

ERGOGENIC EFFECTS OF CAFFEINE DOSE ON MAXIMAL AEROBIC POWER OF NORMAL NIGERIAN UNDERGRADUATE STUDENTS.

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SUMMARY

Objective:- The objective of this study was to determine the effects of 5mg/kg dose of caffeine on maximal aerobic power of normal male Nigerian adults.

Method:- Twenty normal male adults volunteers participated. A repeated measure 2 randomized crossover (counter balanced) double blind design was used in data collection. Subjects engaged in 20 meter shuttle run test (20 MST) one hour Post caffeine (5mg.kg⁻¹) and placebo doses ingestion. Endurance Performance indexes (VO₂ max, run time & number of exercise laps) were recorded.

Result:- Repeated measures t-test was used to assess the level of significant difference between caffeine doses and placebo dose in VO₂ max, run time and number of exercise laps. The result showed no significant effect of caffeine doses over placebo dose at P<0.05.

Conclusion:- It was concluded that instant soluble coffee (Caffeine) dose of 5mg/kg (300mg caffeine) seems not have any ergogenic effect on max aerobic power of normal Nigerian Adults.

Key words : Coffee, Caffeine, Exercise, ergogenic, VO₂ max

INTRODUCTION

Caffeine (1,3,7- trimethyl-xanthine) is a methyl derivative of xanthine (Robertson et al, 1981; Van Handel, 1983). It is basically a Purina compound containing two condensed heterocyclic rings. It is a naturally occurring chemical found in over 60 different species of plant leaves, seeds and fruits. Specifically, caffeine is found in coffee (coffee Arabica), tea, cola nuts (cola acuminata). It is also found but in little quantity in cocoa (theobroma cacao) Essig et al, 1980; Van Handel 1983; Wilcox 1990).

The ability of caffeine and other xanthines to aid sport performance is based on the direct action on the heart or skeletal muscles or indirect actions on these organs, mediated through the nervous system, altered hormonal activities or shift in mobilization of substances (free fatty acid mobilization and glycogen sparing). There is also the possibility that the drug may alter the release, binding or activity of neurotransmitter in the brain, thereby affecting the perception of work intensity (Robertson et al., 1981).

The controversy surrounding the use of caffeine as food beverages by laymen or use as an ergogenic aid by local, national and international athletes has drawn the attention of many scientists to research into the effects of this drug. Some studies (Wilcox, 1990; Graham et al, 1994; Clark, 1997) view this aid as a justifiable extension of the body's natural capacities, while others (Jacobson and Kulling, 1989; Engs, 1991; Spriet, 1995; Ahrendt, 2001) see it as a dangerous and unethical violation of the code of fair play in sports.

Due to the controversial reports of some studies (Perking and Williams, 1975; Costill, 1978; Costill, et al 1978; Ivy et al., 1979) on the ergogenic effect of caffeine on performance, the International Olympic Committee (IOC) had a series of banned, un-banned and finally pegged the use of caffeine in sports competition to a tolerance limit of 12 ug.ml⁻¹ urine (Wilcox, 1990; Devries & Housh, 1994; Pasma et al., 1995). Pasma, et al. (1995), Kovacs, et al (1998) and Bruce, et al. (2000) reported that the doses below 6mg.kg⁻¹ caffeine do not exceed the IOC urinary caffeine limit. However, in 2004 and to date, the World Anti Doping Agency (WADA) completely removed caffeine from the list of banned substances (WADA 2003; 2004; 2005; 2006; 2007).

However, previous studies on the ergogenic effect of caffeine has been equivocal, mostly laboratory oriented and on white or other non African black subjects. Hence,

the present study was therefore designed to investigate the ergogenic effect of varied doses of caffeine on black Africans (Nigerian subjects) using maximal aerobic field test (20 meter shuttle run test).

MATERIALS AND METHODS

Subjects:- Twenty (20) male subjects of Bayero University Nigeria aged between 18-25 years participated. They were non athletes, non regular users of caffeine, non smokers and apparently healthy. Subjects were fully informed about the experimental procedure, risk and protocol. Subjects gave informed consent in accordance with the American College of Sports Medicine guidelines, regarding the use of human subjects (ACSM, 1991). Also, the ethical approval of the Bayero University, was given through the Ethical Committee. The subjects' physical (weight and height) characteristics were measured and recorded using standardized anthropometric protocol (International Society for the Advancement of Anthropometry, 2001).

Design of the study:- Post-test placebo controlled design in which each subject served as his own control was used. It is a double blind 2 randomized counter balanced cross over order. The ingestion of 5 mg.kg⁻¹ of caffeine and placebo, coupled with exercise was separated by seven days' interval to avoid carry over effect of caffeine and exercise (Graham, et al. 2000; Anderson, et al. 2000).

