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EFFECTS OF COLA NITIDA ON URINE SODIUM, POTASSIUM AND CHLORIDE CONCENTRATIONS IN INDIVIDUALS UNDER DIFFERENT CONDITIONS

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Abstract: **The study investigated the influence of *Cola nitida* on urine output after its consumption in relation to urine sodium, potassium and chloride concentrations 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 used 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, with a room temperature (RT) of 27^{0}C and a relative humidity (RH) of 70%, the raised chamber temperature, with RT of 37^{0}C and RH of 90%.In the aforementioned conditions, the subjects sat quietly in the sweat chamber for 20 minutes. The third condition was the normal chamber temperature with exercise, when RT and RH were maintained at 27^{0}C and 70% respectively and the subjects pedalled a bicycle ergometer 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. Estimation of urine sodium, potassium and chloride were carried out. Conclusively, *Cola nitida* significantly influenced fluid loss via the urinary system, with no significant changes observed in the respective urine electrolytes. If Cola nitida conserved the said electrolytes under the different experimental conditions, this might lead to an imbalance of the electrolytes within the body fluids. Therefore, some caution should be applied in the consumption of *Cola nitida* by human subjects (even among those already adapted to Cola nut eating).**

Keywords: ***Cola nitida*, urine sodium, potassium and chloride concentrations, hypertension, kidney.**

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 rate.

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 used 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.

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Inclusion/Exclusion Criteria

Subjects with hypertension (Artfield, 1985), kidney and heart-related conditions (Reiling, 1999; Chukwu *et al*., 2006) were excluded from the study. Knowing that the commonly accepted body mass indices (BMI) are: underweight (under 18.5 kg/m^2), normal weight (between 18.5-25.0 kg/m^2), overweight (between 25.0-30.0 kg/m^2) and obese (over 30.0 kg/m^2) (Omorede *et al*., 2016); only the subjects that were underweight, normal weight and overweight but not obese were so categorized and included in the study. Volunteers discontinued the experiment on reaching any one of the two criteria: 20 continuous minutes of exercise and voluntary cessation (Troy *et al*., 2008).

Each subject was studied on different days and studies commenced without breakfast (Marriot, 1993). Before entering the sweat chamber, the subject was told to void the bladder (Obika *et al*., 2009) in preparation for the timed urine volume measurement and immediately after the experiment in the sweat chamber, the subject also voided urine for measurement. The subject passed urine into a container which was in turn transferred into a measuring cylinder for measurement.

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.

Estimation of Urine Electrolytes

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

Chloride ion: "Teco Diagnostics" Chloride reagent kit/Colorimetric method; for the quantitative colorimetric determination of chloride in human sweat (Ugwu, 1987; Tietz, 1976).

Data Analysis

All results were expressed by suitable tables and 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

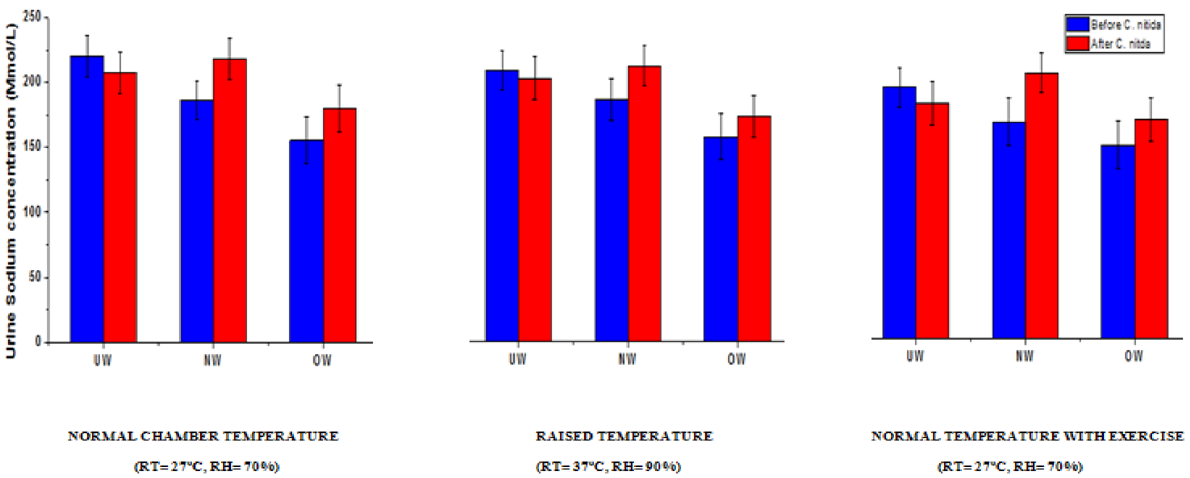

FIG. I: SHOWING THE *URINE SODIUM CONCENTRATION* IN INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

*$P<0.05$ 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.

