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THE EFFECTS OF *COLA NITIDA* ON SWEAT RATE OF INDIVIDUALS WITH VARYING DIFFERENT TEMPERATURE

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Abstract: **The study investigated the influence of *Cola nitida* on sweat after its consumption in relation to sweat rate in the male and female human subjects. Sixty (60) non-obese volunteers (30 males and 30 females) and non-habitual Cola nut chewers, aged 18-28years were recruited for the study. They were sub-divided into three (3) subgroups: underweight (n=10), normal weight (n=10) and overweight (n=10) for each gender. Subjects with hypertension, kidney and heart-related conditions were excluded from the study. Three environmental conditions were involved: The normal chamber temperature, the raised chamber temperature and third condition was the normal chamber temperature with exercise at moderate workload of 750J/minute for 20 minutes. The three conditions were before taking *Cola nitida*. Before entering the sweat chamber, the subject was told to void the bladder in preparation for the timed urine volume measurement and immediately after the experiment in the sweat chamber, the subject also voided urine for measurement. 0.5g/kg body weight of *Cola nitida* was administered to each subject and chewed as a bolus, under each of the three experimental conditions. After ingestion, 50ml of deionized water was given to each volunteer to flush the masticated *Cola nitida* down the gut and the subject was allowed to rest for 90 minutes before being admitted into the sweat chamber. The sweat capsule technique was used in sweat collection, after which the sweat rate was estimated accordingly. Conclusively, *Cola nitida* significantly influenced fluid loss via the sweat glands. Therefore, some caution should be applied in the consumption of *Cola nitida* by human subjects (even among those already adapted to Cola nut eating), especially under raised temperature and exercise conditions.**

***Keywords: Cola nitida*, sweat rate, sweat chamber.**

1. INTRODUCTION

Cola nitida contains caffeine (as the most active ingredient) amongst many other principles (Umoren *et al*., 2009). Caffeine, theophylline and theobromine (all in *Cola nitida*) are naturally occurring plant alkaloids referred to as methylxanthines. Methylxanthines share the ability to relax smooth muscles, stimulate the central nervous system (CNS) and produce diuresis (Umoren *et al*., 2009).

The ability to sense and regulate body temperature is a key feature of human survival as a deviation of ±3.5^{0}C from the resting temperature of 37.0^{0}C can result in physiological impairments and fatality (Moran and Mendal, 2002).

Thermoregulation is a neural process that matches information about the external environment with the appropriate human response to maintain a more or less stable internal environment relative to external variation (Nakamura and Morrison, 2008). It involves sensation of environmental conditions and the internal thermal state of the individual, the transmission of this information to the brain via afferent neural pathways and the initiation of the response by efferent signals from the brain (Nakamura and Morrison, 2008). The thermoregulatory system interacts with body fluid regulatory and cardiovascular systems (Takamata *et al*., 2001). The maintenance of body fluid status prevents progressive hyperthermia during exercise in a hot environment (Sawka and Montain, 2000).

Sweating is the production of a fluid that is excreted by the sweat glands in the skin of mammals (Ugwu, 2010). It is a thermoregulatory physiological adaptation associated with sweat gland function after heat exposure. The rate and sensitivity to sweating; increases with increasing environmental temperature (Armstrong and Maresh, 1991; Libert *et al*., 1988). Sweating serves both excretory and thermoregulatory roles, especially in humans (Ugwu, 2007; Blood *et al*., 2007). The sympathetic nervous system mainly regulates sweating (Stocking and Gubili, 2004). Sweat composition is mainly dependent on the secretive and absorptive mechanisms in the sweat glands that may increase or decrease the concentration of solutes (Ugwu, 1996; Shona *et al*., 2010).

Increased temperature causes the autonomic nervous system to stimulate the eccrine glands; to secrete fluid onto the surface of the skin (Ugwu, 2007; Wyart *et al*., 2007). The thermoregulatory center in the hypothalamus controls body temperature by regulating eccrine sweat output and blood flow to the skin (Holzle, 2002). It responds to changes in the core body temperature, hormones, endogenous pyrogens, physical activity and emotions; via the limbic system (Holzle, 2002). Caffeine also stimulates sweating in humans. Both intracellular and extracellular fluid contains dilute solutions of electrolyte minerals that cells rely on to perform a number of functions.

