**Graph 3.45:** Effects of *Boswellia serrata* gum extracts, control and standard groups on BUN and Creatinine.

### 4. DISCUSSION

#### 4.1 Hepatoprotective activity:

Hepatic disease is still a world wide health problem. Unfortunately conventional or synthetic drugs used in the treatment of Liver diseases are inadequate and sometimes can have serious side effects. Numerous medicinal Plants and their formulations are used for Liver disorders in ethnomedical practices and in traditional system of medicine in India. Most of the herbal drugs speed up natural healing process of Liver. Therefore the search for effective hepatoprotective drug continues\(^{(159)}\).

The efficacy of any hepatoprotective drug is essentially dependant on its capability of either reducing the harmful effects or in maintaining normal hepatic physiological mechanism which have been imbalanced by hepatotoxins\(^{(160)}\).

In the present study, hepatoprotective action of *Boswellia Serrata* plant extracts in an animal model was assessed using biochemical parameters. Liver cell contain several enzymes which may be released into the blood circulation on liver damage. Measurement of selected enzymes in serum is often used to access the liver function. Serum enzymes provide valuable information for the liver function tests. Some of them undertaken for study are SGPT, SGOT, and ALP. The activities of
two Serum transaminases namely SGPT and SGOT are widely used to access the liver function. SGPT is a cytoplasmic enzyme while SGOT is found in both cytoplasm and mitochondria. Serum SGPT and SGOT are elevated in liver damage. However SGPT is more sensitive and reliable for the assessment of liver function tests. Enzyme ALP is also derived from liver. A rise in serum ALP is usually associated with cirrhosis of liver. Serum bilirubin is an indicator of biliary obstruction.

Liver participates in a variety of metabolic activities and contain lot of enzymes. Liver could be injured by many toxicants, chemicals and drugs.

NSAIDs have been widely used to manage various types of pain and inflammations. The gastro intestinal upset is the common side effects of conventional NSAIDs\textsuperscript{[161]}. Paracetamol, a widely used anti-pyretic, anti-inflammatory, analgesic. It produces acute liver damage if accidental over dosage (which may occur in alcoholics and elderly) are consumed\textsuperscript{[162]} It was administered (in acute dose of 3gm/kg body wt.) as hepatotoxicant to produce acute liver injury in rats. Paracetamol gets converted into N-acetyl-P-benzoquinoneimine (NAPQI) in liver\textsuperscript{[163]} by action of cytochrome P-450\textsuperscript{[164]} and alters the functional integrity of hepatic mitochondria leading to Liver damage\textsuperscript{[165]}. When hepatic cell membrane is damaged, the enzymes SGOT, SGPT and ALP which are normally located in the cytosol, leak into blood circulation from hepatocytes\textsuperscript{[166-167]}. As a result, serum levels of SGPT, SGOT and ALP will increase\textsuperscript{[168]} Similarly
Paracetamol decreases the membrane bound enzymes viz., Na/K ATPase, Ca ATPase and Mg ATPase. Hyperbilirubinemia, seen in liver injury, can result from impaired hepatic uptake of unconjugated Bilirubin \(^{(169)}\). Paracetamol induced liver injury results in decreased serum total protein level and an elevated level of SGPT, SGOT, ALP and Bilirubin and reduced level of membrane bound enzymes and total proteins \(^{(170-171)}\).

The increase in the levels of serum bilirubin reflected the depth of jaundice and the increase in transaminases and alkaline phosphatase was the clear indication of cellular leakage and loss of functional integrity of cell membrane\(^{(172)}\). The decrease in the level of total protein also confirms the depth and intensity of liver damage\(^{(173)}\).

Treatment with *Boswellia serrata* extracts showed reduction in the elevated levels of SGPT, SGOT, ALP and Bilirubin and increased membrane bound enzymes and total proteins. The Hepatoprotective activity can be evidenced by observing Tabular data of the extracts and graphical representations.

*Boswellia Serrata* plant extracts reduced the damaging effect of Paracetamol on hepatocyte membrane. These biochemical restorations may be due to presence of the active phytoprinciples (Tables-3.1-3.6) & chromatograms (3.1-3.3) in the plant extracts. Phytoconstituents like flavonoids, triterpenoids, saponins and alkaloids are known to possess hepatoprotective activity.
These observations were supported by histopathological profile of Liver sections of rats.

The PBE, ALE, & PGE were found to be effective among the extracts as they showed significant hepatoprotective activity.

**4.2 Anti-ulcer Activity**: There are several factors that may induce ulcer in human beings such as stress, chronic use of anti-inflammatory drugs, continuous alcohol ingestion, *H. pylori* infection, Zollinger Ellison syndrome, etc. Although in most cases the etiology of ulcer is unknown it is generally accepted that it is the result of an imbalance between aggressive factors and maintenance of the mucosal integrity through endogenous defense mechanism. An effective Anti-ulcer drug should basically act either by reducing the aggressive factors on gastroduodenal mucosa or by increasing mucosal resistance against them. The critical factors in maintaining defense and integrity of gastric and intestinal wall, mediated by prostaglandins are mucosal blood flow, mucous and bicarbonate secretion, epithelial proliferation and repair. Aspirin induces gastric lesions through blocking prostaglandin production\(^{(174-175)}\).