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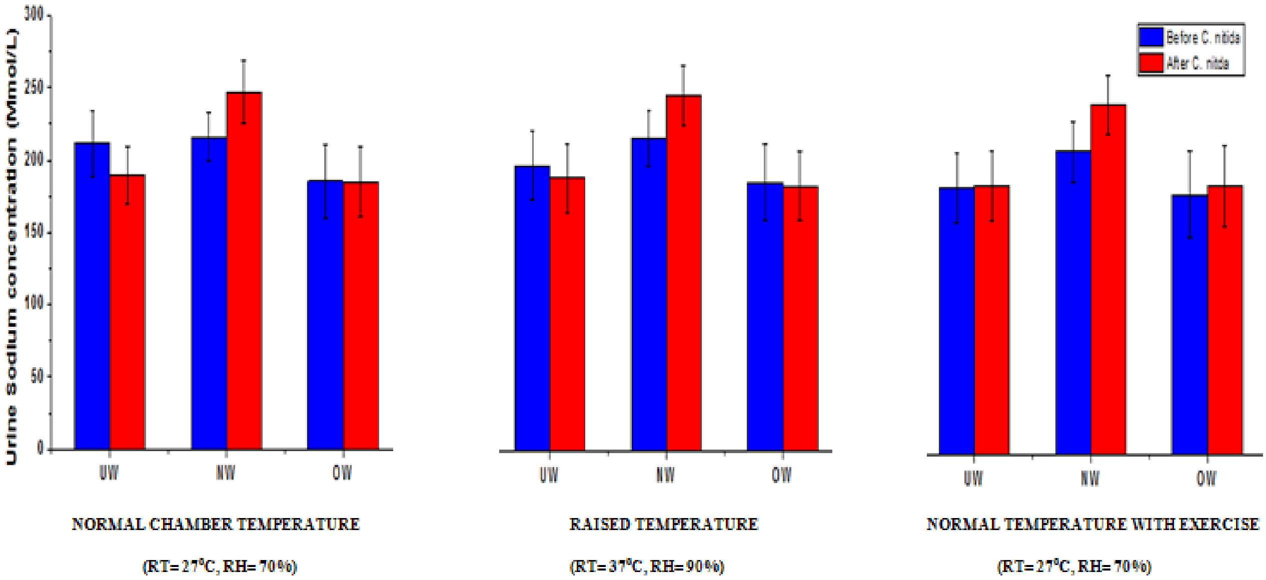

FIG. II: SHOWING THE *URINE SODIUM CONCENTRATION* IN MALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

*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.

