

Acute physiological responses and performance following subsequent CrossFit ‘CINDY’ workout with *Zea Mays* juice

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Abstract

Purpose: The purpose of this study was to investigate the physiological responses and performance following subsequent repeated high intensity exercise with consumption of *Zea may* juice (ZM).

Material: Total of seventeen participants involved in the study. They were physically active who had cardio and strength training at least 3 times per week. The age of participants was 21.8±1.7 years old, body weight 65.4±11.2 kg and height 169.7±7.2 cm. Crossfit ‘CINDY’ exercise were repeated between two hours of rest. Treatment beverage of (ZM) juice vs Carbohydrate-electrolyte (CE) drinks were consumed immediately after exercise in double blind cross over manner. Number of complete set of exercise, heart rate, blood lactate and rate of perceived exhaustion (RPE) were recorded at the end of each exercise session.

Results: Total number of complete ‘CINDY’ exercise significantly increased in ZM juice group during second bout of exercise compared to CE drink group. There were no significant difference in heart rate, blood lactate and RPE in both groups.

Conclusions: ZM juice has potentials an alternative recovery beverage to promote subsequent repeated exercise within short rest time.

Keywords: Zea mays, recovery beverage, performance, physiology responses.

Introduction

High intensity exercise with repeated bout session within short period of time need proper recovery plan to support performance [1]. Athletes that involved in repeated event within short rest time such as swimming, sprinter, combat sports, badminton, squash and team sports like hand ball and futsal, need to recover as fast as possible in order to promote performance during each stage of competition [2]. During the competition, the athletes usually have less than 2 hours before performing the next event. Therefore they need to consume enough energy and fluid in order to prepare their body for the next game [3, 4]. Recovery food or fluid that contains carbohydrate, protein and mineral such as sodium were proven to fasten recovery [3, 5]. Liquid form of recovery meal was preferred [6] for better acceptance and absorption due to short time in between games and appetite suppression issue after high intensity exercise. For that reason palatable beverage is warranted [7, 8] in promoting total intake of recovery beverage.

CrossFit is a fitness training that incorporates resistance (e.g. deadlift, power clean, snatch etc.) and endurance (e.g. rowing, running, cycling) activity within single bout [9, 10]. It is designed to complete the exercise task within short period of time in high intensity environment. There are exercise tasks involved in CrossFit workout which is called workout of the day (WOD). They ‘named’ the exercise so that it is easy to monitor the progress. One of the WOD was named ‘CINDY’ which consists of pull up, push up and squat. Physiology and metabolic response of ‘CINDY’ had been classified as moderate to vigorous

intensity exercise [11, 12] according to American College of Sports Medicine guideline [13]. The classification was similar to the games environment where athletes need to give their performance best at each stages to go further round. Therefore practice on recovery plan is warranted to support performance toward the final round.

An electrolyte carbohydrate drink is well known for its benefit to rehydrate and recovery [14–16]. Presence of protein had been proven in supporting muscle synthesis [17, 18], thus fasten muscle recovery [19]. ZM juice is a beverage that made up of sweet corn that contains carbohydrate, protein and sodium. The nutrient contents showed that the beverage could be proposed as an alternative recovery beverage. Therefore this study was to investigate the ability of ZM juice as a recovery beverage in promoting subsequent high intensity exercise within short rest time.

Materials and Methods

Participants

The protocol of this study was reviewed and approved by University Pendidikan Sultan Idris Research Committee. Total of seventeen active male university athletes participated in this study. They are actively represented University as hockey and football players. The participants were physically active who had cardio and strength training at least 3 times per week. This is to ensure the participants familiar with high intensity and strength exercise. The trial was conducted upon their free time with no competition the day before the test. The participants were told to refrain from heavy exercise and protein supplement (if any) 24 hour prior to the testing day.

Procedures

The participants were briefed about the test together with demonstration of exercise protocol done by the research assistant. When the participants agreed to be a volunteer, they sign in the consent form and self-reported medical health status form. Simulation of the protocol were conducted a week before data collection together with anthropometry measurement and 20m multistage fitness test to predict their VO₂ max. The study was double blind cross over design where the participants were given different types of beverage during each session. The beverage was prepared by the research assistant without researcher knowledge. The participants were also asked to record their 24 hours diet intake (a day before trial) during the first session of trial and were reminded to consume the same type and amount of food during the second trial.

