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EFFECT OF VOLUME LOADING WITH WATER, NORMAL SALINE, PALM WINE AND LIPTON TEA ON URINARY OUTPUT, pH, SPECIFIC GRAVITY, SODIUM AND POTASSIUM CONCENTRATIONS IN HUMAN SUBJECTS.

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Summary: A comparative study of the diuretic effect of water, normal saline, palm wine and Lipton tea was carried out on forty (40) randomly selected, apparently normal undergraduate students of Medicine and Pharmacy at the University of Uyo, Nigeria. One and a half (1.5) litres of water, normal saline, palm wine and Lipton tea were given on separate days to the same subjects. The subjects were made to void their bladder before ingesting these substances and the urine sample collected was taken as control sample at the time zero. Thereafter, all the subjects emptied their bladder hourly for 3 hours. The urinary output, pH, specific gravity, sodium and potassium concentrations were determined. The results showed that water, palm wine and Lipton tea produced diuresis. Normal saline did not. Reduction of specific gravity and pH of urine accompanied these diuretic effects. Administration of normal saline and Lipton tea caused natriuresis. Potassium sparing diuresis was seen with Lipton tea and palm wine, whereas, water diuresis led to increased levels of potassium in urine. Volume loading with the above substances affected not only urinary output but also renal handling of sodium and potassium ions.

Key Words: *Volume loading, Diuresis, urinary electrolytes, palm wine, tea.*

Introduction

Water and electrolyte balance is a vital homeostatic function of the kidney. Their excretion depends on various factors such as state of hydration and plasma osmolarity. Paudel and Karma, 2003). While diuresis following water load is well known, report on the effect of this diuresis following ingestion of Lipton tea and palm wine on urinary sodium and potassium are scarce.

Consumption of water is regular at meal time, water also form a major component of most foods and drinks. Normal saline is in common use in hospital experimental practice. Lipton tea is widely consumed in this part of the world either as part of meal or just for refreshment. Lipton tea contains xanthine compounds (caffeine, theophylline and theobromine) which are potent diuretics, (Iswariah and Guruswani, 1979). It also contains flavonoids and antioxidants. It is a staple diet of most middle and upper class families in Africa.

Palm wine is the sap of a monocarpric crop, Rafia palm, widely grown along the coast of West and central Africa (Ekanem, 1959 and Bassier, 1968). It is widely consumed at homes and in social events including marriages. It is also used in the performance of some traditional rites and is a component of various herbal remedies. Fresh palm wine contains sugar (8.40g/dl), proteins (0.37g/dl), titrable organic acids (0.28g/dl), alcohol (0.79g/dl) and water (Esechie, 1978). The quantity of alcohol content increases as the wine is left to ferment, (Ndon, 2003). Owing to the paucity of information on the effects of Lipton tea and palm wine on diuresis in humans, this study was aimed at ascertaining their effects on diuresis as well as specific gravity, pH of urine, sodium and potassium concentration.

Materials and Methods

Subjects:

A total of forty (40) healthy undergraduate students were recruited for the study. A questionnaire was administered to eliminate those considered unsuitable for the study namely; heavy drinkers, diabetics and those with strong family history of diabetes.

Four (4) practical sessions were held, on four (4) separate days. The day before the practicals, the students were given instructions to abstain from strenuous exercise, smoking and consumption of alcoholic beverages. They were also instructed to have dinner at the same time, minimum of 6 hours of sleep, similar breakfast with only a glass of water on the day of experiment.

Administration of fluid and determination of parameters

On the day of the experiments, all the subjects reported to Physiology laboratory at 8.00 am and were asked to void urine. This was taken as control sample at time zero. Water, normal saline, Lipton tea and palm wine were administered on separate days. The students consumed 1.5L of these substances in 5 minutes. In the case of Lipton tea, 1 bag (about 2g) was extracted in 1.5L of hot water, refrigerated and served cold. The students emptied their bladder every 30 minutes and the above parameters determined. The samples were collected with an appropriate measuring cylinder and transferred to volumetric flask to determine the volume. Urinary volume, pH, specific gravity, sodium and potassium concentrations were determined. pH was measured with a digital pH meter, (model Eq 610, Equip tronics, England), specific gravity with Urinometer and sodium and potassium ions with flame photometer (model PF D7, Jenway, England).

Statistical Analysis

The results are presented as mean values ± SEM. Statistical analysis was done using the SPSS package. Obtained results were compared with control values for each group using paired students t-test. Since, each individual served as its own control. A p-value less or equal to 0.05 was taken as significant.