Caffeine intake increases renal excretion of sodium (alongside other electrolytes) and water. This is caused by both slightly increasing the glomerular filteration rate and inhibiting the tubular reabsorption of sodium and water (Milon *et al.*, 1988; Rieg *et al*., 2004). Because of its diuretic effects, some authorities have recommended that athletes or airline passengers avoid caffeine in order to reduce the risk of dehydration through stimulation of urinary output (Maughan *et al*., 2003). The aim of the study was to observe the influence of *Cola nitida* on sweat

2. MATERIALS AND METHODS

SUBJECTS

Sixty (60) non-obese volunteers (30 males and 30 females) and non-habitual Cola nut chewers (Chukwu *et al*., 2006), aged 18-28years were recruited for the study. Individuals from the University of Benin were used. Their health status was assessed with the aid of questionnaires and physical examination (Ugwu, 2007; Ugwu and Oyebola, 1996). All the subjects were active but none was athletically trained as defined by the absence of a regular physical exercise programme during the last six months before the experiment (Kokkinos *et al*., 1995). They were divided into three (3) subgroups of underweight (n=10), normal weight (n=10) and overweight (n=10). Informed consent was obtained from each subject before the study and permission of the ethical committee of the university was also obtained.

Three environmental conditions were involved:

- The normal chamber temperature condition, with a room temperature (RT) of 27^{0}C and a relative humidity (RH) of 70%.
- The raised chamber temperature condition, with RT of 37^{0}C and RH of 90%.
- The normal chamber temperature with exercise condition, when RT and RH were maintained at 27^{0}C and 70% respectively (Ugwu, 1985; Ugwu, 1996).

The Sweat Chamber

Professor (Sir) A.C. Ugwu's Sweat Chamber (situated in the University of Benin) was used for the study. It is a room with the dimension 4m x 3m (Ugwu, 1978; Ugwu and Oyebola, 1992). A heater was used in raising the room temperature and a thermometer used in measuring it. An air conditioner was used to maintain the relative humidity while a hygrometer was used to measure it at the desired level (Ugwu and Oyebola, 1992). Prior to the studies, the subject's age (years), weight (kilogram), height (metre), blood pressure (mmHg), pulse rate (beats/minute) and timed urine volume (milliliter) were recorded.

0.5g/Kg body weight of *Cola nitida* (refers to a preliminary study in which the dose of *Cola nitida* taken in the study was worked out by allowing an ad libitum intake until the subjects were satisfied. The range of the intake was between 0.39g/kg and 0.57g/kg body weight (Obika *et al*., 1995) was administered to each subject to be chewed as a bolus) (Igwe *et al*., 2007). After ingestion, 50ml of deionized water was given to each volunteer to flush the masticated *Cola nitida* down the gut (Igwe *et al*., 2007). The subject was allowed to rest for 90 minutes (preliminary experiments had suggested that the effects of the nuts were observable in body tissues 90 minutes after ingestion) (Igwe *et al*., 2007). Thereafter, the subject was admitted into the sweat chamber.

Sweat Output

In the normal chamber temperature and raised chamber temperature conditions, the subject sat quietly in the sweat chamber for 20 minutes (Ugwu, 1986; Ugwu and Oyebola, 1996). While in the normal chamber temperature with exercise condition, the subjects pedaled a bicycle ergometer at moderate workload of 750J/minute for 20 minutes (Ugwu and Oyebola, 1992).

Sweat Collection (The Sweat Capsule Method)

Sweat was collected from the mid-forehead in each subject using the sweat capsule technique as invented by Ugwu and Oyebola (1996) from an area of 28.3cm^2 using a 3cm radius filter papers and applying the formula πr^2-where π=3.142 x 3^2. The sweat capsule consisted of three genuine Whatman filter papers stacked over each other and placed over the demarcated collection site on the mid-forehead with the aid of a watch glass for 20mins. It was weighed before sweat collection and re-weighed immediately after each collection in order to give the weight of the sweat produced over the calculated area. The difference gave the apparent sweat volume produced in the given period of sweating from which the sweat rate was calculated.

Data Analysis

All results were expressed in graphs as the Mean ± SEM. Statistical analyses were carried out using Microcal Origin version 8.0 statistical software and the 0.05 level of probability ($P<0.05$) was regarded as significant.

