Introduction
Relation between Man & Arsenic
Global pollution is increasing due to variation in natural and anthropogenic activities, leading to contamination of various terrestrial and aquatic ecosystem with metals, nonmetals organic and inorganic compounds (Ruiz-payana et al., 2005; Burger Chakraborty et al., 2013).

Metal compounds being parts of earth crust, are redistributed naturally in the environment by both geological and biological cycles. Increasing human activities have modified the global cycle of various metals. About 80 of 105 elements in the periodic table are regarded as the metals but less than 30 have been reported to produce toxicity in humans. Due to extensive use of toxic metals and their compounds in industry and consumer products, these agents have been widely disseminated in the environment (Corradi and Mutti, 2011).

A heavy metal includes the transition metals and some metalloids, such as arsenic (As), mercury (Hg), cadmium (Cd), Nickel (Ni), Chromium (Cr), Manganese (Mn) and Lead (Pb) etc. Heavy metal toxicity can result in damaged or reduced mental and central nervous function [Autism and autism spectrum disorder (ASD) (Obrenovich et al., 2011)], lower energy levels and damage to blood composition (Antonio Garcia et al., 2012), kidneys (Miller et al., 2013), liver (Shukla and Kumar, 2009; Yapr et al., 2010) and other vital organs (Wikipedia, 2013)

Among these metals, Arsenic, a highly poisonous metalloid, is one of the natural constituents of the earth's crust that is present in soil, water and air in various forms; it is released in the environment from both natural and man-made sources (Bao and Shi, 2010).
It is found in various concentrations in all ecosystems. It can occur in both organic and inorganic forms. Inorganic arsenic of geological origin is found in ground water used as drinking-water in several parts of the world and causes widespread contamination. Daily exposure to toxic metals through polluted water appears to be an integral part of modern life (Patterson et al., 2013).

The most common forms of arsenic are water-soluble arsenite (the trivalent form, As III) and arsenate (the pentavalent form, As V); trivalent arsenic is more toxic than pentavalent arsenic and its inorganic forms are more toxic than organic forms (Arsenobetaine) (Yousef et al., 2008).

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\begin{align*}
\text{OH} & \quad \text{OH} \\
\text{HO} & \quad \text{HO} \\
\text{- As} & \quad \text{- As} \\
\text{OH} & \quad \text{OH} \\
\text{Trivalent} & \quad \text{Pentavalent} \\
(+3) & \quad (+5)
\end{align*}
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\text{Arsenobetaine (present in seafood)}
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Human exposures to the generally more toxic inorganic arsenic compounds occur in occupational or environmental settings as well through medicinal use of arsenicals. Arsenic is used in many human activities such as manufacturing, agriculture (herbicides, insecticides and rodenticides) (ATSDR, 2011; Chattopadyay et al., 2011) and medicine (Mathews et al., 2013). Despite its notoriety as a deadly poison (Wikipedia, 2012a), arsenic is an essential trace element for some animals (Chapman and Johnson, 2002) and
maybe even for humans (Tsai et al., 2010), although the necessary intake may be as low as 0.01mg/day (Lentech, 2013).

Arsenic is present in all living organisms and every organism from bacteria (haloalkaliphilic) to man has developed biotransformation pathways (Oremland and Stolz, 2005). Arsenic, like other naturally occurring minerals tend to cycle in the environment. This cycling insures that humans are always and unavoidably exposed to arsenic that impose a big challenge (Kim et al., 2006).

The mechanism of geological accumulation of arsenic is thought to have occurred during the late Quaternary age (Holocene age) with arsenic-containing alluvial sediments deposited by rivers. The arsenic in sediment rocks is adsorbed as arsenic oxy-anions, oxy-hydroxides of iron, aluminium, and manganese and then mobilized in the alluvial aquifers by biogeochemical processes, releasing the arsenic into the groundwater (Ratnaike, 2003) (Figure.1).

Large number of diverse chemical and biological reactions i.e. oxidation, reduction, adsorption, precipitation, methylation and volatilization participate actively in cycling of this toxic element. These reactions control the availability of arsenic and hence, arsenic concentrations effectively available to exposed humans are governed more by arsenic speciation than by total amount of arsenic. Factors such as oxidation and pH affect the mobility of arsenic in the subsurface environment (Camacho et al., 2011).

