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ASSESSING COLA NITIDA'S EFFECTS ON SWEAT SODIUM, CHLORIDE, AND POTASSIUM CONCENTRATIONS OF INDIVIDUALS UNDER DIFFERENT CIRCUMSTANCES

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Abstract: **The this study, Cola nitida was used as a test substance to see how it affected sweat electrolytes under different conditions. Participants in the study were sixty (60) non-obese volunteers (30 males and 30 females), aged 18-28, from the University of Benin, and non-habitual chewers of Cola nuts. There were three (3) subgroups: underweight (n=10), normal weight (n=10) and overweight (n=10). The study involved three conditions: a normal chamber temperature of 270 C, a raised chamber temperature of 370 C, and the normal chamber temperature with exercise condition, in which RT and RH were maintained at 270 C and 70%, respectively. In the aforementioned conditions, the subjects sat quietly in the sweat chamber for 20 minutes. In the third condition, the chamber temperature was maintained at 270°C and 70% relative humidity for 20 minutes as the subjects pedaled a bike ergometer at a moderate workload of 750J/minute. The three conditions were before taking Cola nitida. Before entering the sweat chamber. In all three experimental conditions, each subject chewed as a bolus 0.5g/kg of Cola nitida bought from the local market at the study area. To flush the masticated Cola nitida down the gut, each volunteer was given 50ml of deionized water after ingestion, and he or she rested for 90 minutes before he or she went into the sweat chamber. After sweat capsules were used in sweat collection, electrolyte concentrations were analyzed according to the collected data. Standard laboratory procedures were followed to analyze the electrolytes in blood samples from these subjects. In conclusion, the concentrations of Na and Cl in sweat increased after consumption of Cola Nitida, whereas K concentrations were maintained. For this reason, cola nitida should not be overused (especially when used by overweight people and under conditions that increase their body temperature and physical activity).**

Keywords: **Cola nitida, Sweat electrolytes, underweight, normal weight, overweight.**

1. INTRODUCTION

In addition to caffeine, Cola Nitida contains theophylline and theobromine. These alkaloids are natural occurring plant compounds known as methylxanthines, which have the ability to relax smooth muscles, stimulate the central nervous system (CNS), and produce diuresis in humans (Umoren *et al* ., 2009).

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It is critically important for human survival to be able to sense and regulate body temperature, since even a deviation of ±3.50C from the resting temperature of 37.00C can lead to physiological impairments and death (Moran and Mendal, 2002).

An internal environment that is more or less stable depends on the responses to the external environment, which is known as thermoregulation (Nakamura and Morrison, 2008). Environment and internal temperature conditions of an individual must be sensed, transmitted to the brain via afferent neural pathways, and the brain must initiate a response (Nakamura and Morrison, 2008).

Body fluid regulation and cardiovascular regulation are influenced by the thermoregulatory system (Takamata *et al* ., 2001). Exercise in a hot environment is prevented by maintaining fluid status in the body (Sawka and Montain, 2000).

The sweat glands in mammals excrete a fluid that they produce through sweating (Ugwu, 2010). A thermoregulatory physiological adaptation that occurs after heat exposure involves sweat glands. When the temperature of the environment is high, sweating rates and sensitivity increase (Armstrong and Maresh, 1991; Libert *et al* ., 1988).

Especially in humans, sweat serves both an excretory and a thermoregulatory purpose (Ugwu, 2007; Blood *et al* ., 2007). Sweating is mainly controlled by the sympathetic nervous (Stocking and Gubili,2004).

Several mechanisms within sweat glands control sweat composition including secretion and absorption, which influence concentrations of solutes in sweat (Ugwu, 1996; Shona *et al* ., 2010).

A rise in temperature stimulates the eccrine glands to secrete fluid on the surface of the skin due to the stimulation of the autonomic nervous system (Ugwu, 2007; Wyart *et al* ., 2007).

Body temperature is controlled by the thermoregulatory center in the hypothalamus by controlling sweat production and blood flow to the skin (Holzle, 2002). Its action is dependent on changes in the core body temperature, hormones, endogenous pyrogens, physical activity, and emotional state; the limbic system is responsible for this (Holzle, 2002).

Both intracellular and extracellular fluid contain dilute solutions of electrolytes, which cells need to perform a number of functions, so caffeine can also stimulate sweating in humans by increasing urinary excretion of sodium (along with other electrolytes) and water.