Physiological measurement:- Subjects SBP, DBP and HR were monitored on the right arm as described by walker et al (1992) Using semi-automated BP monitor (Omron digital BP monitor model 11 EM-403c, Tokyo Japan). The measurement was done in the morning between 9am and 10 am each test day.

Caffeine and placebo measurement:- The quantity of coffee to give the desired amount of caffeine needed (5 mg.km⁻¹) was measured using electronic weighing machine (Sartorius GMBH by Cottingen Germany). According to Eteng et al (1999), every 10.68 mg coffee (Capra Nescafe coffee) commonly found in Nigeria contains 1mg caffeine, therefore 5mg caffeine amounted to 53.4mg coffee. Since pure caffeine is not readily available, Capra Nescafe coffee by Capra Nestle Company Abidjan, Cote De Voire was used. It is 100% pure instant soluble coffee. 0.1ml liquid food colour (coffee colour) by Ransons Exports, Faridaba Haryana India was used as Placebo. Both coffee doses and placebo were dissolved in 200 ml warm water (Camba, 2001) and sweetened with artificial sweetener (Sweetex-saccharin by Crooks Healthcare Nottingham) as described by Engels et al (1992).

Test Procedure:- The test was conducted between 8 am and 10 am; on arrival to the field (Bayero University Sports Complex) and following 10 minutes' rest in sitting position. Subjects SBP, DBP and HP were measured. Immediately subjects randomly ingested caffeine dose and placebo,

subjects remain in sitting position for an hour (60 minutes). According to Robertson et al (1981) caffeine peak plasma concentration are reached at approximately 60 minutes regardless of the dose. Immediately after 60 minutes of the post caffeine ingestion, subjects warmed up for about 5minutes (easy jogging and stretching exercise) and got ready for the 20 MST.

The 20 MST was conducted on a leveled 20metre marked course with chalk at each end. The test was performed in accordance with one minute protocol by Léger and Gadoury (1989) using the Progressive Aerobic Cardiovascular Endurance Run (PACER) tape. The tape gave a 5 second count down (5,4,3,2,1) and instructed subjects to "begin".

About 10 subjects lined up behind the starting line. A partner was assigned to each subject to count the number of laps completed (a lap consisted of 20 meter distance). At the command "start", subjects ran in a straight line forth and back between restraining lines in accordance with the pace dictated by the audio signal emitted at a set intervals from the PACER tape. Subjects continued in this manner until they were unable to catch up with the sound of the beep for two consecutive times after which the test was terminated. The number of laps and time completed by each subject was recorded as his predicted cardiorespiratory fitness score using the formula of Reunsbottom, et al, (1988) as follows:

$$VO_2 \text{ max} = 14.4 + 3.48 (\text{minute completed}).$$

The total test duration was 2 weeks ([once weekly] to avoid carry over effect) in a 2 randomized (5 mg.kg⁻¹ and placebo) crossover counterbalanced manner.

Statistical analysis

Following data collection, the variables of interest were statistically analyzed. Mean and Standard Deviation were determined for all variables. Caffeine dose (5 mg.kg⁻¹) and placebo dose exercise performance (VO₂ max, run time, and no of laps) were statistically analyzed using repeated measured t-test. All statistical analysis was performed on an IBM compatible micro computer using the Statistical Package for the Social Science (SPSS), Chicago IL USA). The probability level for all the above tests was set at 0.05 to indicate significance.

RESULTS

Twenty males participated in this study, subjects mean (SD) age, resting SBP, DBP and HR and were 22.3 (4.0) years, 127(5.4) mmHg, 78(4.2) mmHg and 70(4.8) beats/minute respectively. Their physical characteristics are presented in table 1. Mean quantity of coffee and equivalent caffeine ingested was 3198.66mg and 299.50 respectively; while placebo was coffee/caffeine free.

Table 2 shows no significant effect of caffeine doses (5mg/kg) over placebo on the number of exercise laps (t[20]=2.08, p=0.750); run time (t[20]=2.08, p=0.760) and VO₂ max (t[20], p=0.801).

Table 1 : Physical characteristics of subjects (N=20)

Variables	Mean	SD	Range
Age (years)	22.3	4.0	18.0-25.0
Height (cm)	169.3	5.4	160.0-180.0
Weight (kg)	59.3	5.5	52.0-73.0
Body mass index (kg.m ⁻²)	21.0	4.6	20.3-22.5
Resting SBP (mm Hg)	127.0	5.4	120.0-130.0
Resting DBP (m mHg)	78.0	4.2	72.0 - 80.0
Resting HR (b/min)	70.0	4.8	68.0 – 78.0

Table 2: Exercise performance responses to caffeine (t-test)

Variables	Mean	SD	t-value
No of laps (meters)	72.8	2.7	.688
Run time (minutes)	9.0	4.8	.720
VO ₂ max (ml.kg ⁻¹ .min ⁻¹)	42.0	4.6	.864

t(20)=2.086 Not significant, p<0.05

DISCUSSION

The purpose of the present study was to determine the effect of 5 mg.kg⁻¹ dose of caffeine on maximal aerobic power of normal Nigerian undergraduate students. The study result showed no significant effect of caffeine doses over placebo dose on maximal aerobic power (VO₂ max), run time and number of exercise laps.

