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THE EFFECTS OF KOLA NUT CONSUMPTION ON PHYSICAL AND PHYSIOLOGICAL PERFORMANCE IN AMATEUR SPRINTERS

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Abstract: The purpose of the study was to find out how certain body physical and physiological response variables will be affected due to Kola nut consumption of amateur sprinters. Quasi experimental research of the randomized control group pre-test post-test research design was adopted, in which there were two groups, one control and the other experimental. The experimental group was further sub divided into three groups with each administered with different quantities of Kola nut, in the order of (i) 100mg.kg-1 of body weight, (ii) 150mg.kg-1 of body weight, (iii) 200mg.kg-1 of body weight. All the four sub-groups were subjected to pre-test and post-test performance of 50m race during the pre-test and post-test exercises. The sample for the study was made up of 16 male students who were athletes and had trained at least three times in a week. They were selected using simple random sampling technique from the population of non-habitual kola nut eater. They were of the age range of 19 – 30 years. Thirty pieces of red colour kola nuts (Kola nitida) were bought from the market at Okene in Kogi State, Nigeria. The descriptive statistic of mean, standard deviation and range, and the dependent t-test inferential statistics at 0.05 alpha level were used to analyze the results. The findings show that there were differences in speed test and body responses to kola nut ingestion; it was therefore recommended that athletes and their handlers should be careful in consuming kola nut when in sport competition, and the general public should know that kola nut affect some physiological processes of the body.

Keywords: Kola nut, Speed, Pyruvate, Packed Cell Volume, Body response

Introduction

Along with other factors such as training, equipment, body build and skills, sport performance is influenced by nutrition. Nutrition has been considered to be the science of food as it concerns feeding the body to improve and maintain health and performance. Food contains nutrients which are chemical substances that aid body functions in the provision of energy for cell, tissue repair and growth. More often than not, athletes are interested in improving their performance through the combination of certain dietary regimen and training.

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Nutrition is the science of food as it concerned nourishing the body for health, tissue growth, development and repair, and performance at optimal level in the case of an athlete. The six basic classes of nutrients are classified on the basis of their chemical compositions. These classes are carbohydrates, fats, proteins, mineral, vitamin and water, sometimes these are compressed to micronutrients and macro nutrients where water serves as the main vehicle and takes the larger percentage of the body fluid mass and as such is considered as the universal solvent. The micro nutrients are minerals and vitamins and the macronutrients are carbohydrates, proteins and fats and oil. The macronutrients are the ones that provide the bulk of materials needed for the body metabolic processes and the release of energy. Macronutrients such as carbohydrates, fats and protein are the only sources of useable energy to the working muscles they are thus refer to as energy nutrients (Foss and Keteyian, 1998). Carbohydrates play an important role in speed and endurance exercises; this is because it has been observed that it is the major source of energy readily available to the performing athlete especially because it is easily hydrolyzed and as such it is consumed in large quality than the other two macronutrients. This may explain the common practice among some athletes called glycogen loading or carbohydrate loading. Glycogen loading is a practice that has its premise on the knowledge of the fact that the amount of glycogen resynthesized by skeletal muscles can be increased to value much higher than the Normal.

According to Haruna and Venkateswarlu (2001), nutrition can be a major determinant in winning or losing a competition. Haruna and Venkateswarlu (2001) also observed that athletes take food supplements to ensure optimum performance. Such food supplements include vitamins and minerals. In competitive sports, food supplements are added to carbohydrates with the belief that there is a connection between supplements supply and performance capacity, this was also corroborated in another study (Haruan, Anigweje, & Ventaketswarly, 2001).

All athletes aim at winning any competition they participate in, and to ensure their chances of winning, some resort to taking performance enhancing drugs or procedures that enhance performance (ergogenic aids). An ergogenic aid is any substance or procedure aimed at improving athletic performance beyond the level of training. It could be nutritional, physical, physiological, mechanical, psychological or pharmacological. Some of such drugs are synthetic products (pharmacological ergogenic aids), while others are consumed in their natural state which are referred to as nutritional ergogenics.

Gamba (2000), states that a drug is any substance that, when taken orally, intravenously or inhaled, has the capacity of changing the body chemistry. Pharmacological ergogenic aid is any synthetic chemical substance taken into the body system to increase the physical performance, while nutritional ergogenic aid is any naturally occurring substance that is taken to enhance performance. According to Okpeke (1987), Kola nut contains about 52% carbohydrates and about 2% fats, while nitrogen containing substances are about 11%, and caffeine is about 3%. Caffeine, a stimulant, is a constituent of kola nut. A stimulant is a substance that can raise the level of physiological and/or nervous activity in the body, and as such kola nut can be used as ergogenic aid when taken in sufficient quantity and at the appropriate time i.e. taking into cognizance the glycemic index of kola nut. It has

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been asserted that a small amount of caffeine tends to increase an individual alertness while decreasing fatigue. This can therefore increase one's endurance level. For endurance to be sustained, regular supply of energy to the tissue cells must be guaranteed. Food is the main source of energy that is available to the living tissue cells both for sustaining life itself and for doing work.