Results

a) Urinary Output (ml)

There was no significant difference in urinary output (ml) with control at 30 minutes (88.72 ± 3.92) with water load. Urinary output began to rise at 60 minutes (174.3 ± 6.23; P< 0.001) and peaked at 120minutes (192.50 ± 1.65; P < 0.001). Thereafter, the value of urinary output steadily declined. However, value at 180 minutes urinary output was still higher than control (121.69 ± 1.86; P < 0.05) (fig. 1).

Normal saline load did not produce any diuretic effect (fig 1). Urinary output dropped to significantly low values compared with control beginning from 30min. collection (29.43 ± 7.64; P < 0.001) to that at 180min. (19.18 ± 9.53; P< 0.001). Palm wine load gave rise to diuresis. Beginning at 60min. larger volumes of urine were produced than with water load (palm wine: 216.05 ± 8.93mls; water: 174.30 ± 6.23mls; P< 0.001) (fig. 1), peak was at 90 minutes (palm wine: 280.45 ± 12.70mls; P< 0.001), 30 minutes earlier than water load. The urinary output showed a decline from 120 minutes (233.48 ± 19.41mls; P< 0.001), the value at 180 minutes was significantly lower than control (106.85 ± 8.16mls; P< 0.001). There was diuresis with Lipton tea. Urinary output showed a gradual rise from 60 minutes (149.73 ± 18.18mls) with a Peak at 90 minutes (194.65 ± 18.73mls). The diuretic effect was however significant compared with control urinary output (P<0.05) (fig. 1). Urinary output at 150 minutes (58.29 ± 9.26mls; P< 0.001) and 180 minutes (54.35 ± 8.16mls; P< 0.001) were less than control.

b) Specific Gravity

Diuresis resulting from administration of water, palm wine and Lipton tea gave rise to excretion of dilute urine (fig. 2). With water, palm wine and Lipton tea, at 30 minutes, even before noticeable diuresis began, there was a significant drop in urinary specific gravity still at 180 minutes compared with control, for all the three fluids. The greatest lowering effect on specific gravity was produced by palm wine, followed by water and Lipton tea. Normal saline load did not affect urinary specific gravity significantly except at 30 minutes (1.009 ± 0.0012 P< 0.001) and 60 minutes (1.002 ± 0.0019, P< 0.001) and at 90 minutes (1.014 ± 0.0019 P< 0.05) when the specific gravity was lower than its control value (fig. 2). Thereafter, the specific gravity of urine was significantly higher than its control value.

c) Urinary pH.

The pH of urine following water load began to drop significantly, compared with control, at 90 minutes (6.81 ± 0.06 P < 0.05), and remained low till 180 minutes (6.52 ± 0.09, P< 0.091) (table 1). With normal saline load urine became less acidic (i.e., pH increased) at 30 minutes (7.20 ± 0.09, P< 0.001). This trend was maintained till 180 minutes (7.34 ± 0.13, P< 0.05). With Lipton tea load there was a significant reduction in the urinary pH beginning from 30 minutes to 180 minutes (P<0.001). Palm wine administration had no significant effect on urinary pH compared with control (table1).

d) Urinary Sodium

Water had the most significant lowering effects on urinary sodium while normal saline administration produced a steadily increasing concentration of sodium in urine up to 180 minutes, significant at P< 0.001 (Fig. 3). Lipton tea produced no steady pattern in urinary sodium concentration (mMol/L). However, values were high at 60 minutes (40.18 ± 3.04 P< 0.001) and 180 minutes (31.97 ± 1.66 P< 0.001). Urinary sodium concentrations were lower than control following administration of palm wine beginning from 60 to 180 minutes, at P< 0.001 (fig.3).

Table 1: Urinary pH in human subjects following volume loading at varying time intervals