The participants were given standard breakfast 2 hours before the trial. This is to mimic the recommendation of before exercise snack. They were allowed to consume plain water in between before the trial. Upon arrival in the gym, they produced urine sample for urine specific gravity (USG) assessment. Participants who had USG reading more than 1.020, 300 ml plain water were given and waited for the next urination. The participants started the exercise when USG result showed well hydrated condition (USG >1.020) (20).

Self-warm up and stretching were done for 10 minutes before starting the Crossfit ‘CINDY’ exercise. The participants need to do 3 types of exercise regime (5 times modified pull up, 10 times push up, 15 times squad) for 20 minutes as much repetition as possible. Verbal instruction and support were given to the participants during ‘CINDY’ exercise. All of them wore heart rate monitor (CHR Casio, Japan) during the exercise. Immediately after finished the 20 minutes of exercise, the participants reported rate of perceive exhaustion (RPE) by pointing the number at the chart and heart rate reading was recorded. The finger prick blood was taken for lactate assessment using lactate Pro 2 test strips (Arkray, Japan) and portable lactate analyzer (Lacate Pro 2, LT1730 COSMED, Italy). Then the participants were consumed treatment beverage blindly within 30 minutes after exercise. The beverage was prepared in opaque water bottle and served chilled. Then they rested in the gym for two hours with no food and minimal movement. The second session of CrossFit ‘CINDY’ was continued with the same protocol. The participants were allowed to consume meal after finished

the second session. The protocol of the test is showed in Figure 1.

Treatment beverages

Two types of beverages were given to the participants. Both of the treatment drinks were prepared with similar calorie matched by the research assistant and kept in opaque water bottle. ZM juice was prepared 500 ml while carbohydrate electrolyte (CE) drink was prepared 700 ml. The additional 200 ml of plain water was given to ZM juice group for similar total volume consumed. Nutrient values of both beverages is presented in Table 1.

Table 1. Nutritional value of treatment beverages

Nutrient	Zea mays juice (500 ml)	Carbohydrate electrolyte drink (700 ml)
Calorie (kcal)	285	282
Carbohydrate (g)	49	68
Protein (g)	12	NA
Fat (g)	4.5	NA
Sodium (mg)	321.5	469.6

Statistical analysis

All data were analyzed by using statistical program for social sciences (SPSS) for windows version 23.0 (Armonk, NY: IBM Corp). Descriptive analysis reported the physical characteristic of participants and two ways repeated measure ANOVA was used for inferential analysis of physiology and performance variables. The significant value was set at p<0.05.

Results

Table 2 shows the participants characteristic. The age of participants was 21.8±1.7 years old with their body weight 65.4±11.2 kg, height 169.7±7.2 cm, and BMI 22.3±2.4 kg/m². Inbody assessment showed that their body fat percentage was 15.1±7.4%. Their VO_{2max} was 39.3±5.5 ml/kg/min.

Figure 1 showed the mean in total number of complete set of ‘CINDY’ exercise in between treatment beverages. ZM juice group showed higher total number of complete set compared to CE drinks group. There was no significant different in mean heart rate (Figure 2), mean blood lactate (Figure 3) and mean RPE score (Figure 4) in both treatment beverages and during both exercise sessions.