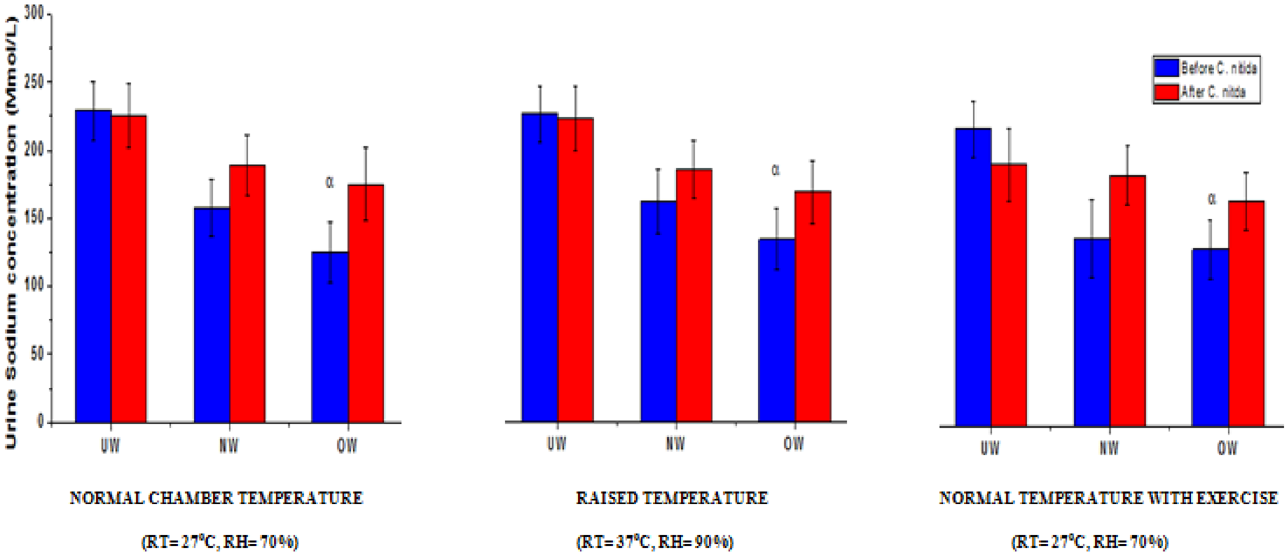

FIG. III: SHOWING THE *URINE SODIUM CONCENTRATION* IN FEMALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

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

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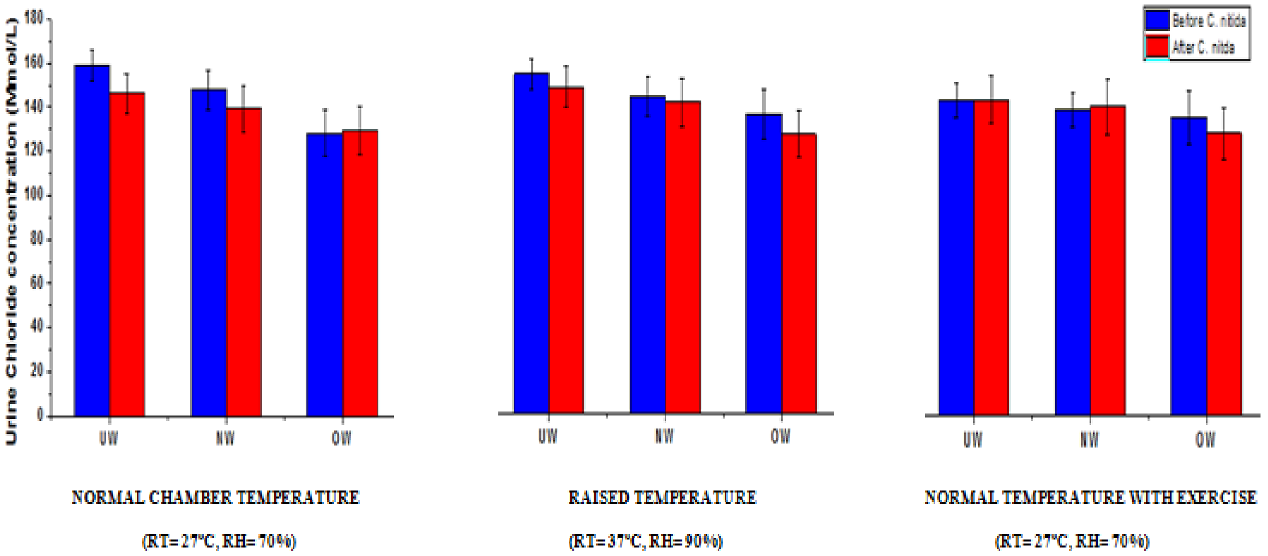

