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ROLE OF *EMBLICA OFFICINALIS* IN MITIGATING THE SULPHUR DIOXIDE INDUCED TOXICITY IN RATTUS NORVEGICUS (BERKENHOUT)

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ABSTRACT: SO₂ is considered as one of the most poisonous and irritant gas because it alters the physiology, biochemistry and behaviour of the living individuals. In the present investigation the effect of oral administration of *Emblica officinalis* on serum electrolyte in SO₂ exposed albino rats. The thirty albino rats were grouped in three sets - control set (1) were kept in control conditions, while, rats of experimental set (2) were exposed to 80 ppm of SO₂ gas 1h/d for 30 and 60 days and rats of experimental set (3) were exposed to 80 ppm of SO₂ gas 1h/d with oral administration of *Emblica officinalis* fruits extracts (200 mg/kg b.wt.) for 30 and 60 days, respectively. The results exhibits that rats of 30 days showed non-significant (P > 0.05) decrease in plasma potassium ion concentration compared with the control while the rats of 60 days showed significant (P < 0.05) decrease in plasma potassium ion concentration compared with the control. The SO₂ exposed subjects show significant (P < 0.05) decrease in chloride, bicarbonate and sodium ions concentrations compared with the control after 30 and 60 days exposed rats. Oral administration of *Emblica officinalis* recovers all these electrolyte concentration at their standard physiological level, hence, play an important role in mitigating the SO₂ induced toxicity in mammalian system.

INTRODUCTION: The air pollution is an evolving threat to developed and underdeveloped globe. It is being leading to catastrophic conditions such as reported earlier in China and other countries. SO₂ is an important air pollutant and one of the major causes of acid rain. The concentration of SO₂ in environment is increasing simultaneously due to enhancement in industrialization and globalization. SO₂ can easily cross the primary defence system such as epithelial cell membrane, once it cross, makes it approach to small blood capillaries, affecting peripheral blood and vitals ¹.

The exposure of SO₂ leads to the abnormal breathing, nasal irritation, bronchial constriction and hyper-reactivity of pulmonary organs ². The exposure of SO₂ also results in depleted endogenous antioxidant level such as Vitamin C in rats ³. The exposure of sulphur dioxide induces the histopathological changes in liver, which is further related to the alterations in the serum enzymes level ⁴⁻⁹. SO₂ is highly toxic to blood and decreases the Hb. Level ¹⁰. The combination of SO₂ and NO₂ is toxic to the brain lipid content ¹¹. However, indoor air pollution is also responsible for the generation of many pathological conditions.

Urban air pollution occurs when there are continuous or large emissions of air pollutants. Urban air pollution is usually associated with high quantities of SO₂, oxides of carbon, oxides of nitrogen and particulate matter present in the atmosphere. The gases of fire smoke like SO₂, CO₂

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and NO₂ have major effect on the absorption, elimination and serum concentration of many physiologically important electrolytes and minerals, besides affecting liver and kidney physiology¹².

The components of air pollution, typically in homes with gas-burning appliances are more susceptible to lower respiratory tract illness¹³. An electrolyte is a substance containing free ions that behaves as an electrically conductive medium and the primary ions of electrolytes are sodium (Na⁺), potassium (K⁺), calcium (Ca²⁺), magnesium (Mg²⁺), chloride (Cl⁻), phosphate (PO₄³⁻), and hydrogen carbonate (HCO₃⁻)¹⁴⁻¹⁵. Those electrolytes that are positively charged are called cations while negatively charged are called anions¹⁶⁻¹⁷. All higher life forms require a subtle and complex electrolyte balance between the intracellular and extracellular medium because the maintenance of precise osmotic gradients of electrolytes is important (Bell 1984)¹⁸. Such gradients affect and regulate the body's hydration, blood pH, and are critical for nerve and muscle functions¹⁹. Muscles and neurons are activated by electrolyte activity between the extracellular fluid or interstitial fluid and intracellular fluid.

Electrolyte balance is maintained by oral, or in emergencies, intravenous (IV) intake of electrolyte-containing substances, and is regulated by hormones, generally with the kidneys flushing out excess levels. In humans, electrolyte homeostasis is regulated by hormones such as antidiuretic hormone, aldosterone and parathyroid hormone. Serious electrolyte disturbances, such as dehydration and over hydration, may lead to cardiac and neurological complications and, unless they are rapidly resolved, will result in a medical emergency¹⁴. Sodium (Na⁺) ion and chloride (Cl⁻) ion excretion from the body is a function of arterial blood pressure. Sodium (Na⁺) ion depletion stimulates rennin release and subsequent production of Angiotensin II, a potent vasoconstrictor²⁰. *Emblica officinalis* (EO) enjoys a hallowed position in Ayurveda - an Indian indigenous system of medicine.