Food is culture bond, and in many parts of Africa and especially the West Africa sub-region, kola nitida and kola acumanita (the two species of kola nut that are common in this sub-region) are eaten extensively (Osborn, 2018 and Okpeke, 1987). These edible fruits are so popular that some eat them as a "dessert" after a meal while others eat them indiscriminately. Kola nut is eaten by yet some people because of its possession of a stimulant (caffeine) which keeps them awake and aler. A good example can be seen in many long-distance vehicle drivers who take kola nut as some do cigarette or snuff due to the presence of nicotine an alkaloid that are stimulants, to obtain similar effects (De Pietro, 2017; Insel and Roth, 2002; Adeogun, 1998). It is therefore necessary to investigate the body's responses to kola nut ingestion and particularly its effect on sport performance. International Olympic Committee and other sport regulatory bodies permit the ingestion up to 100mg.kg^{-1} of caffeine; this may however produce an ergogenic effect on sport performance (Spriet, 2018). In various communities in West Africa, kola nut is eaten as dessert. Many among the eaters have become addicted to it rather than as a result of its nutritional value. Yet according to Okpeke (1987) more than half of kola nut content is carbohydrate. In another study it was reported that kola nut is part of the ingredients used in some beverages and soft drinks, due to its phelonic properties (Odebode, 2003). Writing on the social significance of kola nut, Okpeke (1987) observed that the use of kola nut is intimately associated with various cultures of West African people. He further noted that it prominently features in religious, social and ritual activities of West African people, such that it is used during ceremonies related to marriages, child naming, funerals, house warming and sacrifices made to various deities, gods and goddesses of African mythology. It is offered a guest who is welcome into the house. However, according to Alaribe, Ejeszie & Ezedinachi, (2003) kola nut, when ingested, mimicked malaria-like morbidity in apparently healthy volunteers. In their study 35g of kola nut was given to each of the 48 participants who were known to have abstained from kola nut or coffee in the month leading to the study in which the pre-test post-test experimental design was adopted, it was observed that kola nut taken at a high dose increases the presence of malaria parasite in the participants.

Kola nut is an edible fruit that occurs in two verities, kola nitida and kola acumanita locally kwnon as *Obi Gbanja* and *Obi Abata* respectively in western Nigeria, *Goro* in the northern and *orji* in the eastern Nigeria. It is a member of the family of sterculiaceae plant, and it has a long history in West Africa. Okpeke (1987) reported that kola nut is of the family of the sterculiaceae plant which is within the generic order of Malvales that belongs to unisexual flowers without petal within the family. Writing on the phytochemical analysis of Kola nut, he further observed that the percentage of the dry matter drops about 5 percent during the first few weeks after the harvest and then gradually rises. It was observed that an unstable complex occurs as kolanin, tannin, and caffeine glycosides in freshly harvested kola nut. This complex oxidizes the hydrolysis to form kola red and free caffeine under the

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influence of enzymes when the nuts are drying out. This process can be hindered by heat treatment (Okpeke, 1987).

He noted further that the caffeine content of kola nut ranges from 1.5 to 3.2 percent of the dry matter. A common range is from 1.5 to 2.7 percent of the dry matter, thus the value of 3.2 percent being exceptionally high. In addition, he reported that kola nut contains very small quantities of the alkaloid's theobromine of 0.02 to 0.08 percent. The mineral content of kola nut was also reported by him to include nitrogen, phosphorus, potassium, calcium and magnesium.

The following tables I & II summarize the chemical and mineral content of kola nut respectively. Table I: the average chemical contents of kola nut express in percentages

CONTENT	**PERCENTAGE %**
Cellulose (fibre)	8.6
Carbohydrates	52.8
Fats	1.6
N. Containing substances	11
Tannins	4.2
Ash	3.5
Caffeine	2.9
Trace elements	15.4
TOTAL	**100**

Table 1a: the average chemical analyses of kola nut content express in percentages of dry matter (Okpeke, 1987).

Tale II: A summary of the nutritionally important minerals that are found in kola nut found in three West Africa countries.

CONTENT	**CONGO**	**GUINEA**	**NIGERIA**
N	1.31	2.09	1.32
P	0.15	0.20	0.10
K	0.92	1.47	1.01
Ca	0.09	0.08	0.27
Mg	0.20	0.27	0.21
TOTAL	**2.67**	**4.11**	**2.71**

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Sources (Okpeke, 1987).

Caffeine and Sports Performance

According to Scott, (2003) caffeine (1, 3, 7-trimethylxanthine) is the most commonly used drug in the world and is consumed regularly by athletes young and old (Laurent, Schneider and Prusaszyk, 2000). At least 80% of Americans ingest caffeine daily through a variety of artificial and natural products, and the average American has a daily caffeine intake of 200mg (equivalent to 2 cups of coffee). Although more people drink tea than coffee, the higher caffeine concentration of coffee makes it the greatest source of ingested caffeine worldwide (Harland, 2000; Graham, Hilbert and Sathasvam, 1998). Several new products have recently been introduced, such as caffeinated water that is increasing caffeine consumption among previous nonusers and young populations.

Caffeine occurs naturally in more than 60 plants, but coffee, tea, mate, guarana, kola and medication constitute the primary sources (Bucci 2000 & Kaplan, Greenblatt and Eherenberg, 1997).

The Problem

The individual athlete is constantly under pressure to win as a result of the enormous rewards given to winners, the society's expectations such as increase performance leading to new records, the need to beat the other competitors, the fierce competitive nature of modern sports, and the individual athlete desire to be the number one in his chosen sport, all these make the typical athlete to seek alternative means to enhance his performance. This is why some athletes in addition to training indulge in the use of pharmacological ergogenic aids wherein caffeine gained a status of notoriety. It is belief that caffeine improves both mental and physical performance, in addition the World Anti-Dope Agency [WADA] in 2004 removed caffeine from the list of banned substances and as at 2022 still retain the removal of caffeine from the list of banned substances [WADA, 2022] however this is not the first time caffeine will be removed and later included on the list of banned substances, furthermore this inconsistency has led to the wide spread use of caffeine among athletes, also in recent time, the issue of drug use such as caffeine of different doses is becoming a great concern which is threatening the existence and application of sportsmanship tenets. The inclusion, removal and re-inclusion of caffeine among the International Olympic Committee's [IOC] list of banned substances confirm the controversy surrounding the use of caffeine in sport, and as such seems to create a greater confusion and a source of worry for coaches and athletes alike. In a study Alaribe, Ejezie & Ezedinachi (2003), reported that Kola nut ingestion mimic malaria presence in the body of participants in a study, will the ingestion of doses ranging from 100mg.kg^{-1} to 200mg.kg^{-1} of Kola nut produce similar result?