FIG. IV: SHOWING THE *URINE CHLORIDE CONCENTRATION* IN INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

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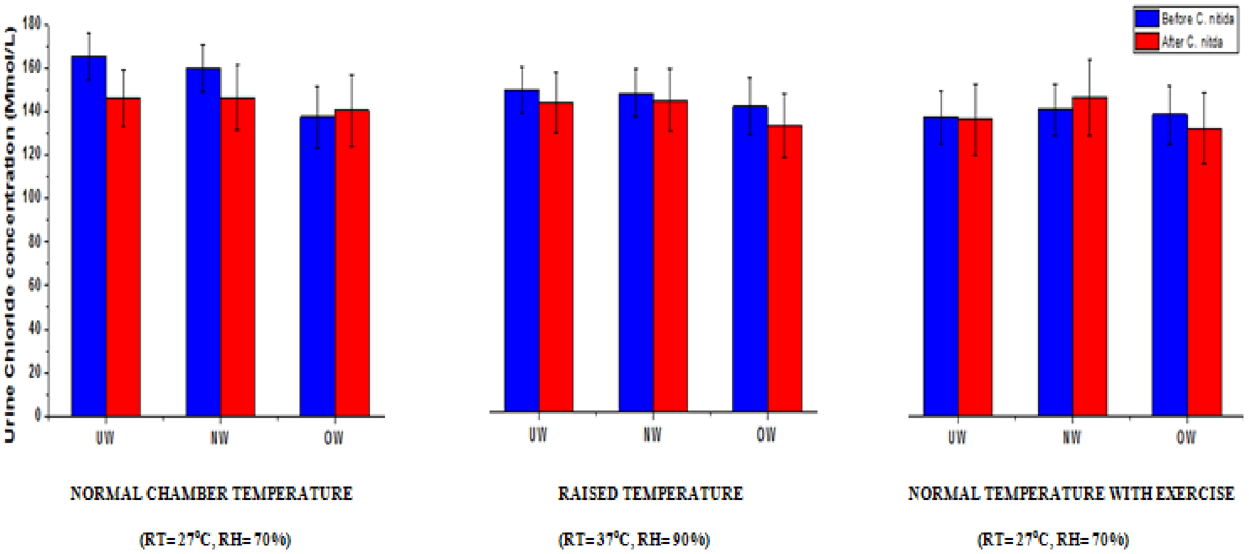
$^{\alpha}$P<0.05 indicates significant difference when underweight is compared with normal and overweight.

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



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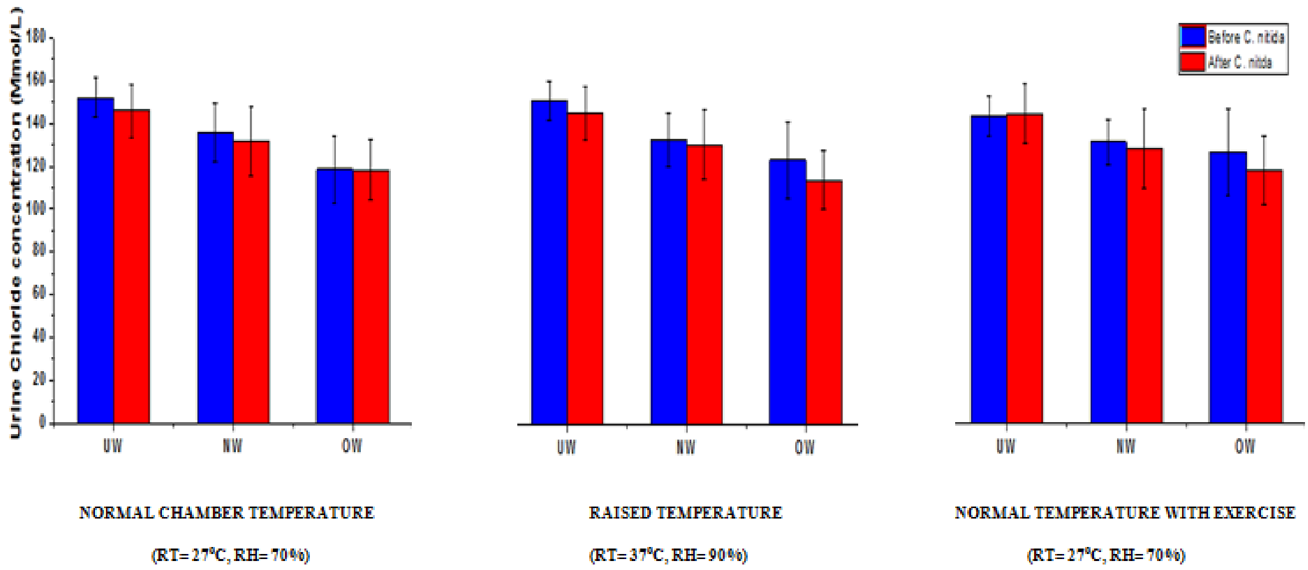

FIG. VI: SHOWING THE *URINE CHLORIDE CONCENTRATION* IN FEMALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

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$^{\alpha}$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.

