilde{V}O_2$max that had been accomplished by the population only around 43.74 ml/kg/min which

mean the $\tilde{V}O_2max$ of the population stands at the low to above average category. The aim of this research was to assess the effect of carrot-orange juice on $\tilde{V}O_2max$ in soccer players.

MATERIALS AND METHODS

Study design

This research was quasi-experimental with the pre-post test without control group design. This study had ethical clearance from Komite Etik Universitas Respati Yogyakarta with the number 009.4/FIKES/PL/I/2018. This research was conducted in two places that are Laboratorium Dietetik dan Kuliner Universitas Respati Yogyakarta (which where the juice is made) and UKM sepak bola UAD (the place where the test is conducted) on January 4th – January 21st , 2018. The population in this research are soccer players from UKM sepak bola UAD. There were 14 soccer players who had been chosen by using purposive sampling.

Subjects

The subject size was calculated using the formula for experimental research (12) with a minimum sample size of eleven subjects. Subjects must first be informed through an agreement. All of the subject's information and data in this research are kept confidential and only used for scientific purposes. The 14 soccer players had met the inclusion criteria such as aged 18-25 years old active member of UKM sepak bola UAD for at least three months, in the research location during the research, not smoker and also not an alcoholic. As for the exclusion criteria were athlete ever with injury history or in the medical treatment and having a heart or lung defect. Meanwhile, only nine subjects finished the study. During the study, one subject was lost to follow-up because he could not be contacted while four other subjects were unable to take the post-intervention test due to sudden personal matters and could not be abandoned. It is not possible to replace the subject because at the recruitment stage the subject was sampling from the entire subject population in UKM UAD.

Experimental protocol

The subject was given carrot and orange juice combination which was made from 75 g of carrots, 25 g of sweet orange and addition of sugar up to 8% diluted to 250 ml. The juice was given 1 x 250 ml every day for **13 days**. The conditioning procedures which were required during the test were the subject had a minimum of 6-8 hours of sleep, not consuming caffeine, energy drink, isotonic or alcoholic beverages, not taking supplements and not doing strenuous activities the day before $\tilde{V}O_2max$ measurement.

$\tilde{V}O_2max$ measurement

The $\tilde{V}O_2max$ measurement used in this study was the yoyo intermittent recovery test level I which conducted before and after the intervention. The yoyo intermittent recovery test level I was the kind of test where the subject was asked to run based on the rhythm of the tape recorder which increases gradually. The equation used to calculate the $\tilde{V}O_2max$ of athletes is (13):

$$\tilde{V}O_2max\ (mL/min/kg) = distance\ (m) \times 0.0084 + 36.4$$

Physical activity, dietary intake, and fluids measurement

Forms of physical activity level, SQFFQ, and fluids food record were used as corrections to the subject conditioning procedure. Other instruments used in the study were informed consent forms, profile data forms, weight scales, microtia, as well as measuring tools and $\tilde{V}O_2max$ equipment. Calibration of scales and microtones has been carried out before the device was used for the study. Univariate analysis was used to perform analysis of each variable studied to know the frequency or distribution of the data. Bivariate analysis was done to determine the effect of carrot-orange mix juice on $\tilde{V}O_2max$ by using *paired T-test* with a 95% confidence level.

RESULTS

All subjects who participated in this study were male student soccer players from UKM UAD.

Subject characteristics conducted in this study included age, weight, height, body mass index (BMI), food consumption, fluid intake and position in the team (**Table 1**).

Table 1. Anthropometric characteristics and macronutrient intake of participants

Subject Characteristic	N (%)	Mean ± SD
Age (years)	9 (100)	20.78 ± 1.99
Body Weight (kg)	9 (100)	59.10 ± 5.98
Height (cm)	9 (100)	163.61 ± 4.63
BMI (kg/m^2)	9 (100)	22.11 ± 2.27
Food Consumption	9 (100)	
Energy (kcal)		2504.23 ± 363.00
Protein (g)		83.02 ± 13.34
Fat (g)		109.58 ± 15.67
Carbohydrate (g)		284.87 ± 45.26
Vitamin A (µg)		3290.61 ± 370.20
Carotene (µg)		400.00 (300.00 – 900.00)*
Vitamin C (mg)		39.51 ± 9.61
Potassium (mg)		1613.07 ± 305.13
Fluid Intake (mL)	9 (100)	2192.50 ± 911.93
Position in the Team		
Defender	5(55.56%)	
Midfielder	1(11.11%)	
Striker	3(33.33%)	

*median (min-max)

According to interviews using physical activity level forms, most subjects had a mild physical activity. Beverage food record form was used as a correction to subject beverage consumption one day before the study. Based on the results of the interview, it was known that one day before the study one subject consumed caffeinated beverages that were not recommended. Moreover, the subjects had a different amount of sleeping duration with most of them were following the recommendation for adequate sleep although some subjects who slept less than 6 six hours. Based on **Table 2**, it is known that there is no $\tilde{V}O_2$maks difference based on physical activity, consumption of caffeinated drinks, and sleep quality.