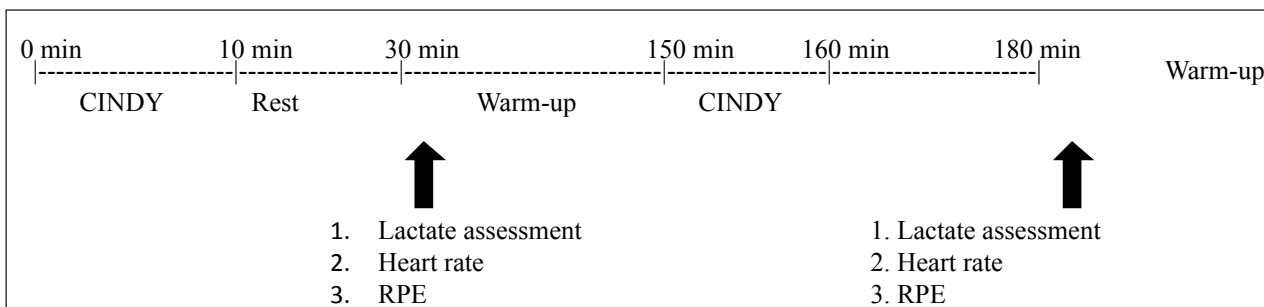


Figure 1: Schematic diagram of the trial

Consumption of both beverages did not affect any changes for those three variables. We assumed that all participants gave their full effort during both session of 'CINDY' exercise by similar heart rate values. The result of blood lactate accumulation showed that exercise intensity was high and both beverages did not able to reduce it within two hours of rest. RPE score showed that subject felt the same level of difficulty during both sessions of exercise within both treatment beverage (mean score ZM juice, EX1=6.6±1.9, EX2=6.8±2.3; CE drink, EX1=6.5±1.9, EX2=6.2±1.9)

Table 2. Participants characteristic (N=17)

Characteristic	Value ±SD
Age	21.8±1.7
Weight (kg)	65.4±11.2
Height (cm)	169.7±7.2
BMI (kg/m ²)	22.3±2.4
Percentage of fat	15.1±7.4

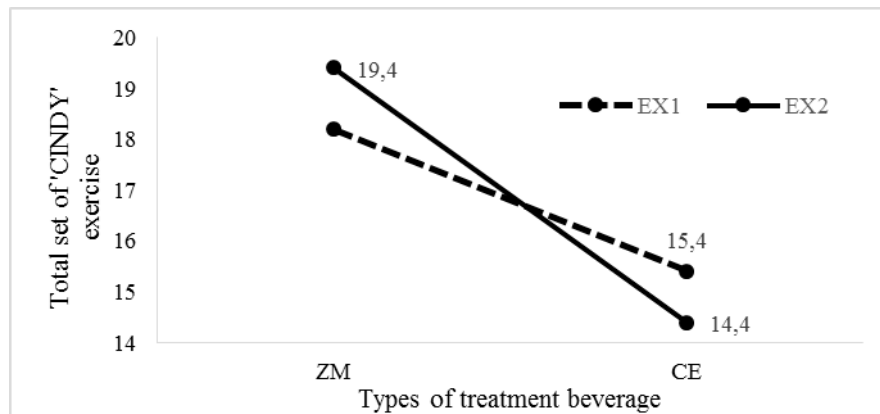


Figure 1. Mean total number complete set of 'CINDY' exercise.

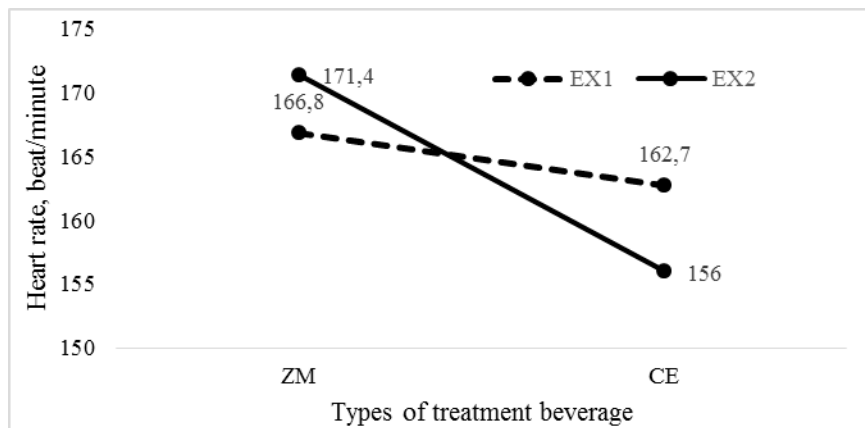


Figure 2. Mean value of heart rate (beat/minute).