Inhibiting sodium and water reabsorption by the tubules and increasing glomerular filteration rate cause this (Milon *et al* ., 1988; Rieg *et al* ., 2004). It has been suggested that athletes or airline passengers avoid caffeine because of its diuretic effects, which may increase urinary output and decrease the risk of dehydration. (Maughan *et al* ., 2003).

Cola nitida was used as a test substance to see how it affected sweat electrolytes under different conditions.

2. MATERIALS AND METHODS

SUBJECTS

Participants in the study were sixty (60) non-obese volunteers (30 males and 30 females), aged 18-28, from the University of Benin, and non-habitual chewers of Cola nuts (Chukwu *et al* ., 2006).

During the six months before the experiment, no subject had completed a regular physical exercise programme, an indicator of athletic training (Ugwu, 2007; Ugwu and Oyebola, 1996). However, all health status measurements that were collected by questionnaires and physical examinations revealed that the subjects were active (Kokkinos *et al* ., 1995).

Informed consent was obtained from each subject and permission of the university's ethical committee was obtained before the study began. There were three (3) subgroups: underweight (n=10), normal weight (n=10) and overweight (n=10).

The study involved three conditions: a normal chamber temperature of 270 C, a raised chamber temperature of 370 C, and the normal chamber temperature with exercise condition, in which RT and RH were maintained at 270 C and 70%, respectively. (Ugwu, 1985; Ugwu, 1996).

The Sweat Chamber

A room of 4m x 3m was used for the study that was conducted in Professor (Sir) AC Ugwu's Sweat Chamber (at the University of Benin) (Ugwu, 1978; Ugwu and Oyebola, 1992). The room temperature was raised by a heater, measured with a thermometer, while the relative humidity was maintained by an air conditioner, and measured with a hygrometer at the desired level. (Ugwu and Oyebola, 1992). Before the study, the subjects' age (years), weight (kilograms), height (metres), blood pressure (mmHg), and pulse rate (beats/minute) were gathered.

The amount of Cola nitida (0.5g/kg) taken in the study was worked out by allowing the subjects to consume as much as they desired until they were satisfied in the study. The range of the intake was between 0.39g/kg and 0.57g/kg body weight (Obika *et al* ., 1995; Igwe *et al* ., 2007).

The masticated Cola nitida was flushed down the gut with 50ml of deionized water after ingestion (Igwe *et al* ., 2007).

Thereafter, the subject entered the sweat chamber for 90 minutes (preliminary experiments had indicated the nuts would induce changes in the body's tissues 90 minutes after ingestion) (Igwe *et al* ., 2007).

Sweat Output

Subject sat in the sweat chamber for 20 minutes at both a normal and raised chamber temperature (Ugwu, 1986; Ugwu and Oyebola, 1996). Exercise on a bicycle ergometer at 750J/min for 20 minutes was carried out in a normal chamber with exercise temperature (Ugwu and Oyebola, 1992).

Sweat Collection (The Sweat Capsule Method)

Ugwu and Oyebola (1996) developed the sweat capsule technique to collect sweat from the mid-forehead 283cm2 using a 3cm radius filter paper and applying the formula *r2 - where π=3.142 x 32 .

A genuine Whatman filter paper was stacked over three other filter papers and placed over the mid-forehead area of the scalp for 20 minutes with the aid of a watch glass.

To calculate the weight of the sweat produced, the area was calculated and the weight was measured before and immediately after sweat collection

In the subsequent process of weighing and soaking the filter papers in deionized water for a few minutes, the filter papers were placed into a clean sample bottle and centrifuged for 15 minutes at 3500 rpm. The supernatant was collected, and the Aliquot part of it was used to estimate sweat electrolytes. (Ugwu and Oyebola, 1996).

Sweat Electrolytes analysis

Sodium and Potassium ions: Flame Spectrophotometry (Ugwu, 1987).

Chloride ion: Teco Diagnostics" chloride reagent kit for measuring chloride in human sweat in a quantitative colorimetric manner (Ugwu, 1987; Tietz, 1976).

3. DATA ANALYSIS

The graphs represent the Mean * SEM of all the results. In order to determine whether the results were significant, we calculated the 005 level of probability (P*005) using Microcal Origin version 80 statistical software.