Many Nigeria athletes, due to the dearth of researches on kola nut and sport performance, may be indulging in trado-ergogenic aids as a result of the consumption of kola nut. It is this possibility that informed the interest of the researchers in wanting to find out how amateur sprinters after the ingestion of various quantities (100mg.kg^{-1}, 150mg.kg^{-1} and 200mg.kg^{-1}) of kola nut, will react physically and physiologically.

Research questions

Based on the above the following research questions were raised:

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- Will there be a difference in speed due to the ingestion of 100mg.kg^{-1}, 150mg.kg^{-1}, and 200mg.kg^{-1} of kola nut?
- Will there be a difference in level of packed cell volume (PCV) due to the ingestion of 100mg.kg^{-1}, 150mg.kg^{-1}, and 200mg.kg^{-1} of kola nut?
- Will there be a difference in level of pyruvate due to the ingestion of 100mg.kg^{-1}, 150mg.kg^{-1}, and 200mg.kg^{-1} of kola nut?

Research Design

The research design was the randomized control group pre-test post-test design in which there were four groups, one control and three experimental groups. A placebo of deep brown chocolate soaked in water solution of better leaf and sun dried, to give it a bitter taste similar to kola nut was given to the control group (A) at a measurement of 150mg.kg^{-1} of the participants, whereas each of the experimental group was given different quantities of the independent variable, kola nitida, in the order of (B) 100mg.kg^{-1} of body weight, (C) 150mg.kg^{-1} of body weight, (D) 200mg.kg^{-1} of body weight. All the four sub-groups, the control and experimental groups, were subjected to pretest and post-test performance of 50m race on each occasion.

Population

The population was made up of all the male amateur sprinters in tertiary institutions in Kogi Central Senatorial District of Nigeria, i.e. Kogi State University of Science and Technology, Osara, Kogi State School of Nursing and Midwifery, Oboroke, Kogi State Polytechnic Itakpe campus and Federal College of Education Okene.

Sample and Sampling Technique

The sample for the study consisted of 16 male students who were athletes and, trained at least once in a week. They were selected using simple random sampling technique from the population of non-habitual kola nut eaters. They were between 19 – 30 years of age.

Method

Field test and laboratory serum analysis, the results were compared with the critical table value at 0.5 alpha levels.

RESULTS AND DISCUSSIONS

Table 1: Mean, Standard Deviation and Range and Demographic characteristics of the participants.

Characteristic	X	SD	R
Age (years)	25.21	5.69	19 – 30 (11)
Weight (kg)	61.53	8.15	56 – 74 (18)
Height (cm)	171.66	7.92	155.2 – 182 (26.9)

The results presented in table 1 show that the mean age of the subjects was 25.21 ± 5.69 within the range of 19-30 years, and that the mean of their weight was 61.53 ± 8.15kg within the range of 56-74 kg, while the mean of their height was 171.66 ± 7.92 within the range of 155.2-182.1cm.

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Table 2: Mean, Standard Deviation and Range of Results on 50m speed test in seconds.

Category	Pre-test			Post-test		
	X	**SD**	**R**	**X**	**SD**	**R**
Control	7.24	1.16	6.57-7.91 (1.34)	7.21	1.11	6.61-7.84 (1.23)
100mg.kg^{-1}	7.32	0.25	7.01-7.60 (0.59)	7.20	0.60	6.66-7.82 (1.34)
150mg.Kg-1	6.96	0.71	6.16-7.80 (1.64)	6.87	0.56	6.10-7.44 (1.34)
200mg.Kg-1	7.13	0.80	6.19-7.80 (1.61)	7.24	0.81	6.48-8.13 (1.65)

The results presented in table 2 show that the mean of pre-test performance of the control group was 7.24 ± 1.16 within the range of 6.57 - 7.91 sec. the mean of the 100mg.kg^{-1} group was 7.32 ± 0.25 within the range of 7.01 – 7.60 sec, while the mean of the 150mg. Kg^{-1} was 6.96 ± 0.71 within the range of 6.16 – 7.80 sec, and the mean of the 200 mg.kg^{-1} group was 7.13 ± 0.80 within the range of 6.19 - 07.80 sec.

The table further shows that the mean of the post-test performance of the control group was 7.21 ± 1.11 within the range of 6.61 – 7.84 sec, and the mean of the 100mg.kg^{-1} was 7.20 ± 0.60 within the range of 6.66 – 7.82 and the mean of 150mg.kg^{-1} was 6.87 ± 0.56 within the range of 6.10 – 7.44 sec, while the 200mg.kg^{-1} group was 7.24 ± 0.81 within the range of 6.48 – 8.13sec.

Table 3: Mean, Standard Deviation and Range of Results on Haematocrit (PCV) value of the participants in %.

Category	Pre-test (50m)			Post-test (50m)		
	X	**SD**	**R**	**X**	**SD**	**R**
Control	43.0	0	43-43 (0)	42.5	2.12	41-44 (3)
100mg.kg^{-1}	42.0	1.41	41-44 (3)	40.5	1.91	38-42 (4)
150mg.Kg^{-1}	43.25	2.5	42-47 (5)	41.75	2.87	40-46 (6)
200mg.Kg^{-1}	42.25	3.86	37-46 (9)	41.75	3.20	40-43 (3)

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The results presented in table 3 show that the pre-test mean of the PCV of the control group was 43 ± 0 within the range of 43 – 43%. The mean of the 100mg.kg^{-1} group was 42 ± 1.41 within the range of 41-44%. That of the 150mg.kg^{-1} group mean was 43.25 ± 2.5 within the range of 42 - 47% and the 200mg.Kg^{-1} group was 42.25 ± 3.86 within the range of 37-46%.