3. RESULTS

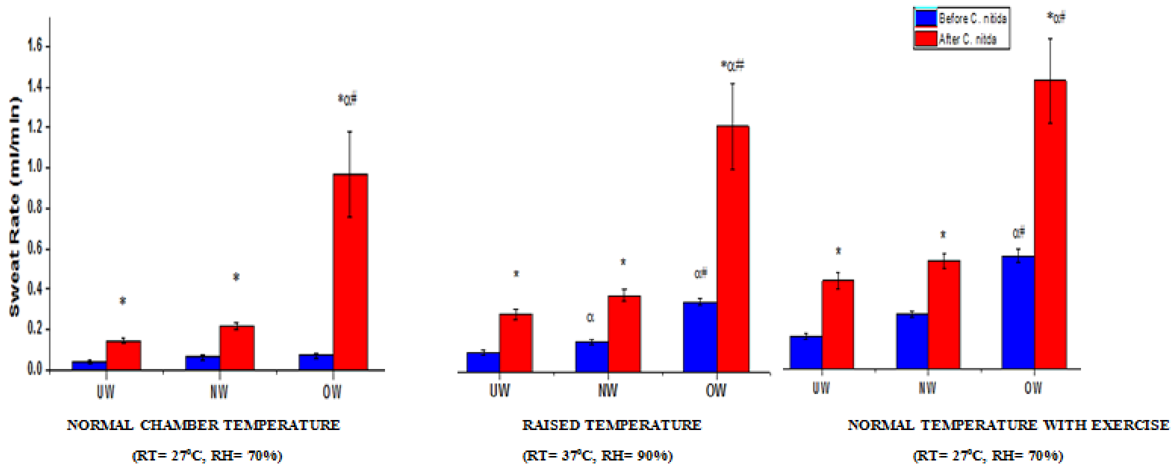

FIG. I: SHOWING THE SWEAT RATE IN INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF COLA NITIDA AT DIFFERENT CONDITIONS.

*P<0.05 indicates significant difference when before ingesting is compared with after ingesting of *Cola nitida*.

$^{\alpha}$P<0.05 indicates significant difference when underweight is compared with normal and overweight.

$^{\#}$P<0.05 indicates significant difference when normal weight is compared with overweight

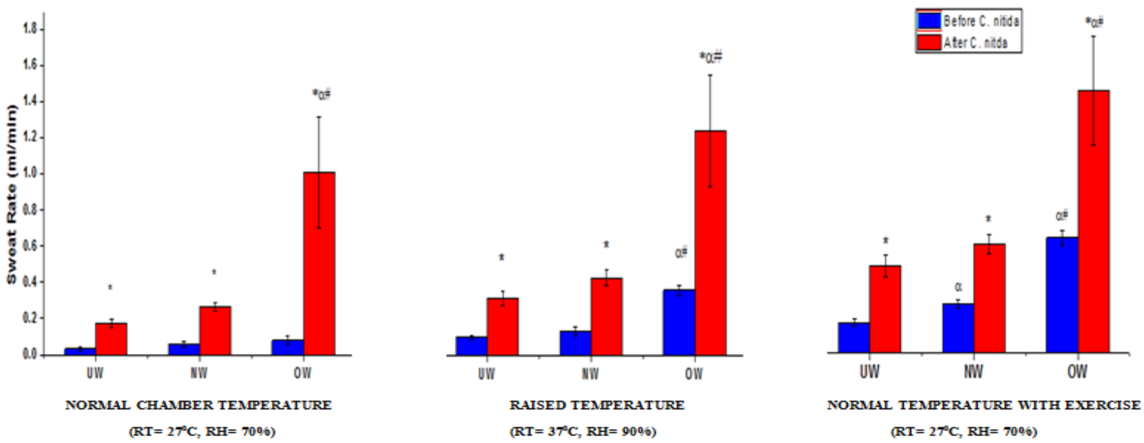

FIG. II: SHOWING THE SWEAT RATE IN MALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF COLA NITIDA AT DIFFERENT CONDITIONS.

*P<0.05 indicates significant difference when before ingesting is compared with after ingesting of *Cola nitida*.

$^{\alpha}$P<0.05 indicates significant difference when underweight is compared with normal and overweight.

$^{\#}$P<0.05 indicates significant difference when normal weight is compared with overweight.