In this study, $\tilde{V}O_2$max was indirectly measured by using yoyo intermittent recovery test level I. There is a different value of $\tilde{V}O_2$max before orange-carrot juice consumption and after getting carrot-orange juice (p=0.003). The average of $\tilde{V}O_2$max before intervention of carrot-orange juice (44.02 ml / kg / minute) was lower than the average of $\tilde{V}O_2$max after the intervention of carrot orange juice (45.88 ml / kg / minute) (**Table 3**).

Table 3. $\tilde{V}O_2$max before and after treatment

Measurement	N	$\tilde{V}O_2$max (ml/kg/ min) (Mean ± SD)	*p*
Before Intervention	9	44.02 ± 2.66	0.003*
After Intervention	9	45.88 ± 3.11	

*significant on $p < 0,05$

Table 2. Physical activity, caffeinated beverages consumption and sleeping quality before and after intervention

Subject Conditioning	PRE			POST		
	N (%)	$\tilde{V}O_2$max (mean ± SD ml/kg/min)	p	N (%)	$\tilde{V}O_2$max (mean ± SD ml/kg/min)	p
Phisical Activity						
Mild	6	43.62 ± 3.01	0.772	7	44.94 ± 2.63	0.463
Average	2	45.30 ± 2.60		1	47.15 ± 0.00	
Heavy	1	43.79 ± 0.00		1	51.17 ± 0.00	
Caffeinated beverages consumption						
Yes	0	-	-	1	43.12 ± 0.00	0.381
No	9	-		8	46.22 ± 3.13	
Sleeping quality						
Good	6	44.01 ± 2.01	0.111	4	46.48 ± 2.63	0.672
Bad	3	44.01 ± 4.25		5	45.40 ± 3.67	

*Mann-Whitney Correlation, α=0,05

DISCUSSION

There is $\tilde{V}O_2max$ significant differences before and after carrot-orange juice consumption (p=0.003) with an average increase of 1.86 ml / kg / minute. This study showed that consuming 250 ml carrot-orange juice for 13 days affects ṼO2max of soccer players. It is consistent with the previous studies where the mean of $\tilde{V}O_2max$ in the group that received 300 ml of orange juice (54.9 grams of carbohydrate) 30 minutes before the test was significantly higher ($p < 0.05$) compared to those who did not receive it (14).

Carrot-orange juice which is produced in this study has total carbohydrate content of 8% or equal to 20 g carbohydrate of each serving. Carbohydrates in carrot come in the form of fiber and sugar which the sugar has the highest amount compared to any other vegetables. There are two kinds of carbohydrates in orange, namely simple carbohydrates in the form of fructose, sucrose and glucose and complex carbohydrates in the form of non-starch polysaccharides (fiber). Carbohydrates in carrot-orange juice act as a substrate for ATP formation-energy source for muscle contraction during exercise (15).

Reduction of carbohydrate reserves such as muscle glycogen and liver glycogen is associated with fatigue and decreased lung capacity. A beverage contains of 6-8% carbohydrates do not interfere with athletes so that carrot-orange juice can provide enough energy to maintain muscle power, prevent fatigue and slowing the decreased of glycogen reserves (16). The factor which predicted to be the cause for the significant results of this study was the higher glycogen reserves when subject received carrot-orange juice given for 13 days compared to glycogen reserves before getting carrot-orange juice. Liver glycogen decreases during physical exercise. It brings compensation in the form of liver glycogen resynthesize by consuming carbohydrates after exercise. Glycogen stores can be increased by several diets and exercise procedures (17). During the period of intervention, the subjects remained on a regular diet with an average of 90% energy fulfillment each day. Subjects also keep running routine training as usual according to the program provided by the coach. The physical exercise carried out continuously allows an increase in liver glycogen deposits. Glycogen deposits are higher in trained person and become 2.5 times higher after exercise (18)height, percent body fat, lean body mass, blood glucose levels and physical fitness with Asian Committee on the Standarization of Physical Fitness Test (ACSPFT).

Same as glycogen reserve, blood glucose levels may influence the results of this study. During the test before the intervention. Subjects were only given plain water to prevent dehydration, while subjects were given carrot-orange juice at the time of the trial after the intervention. This condition causes a difference in the intake of carbohydrate which blood glucose is higher during the test after the intervention compared to blood glucose during the trial before the intervention. Good carbohydrate intake and sufficient glycogen storage are the keys in maximum aerobic endurance during exercise. Low levels of muscle glyc ogen before exercise can cause a decrease in performance (19). soccer athletes receiving carbohydrate-electrolyte supplementation experienced less weight loss and had better sprint performance than athletes who did not get any supplementation (20).

In the aerobic energy system, increased oxygen consumption during exercise will be followed by an increase of free radicals formation in the muscle cells especially skeletal muscle cells (21). Increased free radical formation in strenuous exercise comes from an increase in the number of leukocytes and xantindehydrogenase enzyme activity (22). When free radicals attack the cell membrane,lipid peroxidation (LPO) will occur which causes changes in muscle conditions or muscle cells damage (23).