Arsenic exposure occurs from inhalation (Erraguntla et al., 2012) absorption through the skin and, primarily, by consuming arsenic contaminated drinking water (Rahman et al., 2009) and food (Jackson et al., 2012). The great majority of seafood consists of complex organic arsenical compounds i.e.
Arsenobetaine, Trimethylarsine. The consumption of fish and seafood provides a relatively small share of arsenic exposure (Borak and Hosgood, 2007).

Figure 1: Global arsenic cycle (cited by Google)

Inhalation usually involves particle containing inorganic arsenic. Most of the inhaled and deposited arsenic will probably be absorbed from either the respiratory or gastrointestinal tract. Inhalation can result in symptomatic chronic exposure, particularly with arsenic gas, which causes severe symptom by inhalation. Pentavalent arsenic is well absorbed through the gut, but the trivalent form is more lipid soluble. (Singh et al., 2011a).

After ingestion, the dissolved arsenic compounds are readily absorbed through the gastrointestinal tract and distributed in the blood to the liver, kidney, spleen, lung and many other organs, i.e., it affects nearly entire organ systems of the body (Mazumder, 2005).
Toxicity results from arsenite form (As$^{+3}$) especially by dermal absorption. Arsenic compounds are well absorbed par enterally within 24 hour’s (Bera et al., 2010).

After absorption, Arsenic initially localizes in the blood bound to globulin. Redistribution and accumulation occurs to various organs (Vahter, 2007) and erythrocytes (Biswas et al., 2010).

Inorganic pentavalent arsenate (iAsV) and trivalent arsenite (iAsIII) exposure via drinking water (through gastrointestinal tract) have been reported in many countries of the world including Bangladesh, Chile, China, India, Mexico and the United State of America, Hungry, Romania and Slovakia (Frisbie et al., 2002; Gardner et al., 2011; Rahaman et al., 2012; Argos et al., 2013) (Fig. 2). By biotransformation in the body, most of arsenic eliminated from the body by urinary and fecal excretion in the forms of monomethylarsenic acid (MMA(V)) and dimethylarsenic acid (DMA(V)) (Cui et al., 2004), remains are accumulated dose-dependently in various internal organs, such as lung, kidney, liver, heart, spleen and so on (Cui and Okayasu, 2008).

Worldwide chronic arsenic toxicity has become a human health threat by targeting ubiquitous enzyme reactions. It affects nearly all organ systems in humans and other animals. Exposure to arsenic may cause severe pathological problems such as arsenicosis (Pimparkar and Bhave, 2010), diabetes mellitus (Patel and Kalia, 2010), respiratory system disease (You and Park, 2012), high blood pressure, hypertension, cardiovascular disease (Chervona et al., 2012; Liao et al., 2012), atherosclerosis (Lemaire et al., 2011), Alzheimer’s, Parkinson’s disease (Jomova and Valko, 2011), hematological effect (Antonio Garcia et al., 2012), spontaneous abortions and congenital malformations in offsprings (Boekelheide et al., 2012).
Fig. 2: Global arsenic groundwater contamination (cited by Google)
The skin seems to be quite susceptible to the effects of arsenic. Arsenic-induced skin lesions seem to be the most common and initial symptoms of arsenicosis. The increase of prevalence in the skin lesions has been observed even at the exposure levels in the range of 0.005-0.01 mg/L arsenic in drinking waters (Walvekar et al., 2007; Argos et al., 2013).

Arsenic is a human carcinogen as arsenic accumulation can be considered a significant factor that causing the carcinogenesis (Cui and Okayasu, 2008). Epidemiological data from regions of the world with very high levels of arsenic in drinking water (>150 µg/L) show a strong association between arsenic exposure and risk of several internal cancers (Cantor and Lubin, 2007). This has led the International Agency for Research on Cancer to classify arsenic as a group 1 human carcinogen (IARC, 2004). Arsenic trioxide, arsenic pento-oxide and arsenate salt are listed as category 1 carcinogens (Wikipedia 2012a). Arsenic causes various malignancies of skin, lung (Surdu et al., 2013), liver (Ivanov and Hei, 2013) and bladder (Ferris et al., 2013).