EO primarily contains tannins, alkaloids, phenolic compounds, amino acids and carbohydrates. It is rich in chromium and has beneficial role in cancer, diabetes, liver treatment, heart trouble, ulcer,

anaemia and various other diseases²¹⁻²². It is an important dietary source of Vitamin C, minerals and amino acids and also contains phenolic compounds, tannins, phyllembelic acid, phyllembin, rutin, curceminoids and emblicol²³. It possesses anti-oxidative, anti-inflammatory, antibacterial, antiviral and hypolipidemic properties. Along with these functions *Emblica officinalis* also may produce beneficial effects on kidney functions. Kidney contributes major role in electrolyte balance and Blood Pressure (BP) regulation. BP is regulated by renal handling of substances like Na⁺, Cl⁻ and HCO₃⁻. It happens under the control of renin-angiotensin mechanism. In this way it maintains homeostasis of the body²⁴. In the present study we tried to find out the effect of *Emblica officinalis* on serum electrolytes in SO₂ exposed rats.

MATERIALS AND METHODS: Adult healthy male wistar albino rats of equal weight ranging from 150 - 195 g were kept in polypropylene cages. Inbred colony of albino rats were maintained at animal house of zoology department in standard condition. The rats were fed on standard laboratory animal diet commercial food pellets, golden feed, New Delhi and water *ad libitum*. The experimental protocol used in this study was approved (Reg.-1608/CPCSEA) by the Institution Animal Ethical Committee (IAEC) for the purpose of control and supervision on experimental animals of Dr. B. R. Ambedkar University, Agra.

80 ppm SO₂ gas was generated by controlled action of 5% sulphuric acid on sodium sulphite in a sulphur dioxide generator²⁵. Rats were exposed in fumigation chamber (AP 07 model SFC 120), Standard Appliances, Varanasi.

The fruits of *Emblica officinalis* were purchased from local market. After pulling of the cuticle the fruit (1 kg) was cut in to small pieces and macerated in the electric mixer. This macerated pulp was soaked on 1 litre of distilled water and stirrer intermittently and then left over night. The macerated pulp was then filtered through muslin cloth²⁶. The dose of *Emblica officinalis* extract (200 mg/kg b.wt./day) was administered in rats by oral gavage. The dose was selected by as guideline as per traditional medicinal system.

The rats were randomly divided into control set (1) and experimental sets (2 and 3) of ten rats each. Control set (1): without SO₂ Exposure. Experimental set (2): Exposed to SO₂ gas (80 ppm/hr./day) for 30 and 60 days. Experimental set (3): Exposed to SO₂ gas (80 ppm/hr./day) along with oral administration of freshly prepared aqueous extract of *Embllica officinalis* (200 mg/kg b.wt./day) for 30 and 60 days.

After stipulated exposure period rats of control and experimental groups were the animals were sacrificed by inhalation of an over dose of chloroform. Blood samples were collected by cardiac puncture into sterilized sample test tubes; serum was prepared by centrifugation and used for serum electrolyte analysis.

The flame photometry method²⁷ was used for the determination of sodium ion (Na⁺) and potassium ion (K⁺) concentration in serum while chloride ion (Cl⁻) and bicarbonate ion (HCO₃⁻) concentration

in serum were determined using the titration method²⁸.

Data collected were expressed as mean ± standard deviation (SD) and the Student 't' test was used for analysis. Values of P < 0.05 were regarded as significant.

RESULTS: Results of the present study indicate that the rats with duration of 30 days showed non-significant (P > 0.05) decrease in plasma potassium ion concentration compared with the control, while, the rats of 60 days showed significant (P < 0.05) decrease in plasma potassium ion concentration compared with the control. The SO₂ exposed rats show significant (P < 0.05) decrease in chloride, bicarbonate and sodium ions concentrations compared with the control after 30 and 60 days. The oral administration of the *Embllica officinalis* fruit extract normalizes all the physiological alterations induced by SO₂ exposure in albino rats (**Table 1**).