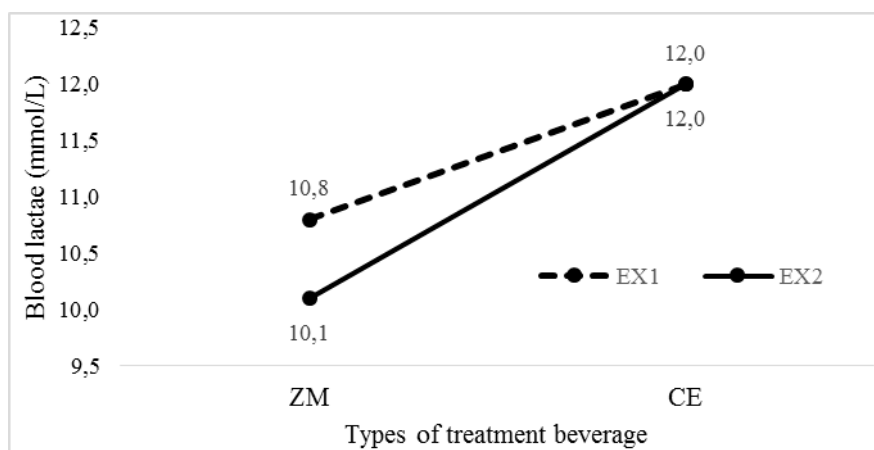


Figure 3. Mean value of blood lactate (mmol/L).

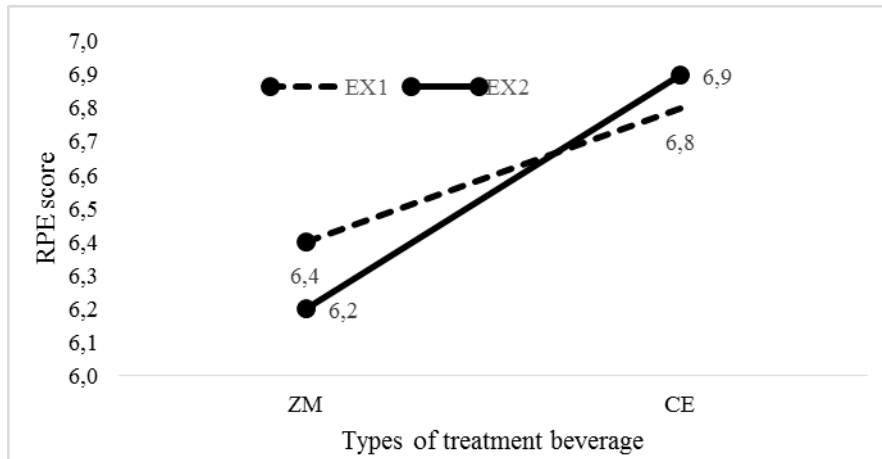


Figure 4. Mean score Rate of Perceive Exertion (RPE).

Table 4. Statistical analysis of physiological responses and performance

Variables	CINDY	Heart rate	Blood lactate	RPE
ZM juice vs CE drink	F(1, 16)=10.84, p=.005, $\eta^2=.404^*$	F(1, 16)=2.77, p=.115, $\eta^2=.148$	F(1, 16)=2.46, p=.136, $\eta^2=.133$	F(1, 16)=4.16, p=.058, $\eta^2=.206$
Between two repeated exercise bout	F(1, 16)=.008, p=.929, $\eta^2=.001$	F(1, 16)=0.029, p=.867, $\eta^2=.002$	F(1, 16)=0.154, p=.70, $\eta^2=.010$	F(1, 16)=0.061, p=.808, $\eta^2=.004$
Interaction between beverage and exercise	F(1, 16)=4.70, p=.046, $\eta^2=.227^*$	F(1, 16)=1.027, p=.326, $\eta^2=.060$	F(1, 16)=0.48, p=.50, $\eta^2=.029$	F(1, 16)=0.206, p=.656, $\eta^2=.013$

Data is significant when $p < .05$

Inferential analysis showed a significant different in total of number complete set of ‘CINDY’ exercise between ZM juice and CE drink treatment, $F(1, 16)=10.84$, $p = .005$, $\eta^2=.404$ and interaction between type of drinks and exercise performed, $F(1, 16)=4.70$, $p=.046$, $\eta^2=.227$, but no significant difference between two exercise bout, $F(1, 16)=0.08$, $p=.929$, $\eta^2=.001$. Consequently, type of drink had a significant effect on the performance of the participants between subsequent repeated exercise bouts by increasing the total number of complete set of ‘CINDY’ exercise during the second bout of exercise.