Table 1: Comparing the mean values of the sweat rate and sweat electrolytes of different BMI following the ingesting of *Cola nitida* at normal chamber temperature

Parameters		**Underweight**	**Normal-weight**	**Overweight**
Sweat rate (ml/min)	Before intake	0.0397 ± 0.011	0.0635 ± 0.013	0.0723 ± 0.015
	After intake	0.1457 ± 0.015	0.2190 ± 0.017	0.9706 ± 0.211
	P-vlaue	P<0.05		
Sweat sodium concentration (Mmol/L)	Before intake	11.85 ± 0.629	12.95 ± 1.014	20.60 ± 2.247
	After intake	12.45 ± 0.783	13.45 ± 1.072	21.80 ± 2.688
	P-vlaue	P>0.05	P>0.05	P>0.05
Sweat chloride concentration (Mmol/L)	Before intake	5.500 ± 0.592	5.450 ± 0.467	10.00 ± 1.136
	After intake	6.800 ± 0.647	6.950 ± 0.789	11.85 ± 1.769
	P-vlaue	P<0.05	P<0.05	P>0.05
	Before intake	2.980 ± 0.238	2.415 ± 0.241	7.195 ± 2.769

International Journal of Novel Research in Interdisciplinary Studies
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Sweat potassium concentration (Mmol/L)	After intake	3.000 ± 0.380	2.235 ± 0.177	6.750 ± 2.580
	P-vlaue	P>0.05	P>0.05	P>0.05
Sweat calcium concentration (Mmol/L)	Before intake	2.890 ± 0.195	3.505 ± 0.210	4.145 ± 0.390
	After intake	2.420 ± 0.181	3.035 ± 0.202	3.730 ± 0.312
	P-vlaue	P<0.05	P>0.05	P>0.05
Sweat magnesium concentration (Mmol/L)	Before intake	2.145 ± 0.104	2.100 ± 0.121	2.195 ± 0.192
	After intake	1.660 ± 0.134	1.720 ± 0.111	3.730 ± 0.312
	P-vlaue	P<0.05	P<0.05	P<0.05

Table 2: Comparing the mean values of the sweat rate and sweat electrolytes of different BMI following the ingesting of *Cola nitida* at raised chamber temperature.

Parameters		**Underweight**	**Normal-weight**	**Overweight**
Sweat rate (ml/min)	Before intake	0.0924 ± 0.013	0.1439 ± 0.015	0.3377 ± 0.017
	After intake	0.2769 ± 0.025	0.3696 ± 0.026	1.187 ± 0.208
	P-vlaue	P<0.05		
Sweat sodium concentration (Mmol/L)	Before intake	10.80 ± 0.878	13.45 ± 1.649	24.80 ± 2.21
	After intake	14.90 ± 3.863	13.90 ± 1.378	24.70 ± 2.688
	P-vlaue	P>0.05		
Sweat chloride concentration (Mmol/L)	Before intake	6.050 ± 0.401	5.700 ± 0.744	12.95 ± 0.936
	After intake	7.750 ± 0.644	7.900 ± 0.962	15.05 ± 1.536
	P-vlaue	P<0.05		
Sweat potassium concentration (Mmol/L)	Before intake	3.635 ± 0.343	3.155 ± 0.442	9.450 ± 2.923
	After intake	2.935 ± 0.560	1.935 ± 0.179	5.895 ± 2.355
	P-vlaue	P>0.05	P<0.05	P<0.05
Sweat calcium concentration (Mmol/L)	Before intake	3.055 ± 0.265	4.445 ± 0.371	6.245 ± 0.689
	After intake	1.880 ± 0.175	2.580 ± 0.201	4.145 ± 0.933
	P-vlaue	P<0.05	P<0.05	P>0.05
Sweat magnesium concentration (Mmol/L)	Before intake	2.025 ± 0.202	2.575 ± 0.261	3.630 ± 0.429
	After intake	1.205 ± 0.113	1.245 ± 0.113	1.495 ± 0.203
	P-vlaue	P<0.05	P<0.05	P<0.05

Table 3: Comparing the mean values of the sweat rateand sweat electrolytes of different BMI following the ingesting of *Cola nitida* at normal chamber temperature with exercise.

