Journal of Medicinal Herbs and Ethnomedicine 2024, 10: 48-51
doi: 10.25081/jmhe.2024.v10.9019
https://updatepublishing.com/journal/index.php/jmhe

Research Article

ISSN: 2455-0485

Effect of differential oral dose administration of aqueous leaf extract of *Senna occidentalis*, *Annona muricata* and *Aju Mbaise* on serum electrolyte levels in Albino rats

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ABSTRACT

Electrolyte imbalances are frequent in medical practice, mostly seen in hospital populations, affecting a wide range of patients and linked to higher rates of morbidity and death. Herbal medicine has been the most accessible and economical form of treatment and it has demonstrated significant promise for the management of a variety of health issues. This study evaluated the effect of differential oral dose administration of aqueous leaf extract of *Senna occidentalis*, *Annona muricata* and *Aju Mbaise* on serum electrolyte levels in albino rats. Twenty Albino rats were used for this study. The rats were grouped into four with 4 rats each. Oral administration of *S. occidentalis*, *A. muricata* and *Aju Mbaise* were carried out at different doses (200, 400 and 500 mg kg^{-1} respectively) for 4 weeks. The rats were sacrificed by jugular decapitation 24 hours after the last administration of the extract and blood samples were collected for serum electrolyte analysis. The result revealed a significant increase $p<0.05$ for chloride, bicarbonate, sodium and potassium ions for the leaf extracts of *S. occidentalis*, *A. muricata* and *Aju Mbaise*. This implies that the leaves of these plants can be toxic and it is therefore advised that consumption of these leaves should be at therapeutic doses since it is associated with an increase in electrolyte levels.

KEYWORDS: Electrolyte, Potassium, Chloride, Bicarbonate, Sodium

Received: July 08, 2024
Revised: October 01, 2024
Accepted: October 03, 2024
Published: October 22, 2024

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INTRODUCTION

The term "electrolytes" refers to electrically charged molecules that are involved in blood coagulation, acid-base balance, muscle contractions, and other processes. The body contains a variety of common electrolytes, each of which plays a unique and significant role. However, the majority of these electrolytes are involved in maintaining the fluid balance between the extracellular and intracellular environments, which is crucial for maintaining pH levels, nerve impulses, muscle function, and hydration. Serum sodium, potassium, and chloride are regarded as the main determinants of the electrophysiological properties of the myocardial membrane (Kughapriya & Evangeline, 2016; Onyiriuka & Oyenusi, 2018).

Electrolyte imbalances are frequent in medical practice, mostly seen in hospital populations, affecting a wide range of patients and linked to higher rates of morbidity and death (Kughapriya & Evangeline, 2016). Numerous pathophysiological factors, either alone or in combination, are important, including dietary conditions, gastrointestinal absorption capacity, coexisting disorders of acid-base balance, pharmaceutical drugs, various associated diseases (mostly renal disease), and acute sickness (Liamis *et al.*, 2014). Electrolyte imbalance has the potential to impact both the management of metabolic syndromes and their progression, as the link between electrolytes and metabolic syndromes (MetS) is intricate (Liamis *et al.*, 2014).

Significant morbidity and mortality are associated with electrolyte problems, and unfortunately, inadequate therapy may exacerbate the issue (Goldberg *et al.*, 2004). Hyperglycemia, primary Na^+ loss from sweating, gastrointestinal loss from vomiting and diarrhea, renal loss from diuretics, salt-wasting kidney failure, the syndrome of inappropriate antidiuretic hormone, hypothyroidism, primary polydipsia, and primary Na^+ gain from heart failure, hepatic cirrhosis, nephrotic syndrome, and chronic renal failure are the most prevalent causes of electrolyte disorders (Hawkins, 2003). Serum potassium values in the majority of hypokalemic patients range from 3.0 to 3.5 mmol per liter (Cai *et al.*, 2016). Dyskalemia raises the risk of death in patients with coronary artery disease, sudden aortic dissection, or diabetes mellitus (Luo *et al.*, 2016) by causing potentially fatal ventricular fibrillation, flaccid paralysis, breathing difficulties, discomfort, and rhabdomyolysis (McPhee *et al.*, 2010; Reid *et al.*, 2012).