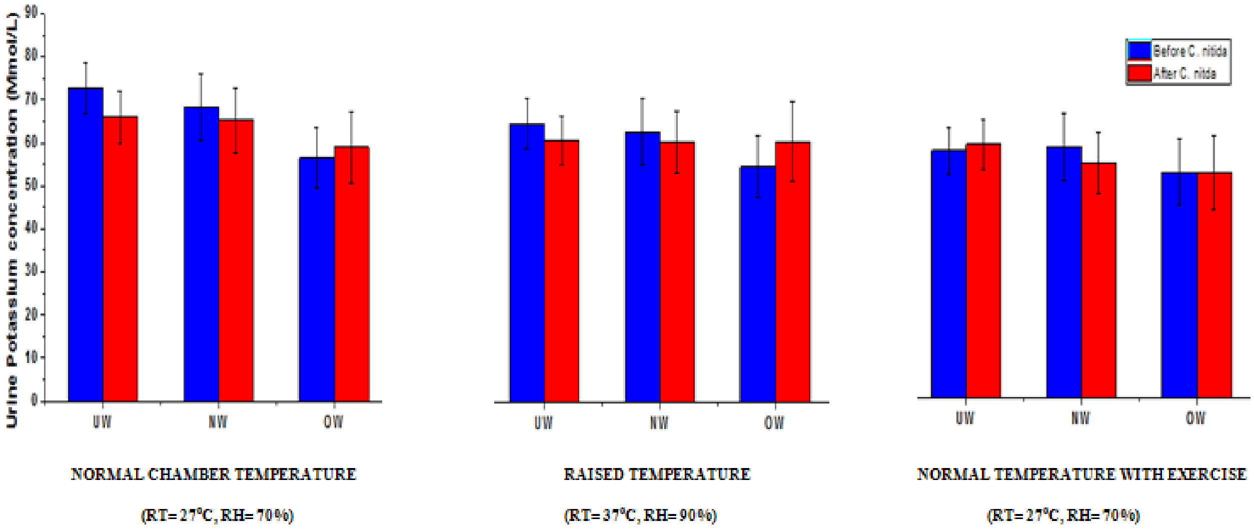

FIG. VII: SHOWING THE *URINE POTASSIUM CONCENTRATION* IN INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

*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.

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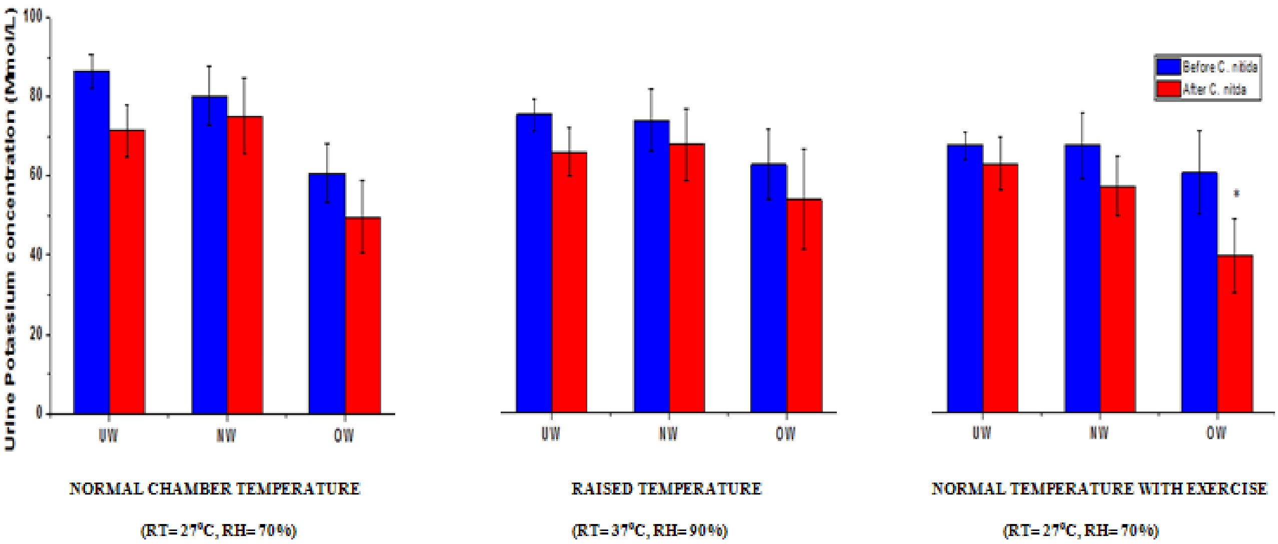