The non ergogenic effect of caffeine as reposted in the present study is in agreement with previous studies (Engels and Haymes, 1992; Anderson and Hickey, 1994; Tunagol et al 1998; Herman and Young 1998). However, more recent studies (Arderson et al. 2000; Bruce et al, 2000; French et al, 2000) reported a contrary notion, that caffeine has ergogenic effect on endurance performance.

The study that was inconsistent with the present study was conducted by Mercola (2002) in which twenty one subjects (13 caffeine users and 8 non users) completed six randomized exercise ride to exhaustion at 80% VO₂ max once per week following ingestion of 5mg.kg⁻¹ caffeine and placebo. The ingestion of caffeine and placebo was preceded by exercise in one, three, and six hours. The study recorded significant effect of Caffeine over placebo in one and three hour and the effect was great in magnitude and lasting (duration) longer in non users.

Graham and Spriet (1995) examined the effect of different doses (3 & 6mg.kg⁻¹) of caffeine and placebo on endurance exercise at 85% Vo₂ max run to voluntary exhaustion. They reported significant effect of all doses over placebo on endurance run time. Graham and Spriet (1991), Anderson et al (2000), and French et al (2000) examined the effect of different caffeine 6mg.kg⁻¹. All the studies reported ergogenic effect of caffeine on trained athletes in a laboratory setting.

Bridge and Jones (2006) investigated the effect of a lower dose (3mg/kg) of caffeine and placebo. Eight distance runner ingested caffeine and placebo, subjects ran 8 km race I hour post caffeine and placebo ingestion. Significant effect of caffeine was reported on enhancement

of performance in an ecological valid race setting. Wiles et al (2006) also reported a similar result. Eight trained cyclist performed a 1km time trial on electronically braked cycle ergometer following the ingestion of 5mg/kg caffeine. They concluded that caffeine has ergogenic effect on short duration, high intensity exercise.

Another study that was inconsistent with the present study was conducted by Stuart et al (2005). Nine competitive rugby players ingested caffeine (6mg/kg) dose and placebo. Subjects performed 2 straight and 3 agility sprints. They reported significant effect of Caffeine over placebo. Similar study was conducted by Schneider et al (2006). In their study, they examined the effect of similar dose (6 mg/kg) of caffeine and placebo on endurance exercise at 35% VO₂ max run to voluntary exhaustion. They reported significant effect of caffeine dose over placebo in prolonged and intermittent sprint ability.

The reason for the inability of the present study to achieve any significant effect of caffeine doses over placebo dose and the disparity in finding between the present study and several other previous studies might not be unconnected to the fact that there may exist interracial, genetics and environmental differences in caffeine pharmacodynamic and pharmacokinetics (caffeine metabolism and tolerance) (Clerk 1997; Gamba, 2001; Grant and Ellis, 1986).

Most of the previous studies involved white or non African black subjects compared to the present study that utilized black African (Nigerian) subjects. Also, the effect of the type of caffeine and placebo used might not be ruled out.

According to Marquis, (1997) better coffees are lower in acid, higher in Caffeine and have longer lasting effect and that ground coffees are generally preferred to canred or instant soluble coffee. According to Burke and Biejn (2000), coffee also contains several other substances that may exert cardiovascular effects such as estrogen, nicotinic and phenols. Also, the effect of the type of placebo used might be another important factor, most of the previous studies used decaffeinated coffee as placebo. Burke and Biejn (2000) stated that various decaffeinated coffee vary considerably in chemical process used to reduce their caffeine content, this could affect caffeine tolerance, metabolism and performance. Also failure to distinguish between pure coffee and pure caffeine is also worth considering.

The effect of different types of exercise utilized vis-à-vis, mode, intensity and duration, separately or in combination with caffeine worth consideration. Most of the previous studies utilize laboratory oriented performance compared to field test (20 MST) in the present study. The psychological effect of motivation and competition mimicry nature of the field test that may mask the ergogenic effect of caffeine might not be ruled out. The effect of environmental factor on caffeine metabolism and tolerance are also worth consideration

CONCLUSION

Based on the result of the present study, it was concluded that instant soluble coffee by Capra nestle of about 3199mg (300mg caffeine) which is equivalent to 5 mg kg⁻¹ body weight, constitute no ergogenic effect on subjects of black African (Nigerian) origin.

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