Historically, traditional medicine has been the most accessible and economical form of treatment (Ferrer *et al.*, 2016; Nigatu *et al.*, 2017; Ugwah-Oguejiofor *et al.*, 2019), and it has demonstrated significant promise for the management of a variety of health issues (Haidara *et al.*, 2018). Around the world, natural products are a valuable resource in both conventional and traditional medical systems. Natural products or their derivatives make up about 40% of authorized medications that are sold on the market (Nigatu *et al.*, 2017; Aljawdah *et al.*, 2022). Herbal medication is thought to be safe because people have used it for a very long time (Ibrahim *et al.*, 2016). On the other hand, new data raises questions about the safety of using several of these medications (Koduru *et al.*, 2006; Aljawdah *et al.*, 2022). Thus, it is imperative to conduct scientific research to determine the effectiveness and safety of these treatments. Folk medicine has utilized *S. occidentalis*, *A. muricata* and *Aju Mbaise* to treat a variety of illnesses (Yeragamreddy *et al.*, 2013; Murugan *et al.*, 2015). This study has thus been designed to investigate the effect of differential oral administration of aqueous leaf extract of *S. occidentalis*, *A. muricata* and *Aju Mbaise* on serum electrolyte levels in albino rats.

MATERIALS AND METHOD

Plant Materials

The leaves of *Senna occidentalis*, *Annona muricate* and *Aju Mbaise* were obtained from the botanical garden of the University of Nigeria, Nsukka, Enugu State, Nigeria. They were identified and authenticated at the species level at the Department of Botany, University of Nigeria, Nsukka, Enugu State, Nigeria. The leaves were washed thoroughly and air dried for 2 weeks to a constant weight. The dried leaves were pounded to fine powder in a mortar with a pestle and then stored in dried containers until needed.

Experimental Animals and Design

The protocol employed met the guidelines of Good Laboratory Practice regulations of the World Health Organization and also the guidelines governing the handling of laboratory animals as stipulated by the University of Nigeria Animal Research Ethics Committee as well as the principles of laboratory animal care. Twenty Albino rats of both sexes weighing 180-200 g were used for this study and they were purchased from animal house of the Department of Medical Laboratory Science, Faculty of Basic Medical Science, University of Nigeria. The Albino rats were housed in well ventilated laboratory cages with 12 hour day/night cycles. They were maintained on a ration containing commercial feed of 54% carbohydrate, 20% protein, 2% minerals, 10% fiber, 1% vitamin and 13% fat. Water was also supplied *ad libitum*. The rats were divided into four groups of 5 rats each. Group 1 served as the control while Groups 2, 3 and 4 were orally given doses of 200, 400 and 600 mg kg^{-1} body weight of the aqueous leaves extract of *S. occidentalis*, *A. muricata* and *Aju Mbaise* respectively using gastric tube for 4 weeks.

Preparation of Plant Extract

The extracts of the leaves of the plant were prepared by suspending 50 g each of the bark powder separately in 100 cm^3 of distilled water and shaken intermittently with a mechanical shaker for 6 hours. The preparation was allowed to stand for 24 hours and then filtered using a Whatmann's no 1 (11 cm) filter paper. The filtrate was concentrated to dryness at 40 °C and under reduced pressure on a rotary evaporator and stored in a refrigerator at -4 °C until required.

Determination of Serum Electrolytes

At the end of the experimental administration period, the rats were anesthetized in a chloroform chamber, and the blood sample was collected through cardiac puncture. The rats were sacrificed by jugular decapitation 24 hours after the last administration of the extract and blood samples were collected. The samples were allowed to clot and centrifuged at 3500 rpm for 10 min and serum was collected for analysis. Serum collected from the blood samples at the end of the treatment was used to assay for serum bicarbonate ion (HCO_3) as described by Van Slyke and Neill (1924), serum chloride ion (Cl^-) as described by Schales and Schales (1941), while sodium and potassium ions were determined by flame emission photometric method of Margoshes and Valle (1956).

Statistical Analysis

Data were expressed as mean±Standard Error of Mean. The statistical analysis was done using GraphPad Prism version 8.0. The differences were accepted when $p<0.05$.

RESULTS

The result in Table 1 shows that the leaf extract of *A. muricata* and *Aju Mbaise* had no effect on the serum electrolyte whereas the leaf extract of *S. occidentalis* had an effect on the physical examination at the doses administered when compared with the control.

The result presented in Table 2 shows that there was a significant increase in Serum bicarbonate ion (HCO_3) and Serum chloride ion (Cl^-) at the different doses of the leaf extract of *S. occidentalis*, *A. muricata* and *Aju Mbaise* when compared with the control group.

DISCUSSION

Administration of *Aju Mbaise* did not affect the rats when examined physically whereas the groups that received *S. occidentalis* and *A. muricata* displayed sluggish behavior and were emaciated as well. This result implies that *S. occidentalis* should be taken with caution in order to minimize the psycho-social behavior of individuals. Also, intake of *S. occidentalis* at non-regulated doses can lead to detrimental weight loss as observed in the physical examination of the rats that received the extracts.