The post-test results in the table show the mean PCV value of the control group was 42.5 ± 2.12 within the range of 41-44% and the 100mg.kg^{-1} group mean was 40.5 ± 1.91within the range of 38 – 42%, and the mean score of the 150mg.kg^{-1} group as 41.75 ± 2.87 within the range of 40 – 46%, also the mean score of the 200mg.kg^{-1} group was 41.75 ± 3.20 within the range of 40-43%.

Table 4: Mean, Standard Deviation and Range of pyruvate concentration of the participants in mmoles/L.

Category	Pre-test (50m)			Post-test (50m)		
	X	**SD**	**R**	**X**	**SD**	**R**
Control	0.02	0	0.02.0.02 (0)	0.035	0.01	0.03-0.04 (0.10)
100mg.kg^{-1}	0.038	0.01	0.02-0.05 (0.03)	0.12	0.015	0.09-0.15 (0.06)
150mg.Kg^{-1}	0.025	0.02	0.01-0.04 (0.03)	0.091	0.06	0.02-0.15 (0.13)
200mg.Kg^{-1}	0.023	0.01	0.01-0.03 (0.02)	0.11	0.05	0.04-0.14 (0.1)

The results presented in table 4 above show that the mean of the pre-test pyruvic acid of the control group was 0.02 ± 0 within the range of 0.02 – 0.02mmoles/L of the blood sample and the mean of pre-test pyruvate of 100mg.kg^{-1} group was 0.038 ± 0.01mmoles/L within the range of 0.020.05mmoles/L of sampled blood. Similarly, the mean of the pre-test pyruvate of 150mg.kg-1 was 0.025 ± 0.02 within the range of 0.01 – 0.04mmoles/L of the blood samples. Also, the mean result of the pre-test pyruvic acid concentrates of the 200mg.kg^{-1} group was 0.023 ± 0.01 within the range of 0.01 – 0.03mmoles/L of the blood samples.

Furthermore, it also shows the post-test results where the mean value of pyruvic acid concentrates of the control group was 0.035 ± 0.01 within the range of 0.03 -0.04mmoles/L of the blood sample, and the mean value of the 100mg.kg^{-1} group was 0.12 ± 0.15 within the range of 0.09 - 0.15mmoles/L of blood samples.

While the mean value of the 150mg.kg-1 group was 0.091 ± 0.06 within the range of 0.02 -

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0.15mmoles/L of blood. The table also shows the mean of the pyruvic acid accumulation of 200mg.kg-1 group to be 0.11 ± 0.05 within the range of 0.04-0.14mmoles/L of blood samples.

Table 5: pre-test, post-test results on speed performance of the control group.

Pre-test (sec)	Post-test (sec)	D	D^2	df	t-tab	t-cal
6.57	6.61	-0.04	0.002			
7.91	7.84	0.007	0.005	1	12.706	0.111

The results presented in table 5 above shows that there was a difference of 0.03sec between the pre-test and post-test performances of the control group speed at 0.05 level of significance the ttable value was 12.706 while the t-calculated value was 0.111 for the control group.

Table 6: Pre-test and t-test results on the Haematocrit (PCV) of the control group.

Pre-test (sec)	Post-test (sec)	D	D^2	df	t-tab	t-cal
0.02	0.03	-0.01	0.0001			
0.02	0.04	-0.02	0.0004	1	12.706	3.0

The results presented in table 6 show that the difference in percentages of the PCV of the control group was 3%. While the t-table value was 12.706 at 0.05 alpha levels with the t-calculated been 3.0.

Table 7: Pre-test, post-test and t-test results on pyruvate concentration of the control group.

Pre-test (sec)	Post-test (sec)	D	D^2	df	t-tab	t-cal
0.02	0.03	-0.01	0.0001			
0.02	0.04	-0.02	0.0004	1	12.706	3.0

The result presented in the table 7 above shows that there was a difference of 0.03mmoles/L of blood pyruvic acid concentrates of the post-test result. The t-test calculated value was 3.0 while the critical value at 0.05 alpha level was 12.706.

Table 8: Pre-test, post-test and t-test results on speed performance of the 100mg.kg^{-1} Experimental group.

Pre-test (sec)	Post-test (sec)	D	D^2	df	t-tab	t-cal
7.30	6.66	0.64	0.41			
7.60	7.82	-0.22	0.05			

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7.01	7.61	-0.60	0.36			
7.35	6.72	0.63	0.40	3	3.182	0.360

The results presented in table 8 were used to test the hypothesis that "there would be no significant difference in speed due to the ingestion of 100mg.kg-1 of kola nut". The results show a total gain on speed post-test over the pre-test to be 0.45 seconds. The t-test result shows the critical t-test value was 3.182 at 0.05 level of significance while the t-calculated value was 0.360. This shows that the stated hypothesis was accepted, that is there was no significant difference in speed due to the ingestion of 100mg.kg-1 of kola nut.

Table 9: Pre-test and t-test on speed performances of the 150kg.kg^{-1} experimental group.

Pre-test (sec)	**Post-test (sec)**	**D**	**D^2**	**df**	**t-tab**	**t-cal**
7.34	7.44	-0.10	0.01			
6.52	6.93	-0.41	0.17			
7.80	7.02	0.76	0.61			
6.16	6.10	0.06	0.004	3	3.182	0.360

The results contained in table 9 above were used to test the hypothesis that stated, "There would be no significant difference in speed due to the ingestion of 150mg.kg-1 of kola nut". The total value of 0.31 seconds was the time gained by the post-test results over the pre-test results, it also shows that the t-test value was critical at 3.182 at 0.05 alpha level, while the t-calculated was 0.360, this suggested a no significant effect, hence the stated hypothesis was accepted.