FIG. VIII: SHOWING THE *URINE POTASSIUM CONCENTRATION* IN MALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

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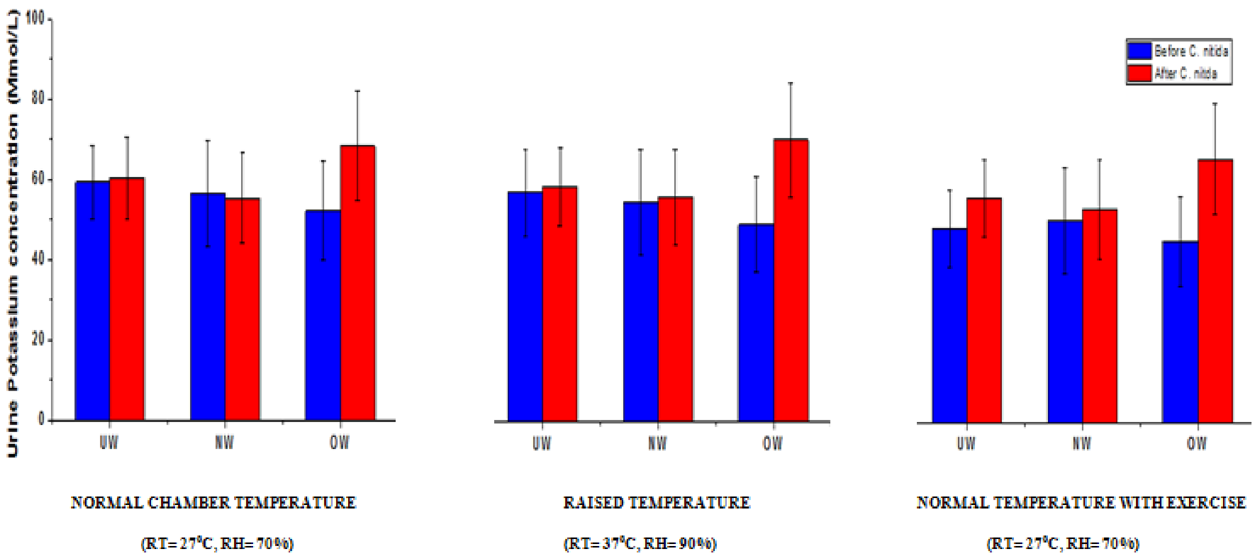

FIG. IX: SHOWING THE *URINE POTASSIUM CONCENTRATION* IN FEMALE INDIVIDUALS OF DIFFERENT BODY WEIGHT BEFORE AND AFTER INGESTING OF *COLA NITIDA* AT DIFFERENT CONDITIONS.

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

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4. DISCUSSION

The results showed that there were no significant changes observed in urine sodium (Fig. I, II and III), potassium (Fig. IV, V and VI) and chloride (Fig. VII, VIII and IX) concentrations, on comparing after ingesting of *Cola nitida* with before. This could be because both heat stress (Venkatachalam *et al.*, 2010) and exercise (Foran *et al.*, 2003) resulted in decreased glomerular filtration rate and the reabsorption of electrolytes. Since antidiuresis and electrolytes retention are increased during exercise (Convertino *et al.*, 2003), sweat production predominates as the primary source of water and electrolyte loss during exercise. Besides, *Cola nitida* might be potentiating antidiuretic hormone activity in circulation (Obika *et al.*, 1996). This could have further conserved more urine sodium, potassium and chloride ions in the body fluids under the aforementioned experimental conditions, especially raised temperature and exercise conditions.

The reabsorption of potassium ions could also be linked to the stimulation of aldosterone activity. Acting on the nuclear mineralocorticoid receptors within the principal cells of the distal tubule and the collecting duct of the kidney nephron, aldosterone upregulates and activates the basolateral Na^+/K^+ pumps, which pumps three sodium ions out of the cell, into the interstitial fluid and two potassium ions into the cell from the interstitial fluid. This creates a concentration gradient which results in reabsorption of sodium (Na^+) ions and water (which follows sodium) into the blood, and secreting potassium (K^+) ions into the urine (lumen of collecting duct) (Palmer and Frindt, 2000).

5. CONCLUSION

Cola nitida resulted in no significant change observed in urine Na, K and Cl concentrations. By implication, it conserved the aforementioned electrolytes in the body fluids. Therefore, to avoid any pathological condition associated with the conservation of these electrolytes, the consumption of cola nitida should not be abused (especially in the overweight subjects and under both the raised and exercise conditions).

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