The observed increase in sodium and potassium ions in the albino rats given the leaf extract may be the reason for the use of these plants' leaves in the treatment of nerve disorders. Potassium and sodium ions are necessary for maintaining neuromuscular irritability and stimulating nerve impulse conduction. The levels of potassium and sodium have a significant impact on aldosterone levels. Because these plants have higher levels of sodium and potassium ions, leaf extracts from them may therefore help treat asthma (Palmer & Schnermann, 2015).

For serum electrolytes, there was a significant $p<0.05$ difference in the serum potassium and serum sodium ions of Groups B, C and D when compared with the control group. This suggests that the extracts of these plants did not alter the capacity of the kidney to regulate sodium. Also, consumption of these plants can help maintain the levels of potassium and sodium ions thereby guiding against hyponatremia which occurs when sodium level is less than 135mmol/L (Buffington & Abreo, 2016). However, the increase in the sodium level is an indication of hypernatremia since the level of sodium ions in the test groups was above 145 mmol/L. The implication of this is that these plants can cause an increase in the level of sodium ions.

For the level of potassium ions, the extract of the leaves was able to maintain the potassium ion levels. This suggests that the extract of the plants is useful in preventing potassium derangements that may result in cardiac arrhythmias. They can also be used as a substitute treatment for hypokalemia since they can raise the potassium ion levels a bit. The plants can therefore be suggested as a treatment for weakness, fatigue and muscle twitching. However, it is advised that they are consumed in recommended doses in order to prevent hyperkalemia which can result in arrhythmia (Viera & Wouk, 2015).

The increase in serum electrolytes that was seen in all of the albino rats that received the plant leaf extract may have resulted from the rats consuming these electrolytes in the aqueous extract. This suggests that, as some studies have shown, leaf extracts may

Table 1: Physical examination of the albino rats after oral administration of *Senna occidentalis*, *Annona muricata* and *Aju Mbaise* leave extracts

Dose of extract	Physical examination
Group 1 (Control)	No physical change
Group 2 (*Senna occidentalis*; 200 mg kg^{-1})	Sluggish and emaciation
Group 3 (*Annona muricata*; 400 mg kg^{-1})	No physical change
Group 4 (Aju Mbaise; 600 mg kg^{-1})	No physical change

Table 2: Effect of *Senna occidentalis*, *Annona muricata* and *Aju Mbaise* on serum sodium, chloride, potassium and bicarbonate ions in albino rats

Groups	Dose of extract	Serum sodium (Na^+) ion (mMol/L)	Serum potassium ion (K^+) (mMol/L)	Serum bicarbonate ion (HCO_3) (mMol/L)	Serum chloride ion (Cl^-) (mMol/L)
Group A	Control	170.40±4.54	5.41±0.38	31.35±0.84	131.04±10.89
Group B (*Senna Occidentalis*)	200 mg/kg	176.06±5.84	5.32±0.46	47.15±2.40*^{A}	165.17±7.91*^{A}
Group C (*Annona Muricata*)	400 mg/Kg	174.80±45.88	5.11±0.71	45.25±1.89*^{A}	154.30±4.39*^{A}
Group D (*Aju Mbaise*)	600 mg/kg	173.85±5.15	5.44±0.55	44.09±0.87*^{A}	160.61±3.02*^{A}

Sample size n=5, Result presented as Mean±SD, *^{A}Value is significantly different at $P<0.05$

be utilized to treat stomach problems, diarrhea, and dysentery. Furthermore, it has been shown that in the gastric mucosal gland, excess chloride reacts with hydrogen ions to generate HCl, which may aid in the destruction of microorganisms that cause diarrhea and dysentery. These plants' extracts may help treat diarrhea and dysentery by restoring electrolyte loss, as seen in the groups that got different leaf extracts.

The observed increase in sodium and potassium ions in the albino rats given the leaf extract may be the reason for the use of these plants' leaves in the treatment of nerve disorders. Potassium and sodium ions are necessary for maintaining neuromuscular irritability and stimulating nerve impulse conduction. The levels of potassium and sodium have a significant impact on aldosterone levels. Because these plants have higher levels of sodium and potassium ions, leaf extracts from them may therefore help treat asthma.

CONCLUSION

From the result obtained from this study, it can be inferred that the leaf extract of these plants can significantly increase serum electrolyte levels and may help in replenishing losses but it is advised that caution be adhered to when consuming them.

AUTHOR CONTRIBUTIONS

EIE wrote the original draft. CCU conceptualized the methodology. OCO supervised the resources. KEE collected the data. CPM reviewed and edited the literature. UPOE was involved in project administration. CCD carried out the $LD_{50.}$ GSC was involved in formal analysis of the data. CE validated the results. EKW was involved in the field work. NYW supervised the work. All the authors read and approved the manuscript.

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