It thus means that there was no significant difference in performance due to the ingestion of 150mg.kg^{-1} kola nut.

Table 10: Pre-test and t-test results on speed performance of the 200mg.kg^{-1} Experimental group.

Pre-test (%)	**Post-test (%)**	**D**	**D^2**	***df***	**t-tab**	**t-cal**
6.19	6.48	-0.29	0.080			
7.78	8.13	-0.35	0.123			

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7.80	7.73	0.07	0.005			
6.73	6.63	0.10	0.010	3	3.182	-1.00

Tale 10 shows the results of the t-test used in testing the hypothesis that states that "there would be no significant difference in speed due to 200mg.kg-1 of kola nut".

A total loss of 0.47 seconds in the post-test result was observed over that of pre-test result. The ttest analysis shows the t-calculated to be -1.00 as against the t-table of 3.182 at 0.05 alpha level. The stated hypothesis was therefore accepted; it means that there was no significant different in speed as a result of the ingestion of 200.kg$_{-1}$ of kola nut.

Table 11: Pre-test, post-test and t-test results on the PCV of the 100mg. kg^{-1} Experimental group.

Pre-test (%)	**Post-test (%)**	**D**	**D^2**	**df**	**t-tab**	**t-cal**
42	40	2	4	`		
41	42	1	1			
44	38	6	36			
41	42	1	1	3	3.182	2.100

Table 11 shows the presentation of the t-test result that was used to test the hypothesis that "there would be no significant difference in body response due to the ingestion of 100mg.kg^{-1} of kola nut".

The table shows a total of 10% gain of PCV scores of the post-test over the pre-test scores. The ttest result shows that t-calculated was 2.100 while the critical value at 0.05 alpha level was 3.182 this indicates that the stated hypothesis was accepted; thus there was no significant difference in physiological (PCV) response due to the ingestion of 100mg.kg-1 of kola nut.

Table 12: Pre-test, post-test and t-test results on the PCV of the 150mg.kg^{-1} Experimental group.

Pre-test (%)	**Post-test (%)**	**D**	**D^2**	***df***	**t-tab**	**t-cal**
42	40	2	4			
47	46	1	1			
42	41	1	1			
42	40	2	4	3	3.182	5.022*

* 5.220 (P < 0.05)

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Table 12 presents the t-test result that was used to test the hypothesis there would be no significant differences in physiological response due to the ingestion of 150mg.kg-1 of kola nut". The table shows a 6% total gain on PCV of the post-test result over that of the pre-test.

The t-test analysis shows the table value of the t-test was 3.182; while the calculated value was5.220 thus the stated hypothesis was rejected. It follows that there is a significant difference in physiological response when 150mg.kg-1 kola nut was ingested.

Table 13: Pre-test, post-test and t-test on the PCV of the 200mg.kg^{-1} experimental group.

Pre-test (%)	**Post-test (%)**	**D**	**D^2**	***df***	**t-tab**	**t-cal**
44	43	1	1			
42	41	1	1			
37	40	-3	9			
46	43	3	9	3	3.182	1.000 *

Table 13 presents the result of the t-test used to test the hypothesis that there would be no significant difference in body response (PCV) due to the ingestion 200mg-kg^{-1} of kola nut. The table shows a total loss of 2% in posttest over pre-test PCV response, and the table value of the ttest was 3.182 while the calculated value was 1.000, at 0.05 level of significance, thus the stated hypothesis was accepted, that is there was no significant difference in PCV that can be adduced to the ingestion of 200mg.kg^{-1} kola nut.

Table 14: Pre-test, post-test and t-test results on the pyruvate concentration of 100mg.kg^{-1} Experimental group,

Pre-test (mmoles/litre)	**Post-test (mmoles/litre)**	**D**	**D^2**	***df***	**t-tab**	**t-cal**
0.04	0.13	-0.09	0.0081			
0.05	0.09	-0.04	0.0016			
0.04	0.15	-0.11	0.0121			
0.02	0.11	-0.09	0.0081	3	3.182	5.593

* 5.593 ($P < 0.05$)

The result in table 14 above was used to test the hypothesis that stated, that "there would be no significant difference in physiological response due to the ingestion of 100mg.kg^{-1} kola nut". The result shows that here were differences in pyruvate concentration of the two test results, which produce 0.33mmoles/L. The t-test calculated value 5.593, which when compared with the t-test critical value of 3.182 at 0.05 alpha level shows that t-test calculated to be of greater value. Hence there was significant differences in the physiological (pyruvate concentration) responses due to 100mg.kg-1 of kola nut ingested; thus the hypothesis was rejected.

Table 15: Pre-test, post-test and t-test result on pyruvate concentration of the 150mg.kg^{-1} experimental group.

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Pre-test (%)	Post-test (%)	D	D^2	*df*	t-tab	t-cal
0.03	0.05	-0.02	0.0004			
0.01	0.02	-0.01	0.0001			
0.04	0.15	-0.11	0.0121			
0.02	0.12	-0.10	0.0100	3	3.182	0.452

Table 15 above shows the result of the t-test that was used to test the hypothesis which stated that "there was no significant difference in physiological response due to 150mg.kg-1 kola nut ingestion". The table shows that the cumulative difference of 0.24mmoles/L of pyruvate concentration of the post-test over that of pre-test concentration was not significant because the ttest result shows that the t-table was 3.182 and the t-calculated was 0.452, thus the hypothesis that was stated above was therefore accepted, it thus follows that there were no significant differences in the physiological response due to the ingestion of 150mg.kg-1 of kola nut.