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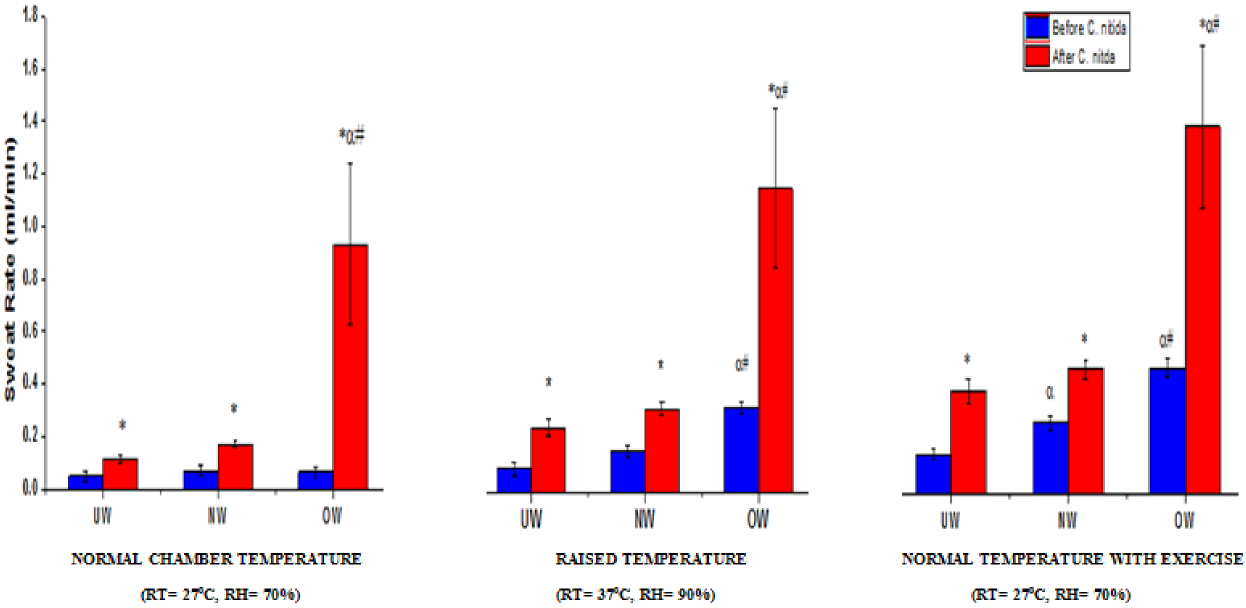

FIG . III: SHOWING THE SWEAT RATE IN FEMALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF COLA NITIDA AT DIFFERENT CONDITIONS.

*$P<0.05$ indicates significant difference when before ingesting is compared with after ingesting of *Cola nitida*.

$^{\alpha}P<0.05$ indicates significant difference when underweight is compared with normal and overweight.

$^{\#}P<0.05$ indicates significant difference when normal weight is compared with overweight.

4. DISCUSSION

The results showed no significant change before ingesting *Cola nitida* (under normal condition). There were significant increases in sweat rate in a comparison between the UW and NW, UW and OW and NW and OW (under raised temperature condition) which could be the effects of raised temperature (Table 3 and Fig. 1). There were also significant increases in sweat rate in a comparison between UW and OW and NW and OW (under exercise condition) which could be due to exercise. An increase in sweat rate leads to the recruitment of more sweat glands with the resultant effects of increased sweat secretion per gland. This is consistent with the works of Wenger (1988) and Wyndham (1973). According to Pappano (1998) and Torres *et al.* (1991), increased sweat rate stimulates increased skin blood flow, thereby enhancing heat transfer from body core to skin.

Following the ingesting of *Cola nitida*, there were significant increases in sweat rate in all the subjects (under all conditions). There were also significant increases in a comparison between UW and OW and NW and OW subjects (under all conditions) and they were most pronounced for the OW subjects and exercise condition. This could be because of the larger number of sweat glands and larger body surface area both of which promote fluid losses (Havenith and Van Middendorp, 1990).

High body fat interferes with heat exchange and increases metabolic heat production (Kolka, 1992). The UW subjects are at higher risk of malnutrition and impaired thermoregulation (Mecklenburg *et al.*, 1974). They also exhibit decreased fat insulation and seemingly increased anabolism and decreased catabolism. They showed higher threshold temperature for sweating compared to the OW subjects. Body fat has low specific heat (Haymes *et al.*, 1975), that is, lower amount of heat is required to increase the temperature of a given mass of fat before sweating can occur. In addition, the lower water content of fat promotes higher water loss due to hypohydration.

Caffeine is the most active ingredient in *Cola nitida*, amongst others (Blades, 2000). Being thermogenic in action, it increases heat production through hypothalamus or catecholamine effects (Armstrong *et al.*, 2007). This could have resulted in further increase in sweat rate following the ingesting of *Cola nitida,* particularly under raised temperature and exercise conditions. The findings are in agreement with the works of Falk *et al.* (1990). Furthermore, caffeine increases resting metabolic rate, Oxygen consumption and heat production during exercise (Poehlman *et al.*, 1985; Cureton *et al.*, 2007).

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