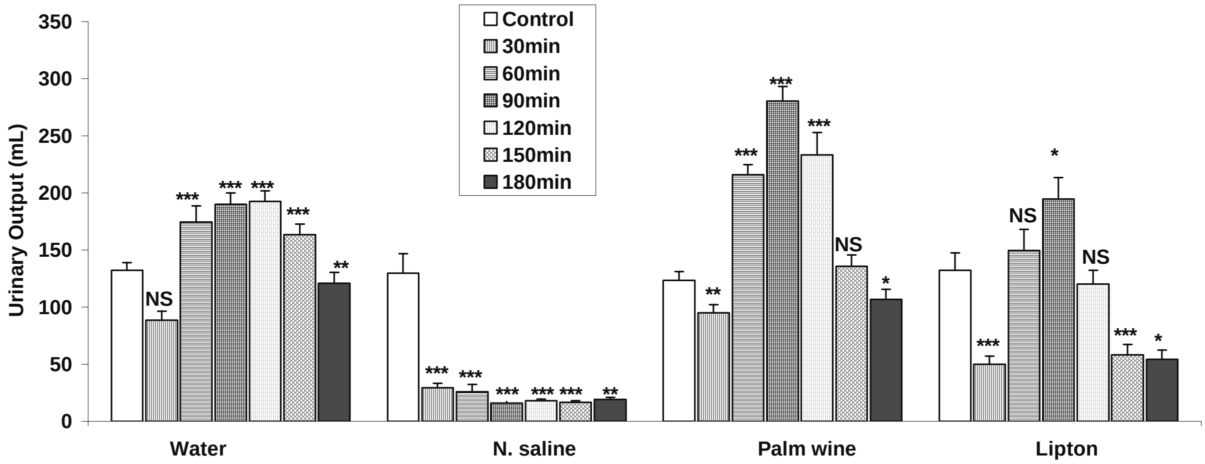
Duration(min)	Control	30	60	90	120	150	180
Water	7.26 ± 0.17	7.22 ± 1.15^{NS}	7.39 ± 0.10^{NS}	6.81 ± 0.06*	6.78 ± 0.05**	6.65 ± 0.06**	6.52 ± 0.09***
N. saline	7.03 ± 0.14	7.20 ± 0.09***	7.67 ± 0.11***	7.66 ± 0.11***	7.51 ± 0.10**	7.48 ± 0.10**	7.34 ± 0.13*
Lipton	8.36 ± 0.13	8.04 ± 0.08***	7.77 ± 0.07***	7.69 ± 0.07***	7.76 ± 0.07***	7.63 ± 0.07***	7.62 ± 0.14***
Palm wine	6.84 ± 0.12	6.97 ± 0.10^{NS}	6.93 ± 0.06^{NS}	6.91 ± 0.07^{NS}	6.93 ± 0.05^{NS}	6.97 ± 0.04^{NS}	6.88 ± 0.09^{NS}

*Values are mean ± SEM, NS = not significant, * = P<0.05, ** = P<0.01, *** = P<0.001*

e) Urinary Potassium (mMol/L)

Fig. 4 shows that following water load urinary potassium (mMol/L) dropped at 30 and 60 minutes (5.86 ± 0.19mMol/L; 4.05 ± 0.50mMol/L; P< 0.001). The values at 90, 120 and 180 minutes were higher than control at P< 0.001. Administration of normal saline produced a drop in urinary potassium (mMol/L) at 60 and 90 minutes (3.28 ± 0.13mMol/L; and 4.07 ± 0.09mMol/L; P< 0.01). Most other analyses showed no significant difference compared with control. Both Lipton tea and palm wine administration brought about a significant (P< 0.001) low levels of urinary potassium compared with control. (fig. 4).

Fig. 1: Urinary Output following volume with water, normal saline, palm wine and lipton tea in human subjects.



** = P<0.05, ** = P<0.001, n = 40.*

Fig. 2: Urinary Specific gravity measured at varying time intervals following volume loading with water, normal saline, palm wine and lipton tea