Table 16: Pre-test and t-test analysis of pyruvate concentration of the 200mg.kg^{-1} experimental group

Pre-test	Post-test	D	D^2	*df*	t-tab	t-cal
0.01	0.10	-0.09	0.00081			
0.03	0.14	-0.11	0.0121			
0.03	0.14	-0.11	0.0121			
0.02	0.04	-0.02	0.0004	3	3.182	2.100

Table 16 above shows the result that was used to test the hypothesis that stated that there would be no significant difference in physiological response (pyruvate) due to the ingestion of 200mg.kg^{1} of kola nut. There was a total of 0.33mmoles/L of blood pyruvate concentration of the post-test results over that of pre-test results. The t-test result shows that the table value was 3.182 at 0.05 alpha levels while the t-calculated value was 2.100. Thus the hypothesis that was stated above rejected. Consequently, it follows that there were not significant differences in the physiological responses due to the ingestion of 200mg.kg^{-1} of kola nut.

Pre test post test, speed test chart

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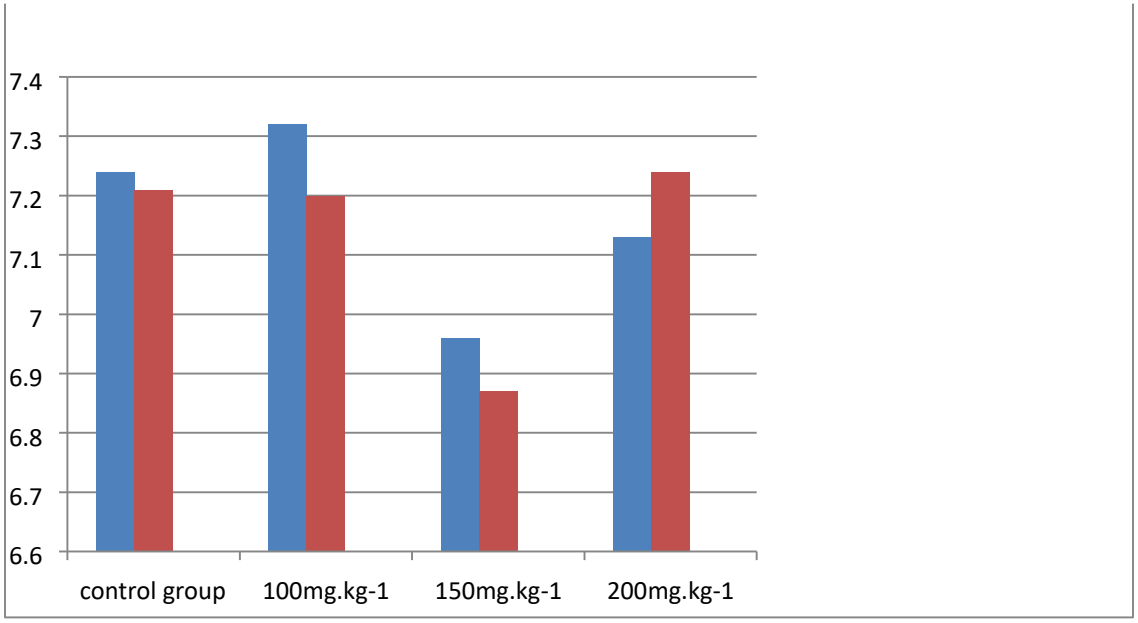