Liver is an important target organ for arsenic toxicity as liver is involved in arsenic biotransformation or arsenic methylation metabolism (Wang et al., 2013a).

Several epidemiological studies are elucidated that arsenic causes hepatotoxicity (Sharma et al., 2007; Sharmilla et al., 2009; Mathews et al., 2012 ). Tandon et al. (2012) and Pachauri and Flora (2013) reported that arsenic exposure produced significant adverse effects on the redox status (GSH content) of liver, which is evidenced by increase in lipid oxidation content.

Recent studies have suggested that arsenic exerts its toxicity through the generation of reactive oxygen species (ROS). Among several mechanisms,
oxidative stress due to accelerated production of free radicals has also been implicated for arsenic-caused injury in liver and other tissues (Celino et al., 2009; Banerjee et al., 2009; Pachauri and Flora, 2013).

The general strategy for prevention and treatment of liver damage includes reducing the production of reactive metabolites by using antioxidants. NATURAL PRODUCTS and their active principles as sources for new drug discovery and treatment of diseases have attracted attention in recent years (Aruoma 1994; Kilikdar et al., 2013; Saha and Khuda-Bukhsh, 2013). Plants show antioxidant activity (Chandranayagam et al., 2013) and are prominent immune boosters or modulators (Thakur et al., 2009; Bhattacharya and Halder, 2012a). Natural antioxidants prevent oxidative damage in various health disorders due to oxidative stress (Shireen et al., 2008; Saafi et al., 2011). Antioxidants appear to act against diseases by raising the levels of endogenous defense [e.g., by up-regulating gene expressions of the antioxidant enzymes, such as superoxide dismutase (SOD), catalase, glutathione peroxidase, and lipid peroxidase] (Samuel et al., 2011; Xu et al., 2013).

To combat against arsenic induced oxidative stress, aim of present study was to find out a suitable antagonist of arsenic poisoning.

Chlorophytum borivilianum (Safed musli) belongs to the family Liliaceae, is a medicinal herb, and is native to the tropical and subtropical regions of Africa and Asia (Kaushik, 2005). It is found in the oldest mountain ranges on the continent, the Aravalis (Rajasthan) India (Thakur and Dixit, 2006). It is a small perennial rhizomatous herb. Rhizomes are short and inconspicuous while roots are usually thicker or fleshy (Marais and Reilly, 1978). The root after peeling widely used as a natural sex tonic (Kaur et al., 2010). It is a rich source of over 25 alkaloids, vitamins, proteins, carbohydrates, steroids, saponins, potassium, calcium, magnesium, phenol,
resins, mucilage, and polysaccharides and also contains high quantity of simple sugars, mainly sucrose, glucose, fructose, galactose, mannose and xylose. Saponins are main active constituent of its root extract (Thakur et al., 2009). Among all the species of *Chlorophytum* present in India, *Chlorophytum borivilianum* produces highest yield of roots along with the highest saponins content (Bordia et al., 1995). Its roots (tubers) are widely used for various therapeutic applications. The major use are aphrodisiacs for cure of oligospermia, lack of libido, cure natal and post natal problems, increase lactation etc. (Kaur et al., 2010). Anti-diabetic (Govindrajan et al., 2005), antistress (Kenjale et al., 2007), analgesic (Panda et al., 2007), anti-inflammatory (Deore et al., 2008), immunomodulatory (Thakur et al., 2009), anticancer (Deore and Khadabadi, 2010), Antioxidant (Kaur et al., 2010) and antibacterial (Sundaram et al., 2011) activities of root extracts have been evaluated. Sundaram et al., (2011) reported that *C. borivilianum* have very potent antibacterial agent against *Staphylococcus aureus, Escherichia coli, Psuedomonas aeruginosa* and *Bacillus subtilis*.

*Chlorophytum borivilianum* is regarded as an important medicinal plant because of its beneficial effects. Its efficacy in relation to the treatment of metal toxicity in general has not been studied earlier. Therefore the present study was planned to determine the effect of root extract of *Chlorophytum borivilianum* on arsenic-induced toxicity.