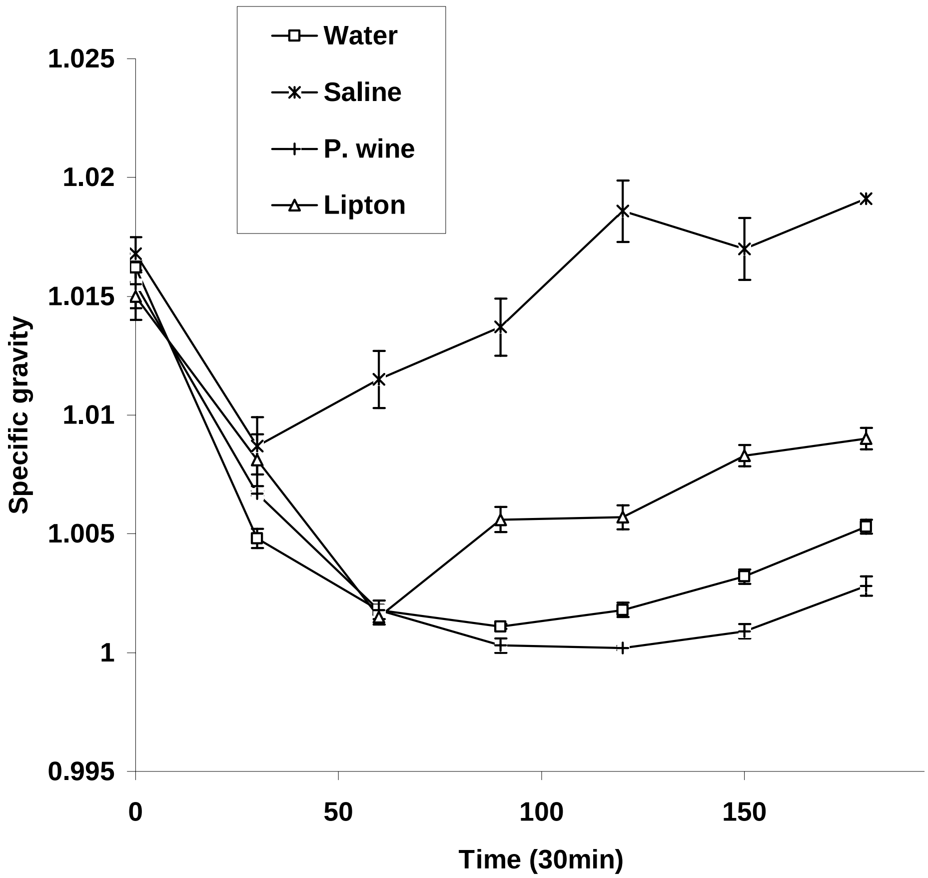
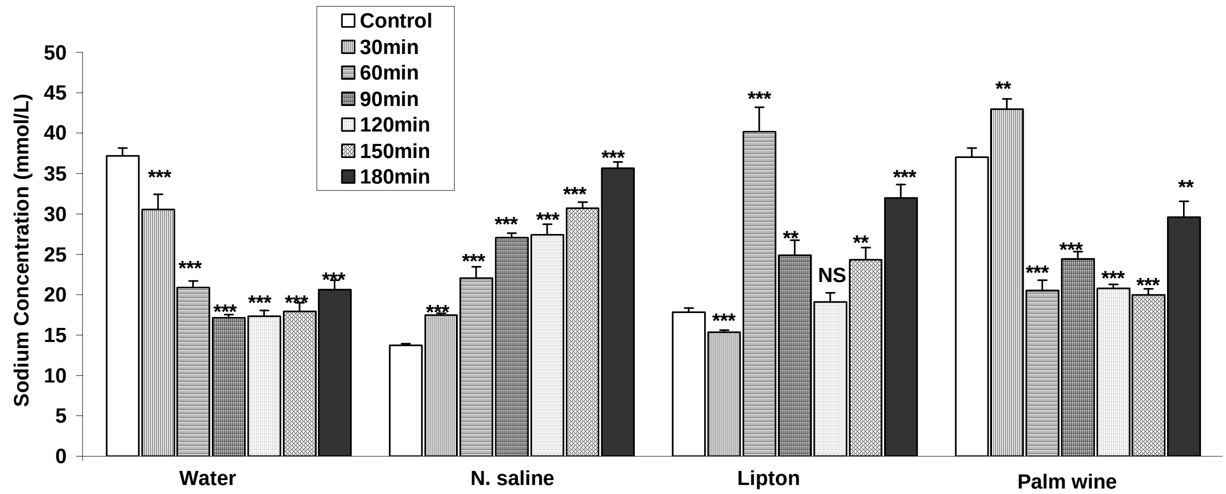


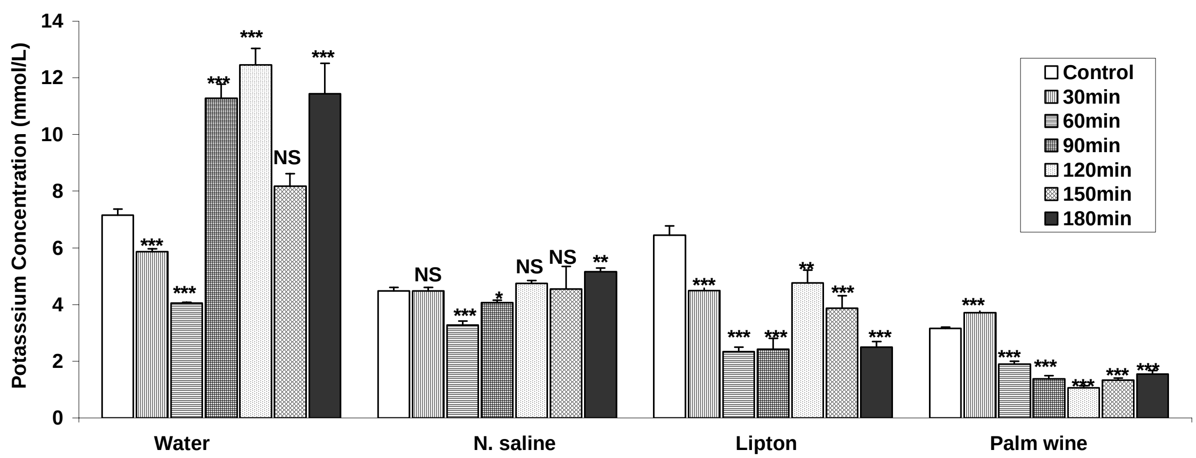
Fig. 3: Urinary sodium following volume loading with wate, normal saline, palm wine and lipton tea in human subjects.