TABLE 1: EFFECTS OF EMBLICA OFFICINALIS ON SERUM ELECTROLYTE CONCENTRATION (mEq/L) IN 30 AND 60 DAYS SULPHUR DIOXIDE EXPOSED ALBINO RAT

Sets	Exposure and pre-exposure supplementation	30 days				60 days			
		Range (Mean ± S.Em)				Range (Mean ± S.Em)			
		Na ⁺ mEq/L	K ⁺ mEq/L	Cl ⁻ mEq/L	HCO ₃ ⁻ mEq/L	Na ⁺ mEq/L	K ⁺ mEq/L	Cl ⁻ mEq/L	HCO ₃ ⁻ mEq/L
Control set-1	Ambient air	139.4 ±3.08	4.4 ±0.33	99.3 ±2.65	22.2 ±1.3	146.31 ±0.45	5.43 ±0.42	135.54 ±2.46	27.13 ±0.87
Experimental set-2	80ppm SO ₂ gas	129.4 ±4.67*	3.34 ±0.52*	82.45 ±7.31*	19.51 ±3.21*	112.72 ±8.47**	3.63 ±0.39**	117.37 ±6.02**	16.75 ±3.0**
Experimental set-3	80ppm SO ₂ gas + <i>E.officinalis</i>	137.8 ±1.92*	4.47 ±0.35*	94.27 ±3.75*	21.84 ±1.63*	136.53 ±2.89*	5.20 ±0.43*	131.2 ±3.46 *	25.2 3±3.81**

Values are mean ± S.E.M., * p < 0.05, ** p < 0.01, significantly different from the group treated with SO₂

DISCUSSION: Electrolytes and minerals are involved in most cellular activities and assume a major role in metabolism. They have multiple functions such as holding fluids in compartments of the body and maintaining normal acid - base balance. Electrolyte disturbances may lead to severe and even life - threatening metabolic abnormalities such as liver disease, frequently have abnormal sodium serum concentrations, with hyponatremia as the most common alteration. Sodium together with potassium assists in the maintenance of the body's electrolyte and water balance. In addition, potassium and sodium play an important role in nerve conduction, muscle contraction, and the transport of substances across membranes.

In the present study SO₂ exposure to albino rats decreases the serum electrolyte concentration including sodium, potassium, chloride and bicarbonate. The findings of the present study gain support by the observations that diabetic rats exhibit low sodium concentration in plasma. The depleted serum sodium ion may be attributed to dehydration which is accompanied with severe loss of electrolytes including sodium, potassium, calcium, chloride and phosphates this electrolytes imbalance might also occur due to inhibition of the rennin - angiotensin aldosterone system, which plays a key role in the regulation of fluid and electrolyte balance²⁹. Air pollution is the primary cause of COPD and the decreased level of serum electrolytes have been reported in COPD patients.

Respiratory acidosis, the main mechanism for decrease in serum chloride, gradually improves and consequently the serum chloride increases³⁰. The findings of the present study also supplemented by the observations that fire smoke can also hampers the serum electrolyte concentration, serum enzymes, renal function, lipid profile and bilirubin level in fire workers and decrease in serum electrolytes in CCl₄ treated rats have also been reported^{12, 31}. Similarly, hepatotoxic and nephrotoxic effect of petroleum fumes has also been observed, that petroleum fumes significantly alter the serum liver enzymes, bilirubin concentration, creatinine level, total protein and urea level, besides, serum electrolyte concentration on peoples of filling station³².

They suggested that long term inhalation of petrol fumes is associated with adverse effect on kidney and liver function. *Emblica officinalis* seeds are used for asthma, bronchitis and biliousness. *E. officinalis* fruit contain ellagic acid, gallic acid, quercetin, kaempferol, emblicanin, flavonoids, glycosides and proanthocyanidins. Vitamin C, tannins and flavonoids present in Amla have very powerful immunomodulatory, antioxidant and anticancer activities³³. The *Emblica officinalis* fruit extract possesses a protective role in neutralizing hyperlipidemia in albino rats,

It significantly normalize altered serum electrolyte level in hyperlipidemic rats, besides, play an important role in protecting kidney damage from oxidative stress³⁴. Similarly, Vitamin C plays a modulatory role in serum electrolyte and lipid profile³⁵. It modulates the rennin - angiotensin system, pertaining to the regulation of electrolyte concentration in plasma. Supplementation of *Emblica officinalis* fruit extract significantly maintained acid - base balance by increasing the absorption of electrolytes and minerals from intestine and inhibited electrolytes elimination through urine³⁶.

CONCLUSION: In conclusion, we describe hereby that the fall in electrolyte concentration is associated with SO₂ induced oxidative stress. We would like to state that fruit extract of *Emblica officinalis* plays a protective role against SO₂ induced oxidative damage due to its highly anti-oxidative property.

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CONFLICTS OF INTEREST: Nil.

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