Fig 1

Pre test post test, PCV Chat

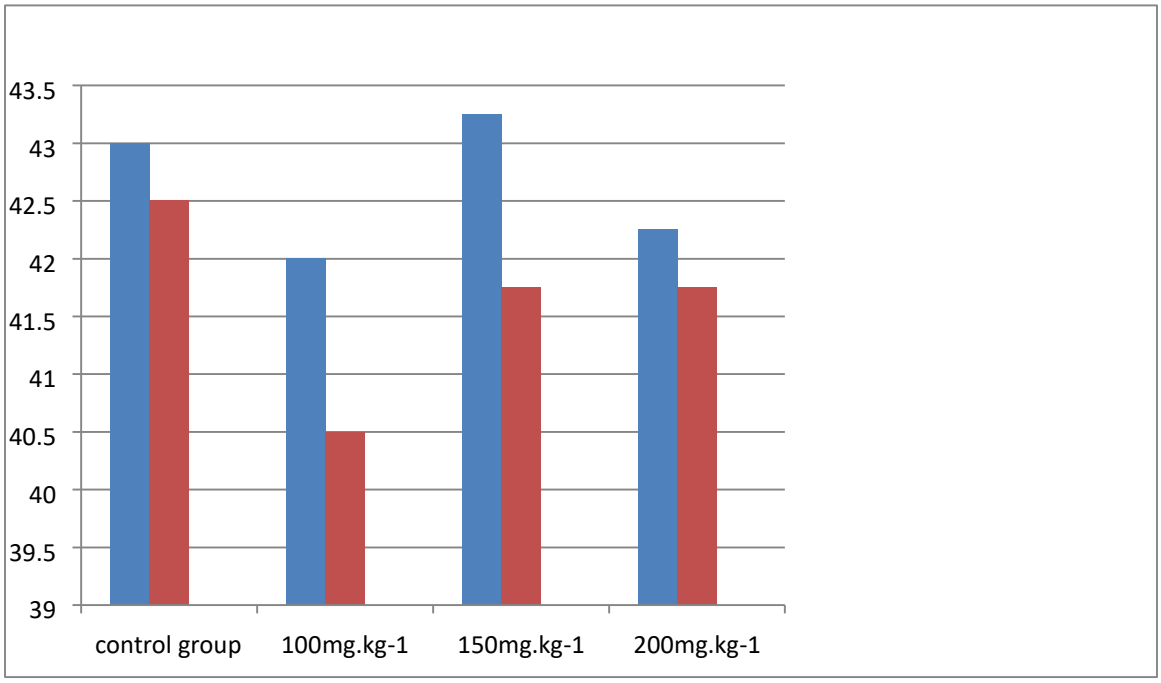

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Fig 2

Pre test post test, Pyruvate concentration Chat

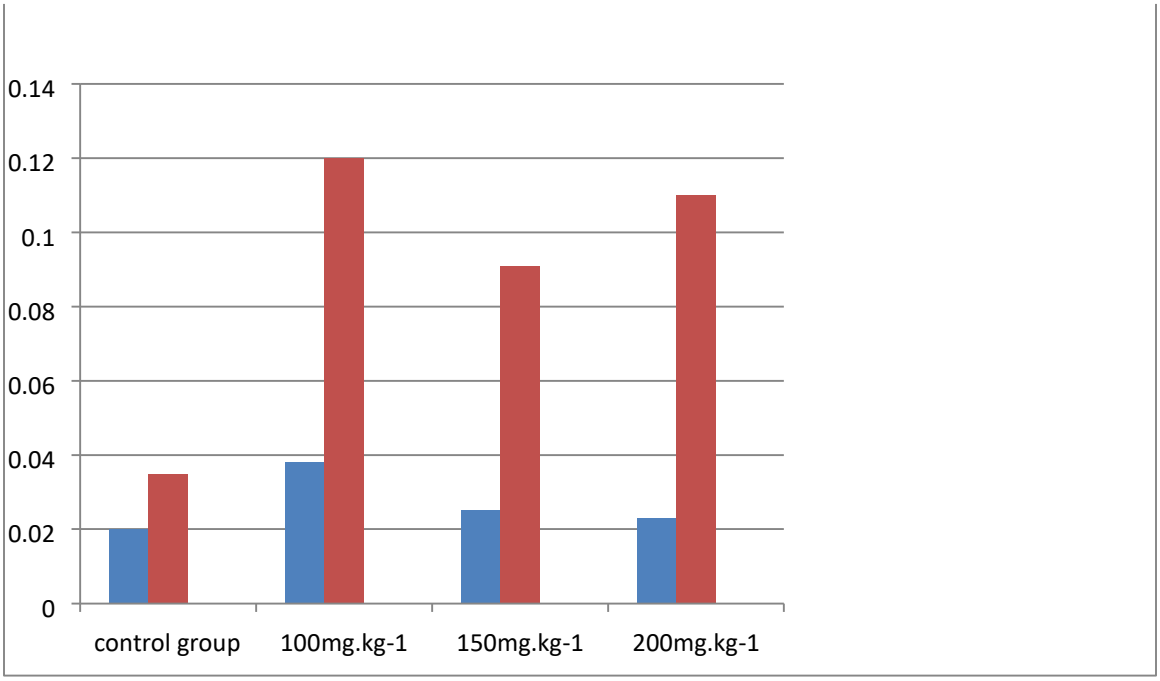

Fig 3

Discussion

The findings show significant differences in speeds performance and physiological responses (pyruvate concentration and PCV) to the ingestion of kola nut (fig. 1, 2 & 3). This general observation can be better understood through the comparison of the results of the control group and the experimental groups. The performances of the experimental groups show a significant difference in time gained in the post-test speed performance over that of pre-test compare to that of control group especially in the performances of 100mg.kg^{-1} and 150mg.k^{-1} as seen in fig 1. A total of 7.21 seconds was the time used by the control group during post-test speed performance for the same distance which they cover in 7.24 seconds during pre-test with a difference of 0.03 second less than the pre-test speed, while for the same distance during the same period the total cumulative time spent by the experimental groups for post-test speed performance was 21.31 seconds and the cumulative time for pre-test speed performance was 21.41 seconds, this showed a difference 0.1 second less than the time spent during pre-test speed performance, this shows, by comparison, a difference of 0.08 seconds which represented the total time gained by the experimental group over the control group (fig. 1) this observation may be ascribed to the ingestion of kola nut, which agrees with Doherty (1998) who found that caffeine ingestion, a

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constituent of kola nut and one of its mains stimulants, prior to a supra maximal exercise resulted in significantly greater anaerobic performance among recreational runner. Similar observation was made by Bell (2001) who reported that a group of untrained healthy participants in a study of maximal oxygen deficit cycling test showed a significant improvement in time spent to exhaustion following caffeine ingestion. This is also in agreement with Anderson et al (2000) in a study utilizing female participants found the ingestion of caffeine to have produced caffeine dose-dependent ergogenic effects during repeated 20,000m time trials among competitive oars women. These observations can further be corroborated by intra group comparison of the control with the $100mg.kg^{-1}$ and $150mg.kg^{-1}$ groups speed performance. The control group pre-test posttest speed performance difference of 0.03 seconds is less than the 0.12 second of the $100mg.kg^{-1}$ experimental group, and the 0.09 second of the $150mg.kg^{-1}$ experimental group. These decreases in time spent during the post-test speed performance of 0.12 seconds and 0.09 seconds of $100mg.kg^{-1}$ and $150mg.kg^{-1}$ respectively in comparison with the control group time can be attributed to the ingestion of kola nut which again is corroborated by the finding that caffeine improved muscles contractility, work output time to exhaustion, and performance during prolonged, moderate-to-high intensity activities lasting up to 120 minutes (Laurent et al 2000; Graham et al, 1998; Graham, 2001; & Appelgate, 2002). On the other hand the decrease in performance of the $200mg.kg^{-1}$ experimental group in comparison with the control group that showed an increase in time spent (fig. 1) in post-test speed performance of 0.11 seconds over that of pre-test speed performance, while the difference in pretest post-test results of the control group showed an improved performance of 0.02 seconds, this observation of the inconsistent performance of the $200mg.kg^{-1}$ group with that of the $100mg.kg^{-1}$ and $150mg.kg^{-1}$ groups may have been caused by other factors, since kola nut at $200mg.kg^{-1}$ would correspondingly contained higher caffeine content than that of $150mg.kg^{-1}$ and $100mg.kg^{-1}$ which as earlier observed produced a significant increase in performances.