*NS = not significant, ** = P<0.01, *** = P<0.001, n = 40.*

Volume loading with palm wine and diuresis

Fig. 4: Urinary potassium following volume loading with water, normal saline, palm wine and lipton tea in human subjects.



*NS = not significant, * = P<0.01, *** = P<0.001, n = 40*

Discussion

Water, Lipton tea and palm wine produced diuresis while normal saline did not. Diuresis was seen from 60 minutes following the ingestion of the fluids but the 30 minute samples were already dilute as observed from their specific gravity. The ingestion of water produces a decrease in the osmolarity of the body fluid with a decrease in the secretion of antidiuretic hormone (Ganong, 1987; Oyebola, 2002). This may explain the antidiuretic effect of water, Lipton tea and palm wine that contained a lot of water. The diuresis observed with Lipton tea and palm wine may also be due to their content of caffeine and ethanol respectively since ethanol and caffeine are diuretics (Burg and Stoner, 1976) and so, must have contributed to the observed diuresis and dilution of urine.

Diuresis peaked at 120 minutes for water and 90 minutes for palm wine and Lipton tea respectively. There was a decline thereafter with complete cessation of the diuresis at 150 minutes and 120 minutes for palm wine and Lipton tea respectively. This may imply that the doses administered were not enough to maintain the diuresis for longer periods. It was also observed that Lipton tea and palm wine produced a more brisk and short-lived diuretic effect than water. Palm wine also had a more prolonged suppression of concentrating ability of the kidneys. This may be due to its direct inhibitory effect on antidiuretic hormone production.

Normal saline inhibited diuresis probably because it increases the osmolarity of body fluids (Guyton and Hall, 2000). Increase in body fluid osmolarity stimulates the release of vasopressin which inhibits diuresis (by water reasborption in the collecting ducts) as observed in this study following saline load.

Water and palm wine diuresis led to low levels of urinary sodium whereas normal saline and Lipton tea caused significant natriuresis. The mechanism whereby water and palm wine consumption which produced significant diuresis also produced fall in urinary sodium is uncertain. It is however likely that the diuresis produced by water and palm wine caused a fall in blood volume. A fall in volume may stimulate the juxtaglomerular apparatus to stimulate the renin–angiotensin system that stimulates the adrenal cortex to secrete aldosterone (Fox, 2004). Aldosterone causes sodium reabsorption leading to a fall in urinary sodium as observed in the results. The loss of potassium in urine following water diuresis may be due to the notion that sodium is usually reabsorbed in exchange for the excretion of potassium ions (Fox, 2004).

The mechanism whereby the consumption of saline and Lipton tea produced an increase in urinary sodium is also not very clear. However, saline increases the osmolarity of the body fluid which suppresses the release of aldosterone. The inhibition of aldosterone release from the adrenal cortex following ingestion of saline may lead to an increase in urinary sodium as was observed in this study. The increase in urinary sodium following the consumption of Lipton tea is not easily explained. It is possible that Lipton tea like saline suppresses the release of aldosterone, thereby leading to an increase in urinary sodium. It is not surprising therefore, that there was a concomitant decrease in urinary potassium as was observed in the results since sodium loss occurs in exchange for potassium reabsorption. So, Lipton tea may be regarded as potassium–sparing diuretic which may be beneficial in the prevention of excessive loss of potassium. Excessive loss of potassium which occurs in some disorders causes hypokalernia which may lead to neuromuscular and electrocardiographic abnormalities.

In conclusion, the consumption of water and palm wine produce potassium loss with sodium retention. On the other hand, the consumption of saline and Lipton tea produced an opposite effect by an increase in sodium loss and potassium retention. The potassium sparing effect of Lipton tea may be beneficial in the treatment of potassium loss which is seen in some disorders thereby preventing the ensuing neuromuscular and electrocardiographic abnormalities

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