Parameters		**Underweight**	**Normal-weight**	**Overweight**
Sweat rate (ml/min)	Before intake	0.1542 ± 0.013	0.2642 ± 0.017	0.5471 ± 0.032
	After intake	0.4270 ± 0.038	0.5268 ± 0.036	1.401 ± 0.207
	P-vlaue	P<0.05	P<0.05	P<0.05
Sweat sodium concentration (Mmol/L)	Before intake	9.200 ± 1.038	13.60 ± 2.408	27.10 ± 2.40
	After intake	9.550 ± 1.017	15.20 ± 1.592	28.85 ± 2.668
	P-vlaue	P>0.05	P>0.05	P>0.05
Sweat chloride concentration (Mmol/L)	Before intake	5.750 ± 0.764	6.175 ± 0.978	15.00 ± 1.504
	After intake	8.800 ± 0.931	10.35 ± 0.933	18.30 ± 1.527
	P-vlaue	P<0.05	P<0.05	P>0.05
Sweat potassium concentration (Mmol/L)	Before intake	3.475 ± 0.359	3.995 ± 0.739	11.19 ± 2.432
	After intake	2.945 ± 0.768	1.720 ± 0.228	5.200 ± 2.138
	P-vlaue	P>0.05	P<0.05	P<0.05
Sweat calcium concentration (Mmol/L)	Before intake	3.205 ± 0.291	4.695 ± 0.513	7.445 ± 0.914
	After intake	1.395 ± 0.158	2.090 ± 0.178	2.485 ± 0.295
	P-vlaue	P<0.05	P<0.05	P<0.05
Sweat magnesium concentration (Mmol/L)	Before intake	2.420 ± 0.274	3.215 ± 0.521	5.405 ± 0.791
	After intake	0.685 ± 0.081	0.855 ± 0.104	1.080 ± 0.193
	P-vlaue	P<0.05	P<0.05	P<0.05

International Journal of Novel Research in Interdisciplinary Studies
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4. DISCUSSION

Compared to UW and OW subjects and NW and OW subjects before and after ingesting Cola nitida, the results showed that sweat Na concentration increased significantly under all conditions (Fig. I, II and III). In this case, it may have been possible that due to the increased sweat rate, Na was reabsorbable over a limited period of time, which would have resulted in much of the Na being lost to sweat (Bijman and Quinton, 1984; Ugwu and Oyebola, 1992).

After ingesting Cola Nitida (under all conditions), the sweat Cl- concentration increased significantly in the UW and NW subjects compared with their initial concentrations (Fig. IV, V and VI). Additionally, Cola Nitida consumption led to a significant increase in both UW and OW, as well as NW and OW.(under all conditions) (Fig. IV, V and VI). Chloride concentration might have probably followed passively that of Na (Ugwu and Oyebola, 1992). The electrochemical balance of the system is maintained by reabsorbing Cl* with sodium cations.

The results of the potassium concentration in all subjects were not significantly different under normal, UW and NW.

Aldosterone may be responsible for this by reabsorbing potassium from sweat glands. In exchange for K+, Aldosterone stimulates resorption of sodium and water from the gut, salivary and sweat glands.

In addition, it could be due to an activation of the enzyme Na+-K+ ATPase that regulates the activity of the Na+-K+ counter-transporter protein.

Both hormone and enzyme would have reabsorbed K following Na loss in sweat, thus conserving both in body fluids after Na loss.

Aldosterone stimulates the basolateral sodium/potassium pumps that remove three sodium ions from the cell, into the interstitial fluid, and bring two potassium ions into the cell from the interstitial fluid, by acting on nuclear mineralocorticoids within the distal tubule and nephron collecting duct.

Consequently, resorption of sodium (Na+) ions and water (following sodium) into the blood, and the secretion of potassium (K+) ions into the urine is induced (lumen of collecting duct) (Palmer and Frindt, 2000).

When NW and OW (under raised temperatures) were compared before and after ingesting Cola nitida, there was a significant increase in sweat K concentration (Fig. VII, VIII and IX). There was a significant increase in sweating in the OW subjects, and this was also supported by Ugwu and Oyeola (1992).

The comparisons of the UW and OW and the NW and OW before ingesting Cola nitida under exercise conditions showed significant differences, which could be attributed to increased sweat rates during exercise and a body fluids-based attempt to preserve K concentration.

In addition, the NW was significantly reduced after consuming Cola nitida (Fig. VII, VIII and IX). In addition, caffeine lowers serum K+ levels by increasing plasma adrenaline (Robertson *et al* ., 1978, Brown *et al* ., 1983). In addition, caffeine lowers serum K+ levels by increasing plasma adrenaline (Terrada, 1966)

5. CONCLUSION

The concentrations of Na and Cl in sweat increased after consumption of Cola Nitida, whereas K concentrations were maintained. For this reason, cola nitida should not be overused (especially when used by overweight people and under conditions that increase their body temperature and physical activity).

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