The findings of the PCV analyses showed a similar trend with the observations found in the speed test, for instance a difference of 0.5% existed between the pre-test and post-test PCV results while a cumulative difference of 3.5% with an average of 1.17% over that of the control group. This shows that in general kola nut ingestion affect the PCV of the subjects blood samples since the packed cell volume of the post-test compared to the pre-test of the experimental group is significantly smaller than that of the control group (fig 3) (Alaribe, Ejezie & Ezedinachi, 2003). This is especially noticeable in the comparison of the PCV of the control group with that of the $100mg.kg^{-1}$ and $150mg.kg^{-1}$ experimental groups.

A difference of 0.5% was observed in the pre-test PCV and post-test PCV of the control group, while a difference of 2.5% was observed between the pre-test PCV results of the $100mg.kg^{-1}$ experimental group and that a difference of 1.5% was observed in the pre-test PCV and post-test PCV results of the $150mg.kg^{-1}$ experimental group, similarly a difference of 2% was observed in the pre-test PCV and post-test PCV results of the $200mg.kg^{-1}$ experimental group which statistically is not significant.

Through all the participants haematocrit results fell within the acceptable range of 40-54% for adult males (Medimedia, 2004) a low haematocrit may indicate anemia, multiple myelonia, nutrition deficiency, over-

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hydration or rheumatoid arthritis. Since kola nut ingestion has been observed to cause a low haematocrit level it follows that the body responded physiologically (PCV) to kola nut.

Since the post-test PCV of the experimental groups showed a significant decrease in comparison to that of the control group this finding suggest that kola nut inhibits the production of blood, this may be so since in a study carried out by Alaribe, Ejezie & Ezedinachi (2003) reported that kola nut mimicked malaria-like morbidity in apparently healthy participants in a study. It is known that malaria causes anemia in patients, thus this may be the explanation for the significant decrease in the post-test blood volume (PCV) of the experimental groups. The findings on the control group pyruvate concentration response shows that the post-test pyruvate was 0.03mmoles/L higher than that of pre-test pyruvate concentration when compared with the total difference between pre-test pyruvate and the post-test pyruvate of the experimental groups, which was 0.09mmoles/L this shows that there was more metabolic activities that generated the increased observed pyruvate concentration which can be attributed to the ingestion of kola nut.

Furthermore, the 100mg.kg^{-1} group shows 0.33mmoles/L which is significantly greater than that of control group's 0.03mmoles/L, thus even at a relatively small doses of kola nut a significant metabolic activity took place to generate the observed pyruvate. In respect of the 150mg.kg^{-1} finding, it was observed that a difference of 0.24mmoles/L was the difference between pre-test and post-test pyruvate concentrations which is a higher value when compared with the difference between the control group pre-test and post-test value which was 0.03 mmoles/L, thus 0.21 mmoles/L was the pyruvate concentration of the 150mg.kg^{-1} group in excess of that of the control group value. This was in consistent with what was observed in the 100mg.kg-1 group, which shows again that kola nut ingestion increases metabolic activities (pyruvate) of the body. Agreeing with this finding was the report of Daley (1993) in which he observed that though the primary action of caffeine may be to block adenosine receptors which lead to very important secondary effects on many classes of neurotransmitters, including noradrenaline, dopamine, serotonin, acetylcholine, glutamate which in turn influences a large number of difference physiological functions. On the findings on the experimental group on pyruvate concentration of a comparison of the 200mg.kg^{-1} with the control group shows an excess of 0.33 mmoles/L of pyruvate of the post-test over the pre-test blood samples, while that of the control group is 0.03mmoles/L, again this is consistent with the finding on the 100mg.kg^{-1} this agrees with Graham et al (2000) observation That circulating adrenaline concentration increased ($p<0.05$) at rest following caffeine ingestion and as well as leg noradrenalin spill over which was elevated ($p<0.05$) above placebo values during exercise.

It follows therefore that on the whole that kola nut ingestion does affect speed performance and that the body responds physiologically both in pyruvate concentration and the pecked cell volume. Furthermore, the findings show that there is a significant difference in speed due to kola nut ingestion which agrees with findings of improvement in anaerobic performance, (Bruce et al, 2000; Doherty, 1998) there was a more significant physiological response to kola nut ingestion which is reflected in the optical density reading of pyruvate contrition thus one can reasonably conclude that ingestion of kola nut at quantity of 100mg.kg^{-1} and above increase the rate

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of metabolism in which pyruvate is produced, and since lesser time was used in speed test in the post-test experiment to cover the same distance covered in pre-test, kola nut can be said to affect speed in anaerobic exercises.

Conclusion

Based on the findings of the study it was concluded that there were no statistically significant difference in speed performance due to kola nut ingestion, but there were however observable differences in the pre-test, posttest speed performances, just as there were differences in body responses to kola nut ingestion.

Recommendations

The following recommendations are made:

- Athletes and coaches should note that the ingestion of kola nut one to two hours before performance does significantly affect speed, hence it can be eaten before exercise to enhance speed performance.
- Since there is a significant increase in pyruvate concentration due to kola nut ingestion it should be eaten about four hours before exercise to increase the pyruvate concentration.
- Athletes with a low level of arousal (high scores on the impulsivity sub-scale) will experience a rise in arousal if kola nut is consumed, now that it is not on the list of banned substances
- Kola nut ingestion was found to increase pyruvate concentration, athletes in endurance exercise may consumed it to increase the time taken for the onset of fatigue
- Further studies should be carried out on its effects on endurance (aerobic) exercises.
- A comparative study should be conducted on the two varieties of kola nut (kola nitida and kola acumanita).
- More Nigerian foods should be studied as they affect athletes and performance.

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