Discussion

The aim of our study was to determine the effect of ZM juice on subsequent high intensity exercise-Crossfit ‘CINDY’ performance compared to CE drink. The study was designed to mimic sports competition that has several repeated heat within short rest time. Recovery beverages that are capable to rehydrate and promote muscle recovery are warrant in order to promote subsequent performance [21]. The ZM juice was proposed as recovery beverage because it contains carbohydrate, protein and sodium that are essentials for recovery [14, 22]. The combination of carbohydrate and protein beverage was established in promoting performance [2, 23, 24]. Most of the study proposed whey [18, 25, 26] and milk based [27–30] as recovery/rehydration choices. Unfortunately, this type of

beverages are not applicable for those individuals who are vegan and lactose intolerance. Therefore, ZM juice would be a better choice to meet the recovery requirement as it is a plant based beverage.

The significant effect of ZM juice on recovery was due to its nutrient content. ZM juice contains carbohydrate and protein that promote recovery by enhancing glycogen repletion and muscle synthesis [31, 32]. Types of sugar of ZM juice were mixture of saccharides (glucose and fructose) that utilize different oxidation pathways. A mixture of saccharides promotes greater absorption rates [6, 33] compared to individual saccharide that presence in CE drink (sucrose). The ratio of carbohydrate to protein content in ZM juice was 1:4 (CHO=9.8g/100ml; Prot=2.4g/100ml). The ratio was similar as in the study of vy and colleague [34] whereby they found out subsequent time to exhaustion after cycling exercise was longer compared to carbohydrate alone. This is due to a better rate of glycogen synthesis when protein was exist [31]. On the contrary, reviewed by McLellan et al [24] stated that protein ingestion provides no further ergogenic effect when sufficient carbohydrate was delivered during exercise. Unfortunately high carbohydrate amount need to consume in meeting the recovery recommendation which usually unpalatable after exhaustive exercise. [3]. A combination of carbohydrate and protein beverage was also promoting fluid retention [35] and better accepted [36].

Most of the study claim that protein from animal which is whey promote greater muscle synthesis [18, 37, 38] compared to plant sources [39]. Generally, whey is preferred due to types of essential amino acid present compared to plant base food and supplement. It was established that essential amino acid-leucine was the main amino acid that plays a role in promoting positive net protein balance and muscle synthesis in strength and endurance exercise [17, 40, 41]. *ZM* juice contains leucine [42] that positively supports the proposed usage of *ZM* juice as recovery beverage. After all, *ZM* juice will also benefit to vegan individual that limited to animal sources but yet desire to meet the recovery objective.

There were no significant different in heart rate, blood lactate and RPE were found in this study. Hall et al [43] found that heart rate and RPE were significantly lower during second bout of cycling exercise in carbohydrate+protein group compared to carbohydrate only. The dissimilarity of this result was due to different exercise intensity used within this study. Even though 'CINDY' was done in 20 minutes, type of activities was different compared to endurance cycling. 'CINDY' mainly used whole body strength and endurance compared to cycling that focused on lower body muscle. The result of this study was similar with the findings by Goh et al. [2] when they used similar calorie content in different carbohydrate:protein ratio treatment beverage where heart rate and RPE during second bout of exercise were not significant different. Besides, we speculate that the insignificant different in heart rate, blood lactate and RPE in both trials indicated that the participants had given the same effort when given different beverages. This situation met the real competition environment.

Conclusion

ZM juice is able to promote second bout of exercise

within short rest time period. The ability of *ZM* juice to boost recovery from first bout exercise session is warranted for better physiology adaptation and performance enhancement. Natural food source of *ZM* juice gave a better choice for all age group of active individuals as when food supplement is limited to young athletes. At the same time lactose intolerance and vegan individuals will get the benefit from *ZM* juice in meeting recovery requirement.

Highlights

The practice of recovery meal/beverage should be applied during regular training for better adaptation and acceptance. Athletes should have an idea on type of food or beverage that is suitable and able to promote their sports performance. Natural food based is preferred as it is safe and nutritious with nutrients for our body.

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Conflict of interest

The authors declare no conflict of interest.

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