Free radicals as a sign of the oxidative stress occurrence can be neutralized by the body's defense system. The body's defense system against oxidant determined by the intake of vitamin and mineral antioxidants and the formation of endogenous antioxidants, such as glutathione (24). Carrot-orange juice contains 12.585.75 IU of vitamin A and 17.73 mg of vitamin C in every 250 ml which

is suspected to improve muscle conditions during endurance exercises. Vitamin C, vitamin E and beta carotene (vitamin A) are secondary antioxidants that are useful for capturing free radicals and preventing chain-breaking antioxidants. This result is in line with the previous studies which stated that vitamin C was sufficient to reduce malondialdehyde levels when subjects received a combination of maltodextrin and vitamin C (25). Vitamin C contained in carrot-orange juice acts as a cofactor of neurotransmitter synthesis and as an antioxidant that can affect energy metabolism. Consumption of vitamin C can reduce muscle weakness after exercise, and the recovery process becomes faster so that it affects the endurance of athletes (26).

Carrots and oranges contain carotene, a form of pro-vitamin A, where vitamin A is a type of antioxidant that can reduce oxidative stress markers during exercise (27). Vitamin A is lipophilic or a 'lipoidal chain antioxidant' which have a roll on the cell membrane to prevent lipid / LPO peroxidation or counteract peroxyl radicals (28).

Another nutrient needed to maintain exercise with high endurance capacity is potassium. Potassium can be lost along with sweat, so it requires natural food intake as a source of potassium to keep its balance in the body (29). Carrot-orange juice contains 285.75 mg of potassium. There was an average increase in potassium intake of 78.3 mg for 13 days of carrot-orange juice intervention.

Potassium plays a role in carbohydrate metabolism, and it helps the storage of glucose into glycogen stored in the liver. Glucose transport from the intestine to the mucosa is affected by the concentration of sodium and potassium in the intestinal lumen. A high potassium ion concentration increases the activity of K +, Na + and ATPase which also makes it easier to enter sugar into the cells (30). Membrane potential that occurs due to the diffusion of Na + and K + ion molecules called primary active transport supports the presence of secondary active transport, and both co-occur. Secondary active transport has the role to transport amino acids and glucose to across the plasma membrane so that the glucose can be used by the cell (11). Not only that, potassium along with sodium can maintain fluid balance during the long duration of exercising to prevent changes in nerve transmission and disruption of muscle contraction (10).

In this study, there are several weaknesses that are suspected to be another factor that causing an increase in the $\tilde{V}O_2$max including the influence of environmental temperature and athlete's readiness. The measurement test is scheduled to be carried out at the same time of the morning in both before and after the intervention but the temperature on the measurement day after the intervention happen to be lower than during the test before intervention due to unfavorable weather. $\tilde{V}O_2$max measurement was done in outdoor so that there are things that cannot be controlled by researchers including weather conditions. Body temperature can rise during the increased physical activity, environmental temperature differences, and relatively high air humidity (31). Increased body temperature can be eliminated by the removal of heat through the skin and a small portion through breathing and urine (19). Hot ambient temperatures above 31^0C will reduce the effectiveness of body heat extraction. This condition is due to the disruption of the body's balance between formation and heat extraction which later affects physical endurance. The decrease in endurance occurs due to an increase in blood flow from the muscle to the skin as thermoregulation efforts during exercise (32).

Another factor that contributes to $\tilde{V}O_2$max is the exercise carried out before the test, nutritional intake, caffeine consumption, and sleep quality. In this study, exercise had no effect on the athlete's $\tilde{V}O_2$max because one day before the test the athlete was conditioned not to engage in heavy activities and training. Nutritional intake also does not effect the athlete's $\tilde{V}O_2$max because one day before the study the athlete is conditioned not to consume certain foods and beverages. This condition is strengthened based on the correction of subject conditioning. Moreover, it was found that there was no relationship between physical activity and all nutrient intake with subject $\tilde{V}O_2$max. In addition, it is also known that there is no difference in subject $\tilde{V}O_2$max based on sleep quality and consumption of caffeinated drinks.

The athlete's readiness factor is also suspected to be another factor that increases the $\tilde{V}O_2max$. From the observations, some subjects felt more prepared to take the test after the intervention because they felt they had understood better the test procedure. The readiness of athletes both physically and mentally will cause athletes to be more relaxed and focused during the game so that it has an impact on increased performance (33).

CONCLUSION

There is a significant effect of carrot-orange juice on $\tilde{V}O_2max$ where the consumption of carrot-orange juice for 13 days effectively increase $\tilde{V}O_2max$ level of soccer players. Athletes should pay attention to the pattern and consumption of food to maintain cardiorespiratory endurance for better performance. Further studies should pay more attention to other variables that can influence $\tilde{V}O_2max$ values such as carbohydrate intake per day and also other foods contain beta carotene, vitamin C, and potassium.

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