The treatment of peptic ulcer disease is mainly aimed at reducing the gastric acid secretion, increasing gastric cytoprotection, eradication of *H. pylori* or curing Zollinger Ellison syndrome. The discovery of potential anti-ulcer agent from plants is a developing area. Several plants have
been screened for anti-ulcer activity and many formulations have been
developed by combining extracts of these plants\textsuperscript{(176)}.

It was reported that Boswellic acid of Boswellia Serrata is a known
inhibitor of leukotriene by inhibiting 5-LOX. It may act by multiple
mechanism. The activity might be due to increasing the gastric mucosal
resistance, local synthesis of cytoprotective prostaglandins and inhibiting
the leukotriene synthesis.\textsuperscript{(67)}

It has also been reported that the presence of phytoconstituents
Tannins, Terpenoids, Sterols and Flavonoids may be responsible for anti-
ulcer activity\textsuperscript{(177-178)}.

Recent reports and extensive literature review indicated that
flavonoids and Tannins show cytoprotective action by increasing mucosal
content of Prostaglandin and mucous in gastric mucosa\textsuperscript{(179)}.

The \textbf{Tables-3.1-3.6 & Chromatograms 3.1-3.3} have exhibited the
presence of active Phytoconstituents.

The Anti-ulcer activity of \textit{Boswellia serrata plant} was evaluated and
represented in Tabular data of the extracts and graphical
representations. The histopathological examinations of stomach also
supported the results obtained.
The ABE, ALE & CGE were found to be most effective compared to other extracts as they were found to be significant in most of parameters and animal models selected for study of anti-ulcer activity.

4.3 Diuretic activity: Comparative study of the plant extracts were done with control. Various parameters such as Urine volume, Na+, K+, Cl-, HCO₃⁻ excretion, pH of urine, Osmolarity of urine, Density, & Specific gravity urine were studied. The other parameters such as Uric acid excretion, BUN level and Serum creatinine level were also studied.

Urine volume was measured and analyzed. The electrolytes were analyzed using easy lyte analyzer and there concentration was determined in milli moles eq/wt. The pH of urine was analysed. The Sp. gravity was determined using Bayers multistrips. Density was determined by taking mass and volume as measures.

Excretion of electrolytes Na+, K+, Cl-, HCO₃⁻ was found to be increased when compared with control. The results of all the extracts showed significant excretion of electrolytes which reflect the diuretic activity of bark, leaves and gum of Boswellia Serrata plant.

The pH of urine indicated the presence of different electrolytes in the urine and also Acid-Base balance of the kidneys.

Osmolarity is a measure of total concentration of dissolved particles in the solution. These particles may be ions or unionized molecules. By
osmolarity studies the presence of ions in urine is confirmed. These determinations give better idea of concentrating ability of the tubules. In our experimental results osmolarity of the extracts was greater than the control showing Diuretic activity.)

Density of urine collected from rats treated with various extracts was found to be increased. The density of urine confirms the concentration of urine i.e., presence of various ions.

Determination of Specific gravity is useful for understanding the concentration and diluting power of kidneys. Excretion of urine of Sp. gravity 1.010 indicates tubular reabsorption. This process is called isothenuria. According to our data, the Sp. gravity of various extracts was found to be 1.010 or more.

In the data obtained, some of the extracts showed increased excretion of uric acid. These extracts may have Anti-Gout activity.

Dehydration usually causes BUN levels to rise more than creatinine levels resulting in increased BUN to creatinine ratio. Where as, kidney disease usually causes both BUN and creatinine levels to increase to similar degree.

In the data obtained, Blood urea nitrogen (BUN) level was raised due to dehydration caused by diuretic effect of our drug, but creatinine level was found to be with in the normal limits. This shows that extracts did not show any toxic effect on kidneys.
The mechanism of action of *Boswellia Serrata* extracts were found to be comparable with the standard drug Furosemide as they significantly acted and caused excretion of Na+, K+, Cl-, ions which is also the action of Furosemide.

Active Phytoprinciples such as Flavonoids, Terpenoids and Saponins are known to be responsible for diuretic activity\(^{(180)}\).

Extensive biological investigations on triterpenoids revealed a broad spectrum of pharmacological and physiological activities such as anti-inflammatory, anti-bacterial, Diuretic activity etc.\(^{(180)}\). As revealed in the phytochemistry of *Boswellia Serrata* plant and also in the Phytochemical screening the presence of triterpenoids is confirmed.

The **Tables-3.1-3.6 & chromatograms 3.1-3.3** have exhibited the presence of active Phytoconstituents.

The Diuretic activity of *Boswellia serrata* plant extracts was evaluated and represented in Tabular data and graphical representations. The bark extracts showed effective Diuretic and kidney protection activity. PBE, CBE, and EBE also showed anti-gout activity. The leaves extracts showed significant Diuretic and kidney protection activity. PLE, CLE, and ELE also showed anti-gout activity. Among the gum extracts PGE and AGE showed effective Diuretic activity. The PGE and CGE showed significant anti-gout activity. All the extracts showed effective kidney protection activity.