Abstract

In nature oxygen availability is essential for existence of aerobic organism on the earth. At high altitude (HA) a decrease in partial pressure of O_2 in air known as hypobaric hypoxia. This environmental conditionis very fatal and causes of major risk factor for developing acute mountain sickness (AMS). Millions of people like pilgrims, trekkers, scientist and military personnel visit high altitude for different purpose and suffer from AMS including high-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE). Simultaneously, changes in haematological parameters, electrolytes imbalance and oxidative stress collectively create a selective pressure on gut microbial ecology that indirectly increase the burden of AMS. However less medical options are available to HA sufferers to reduce the burden during acclimatization at HA.

In the present study male albino rats were exposed to different high altitude condition respectively in 11.8 psi (at 6000 feet altitude, group HA-I), 9.3 psi (at 12000 feet altitude, group HA-II), and 7.3 psi air pressure (at 18000 feet altitude, group HA-III), whereas the control group was kept at normobaric condition (14.3 psi, group NA/C). At the same time, different commercial probiotics (VSL#3, TruBiotics, Yogut and Propolis Plus) were ingested during hypoxic stress and different physiological and haematological parameters, uremic profiles, oxidative stress markers, microbial diversity and microbial associated enzymes were studied. Besides, histological studies were performed of kidney and liver tissues.

From the experiment it was found that lower atmospheric pressure at high altitude reduce the body weight and decreased organ weight including kidney & liver at HA-II and HA-III during acclimatization of 28 days. Increased in concentration of RBC, Hb, WBC and imbalanced of electrolytes like sodium, potassium and chloride was found in HA-II and HA-III groups. Apart from imbalance in electrolytes, uremic toxins like urea and creatinine level

increased in plasma of hypobaric hypoxic exposed animals. Accumulation of uremic toxins in blood lowered the antioxidant enzymes like SOD and catalase and increased in MDA formation. The changes in physio-chemicals parameters encouraged the growth of facultative anaerobes (*E. coli*) in gut that encouraged the growth of another total anaerobes and other anaerobes like *Bifidoacterium* sp, Lactic acid bacteria and *Bacteroidetes* sp. The increase in population density of facultative anaerobes encouraged in more acids and gas formation in the gut. The increase in microbial associated enzymes like α-amylase, proteinase, β-glucuronidase and alkaline phosphatase indicated the alteration of metabolic activities in gut microenvironment and increasedthe immunoglobulins (IgG & IgA). The histological structures of kidney and liver of group HA-II and HA-III animals showed a severe disorganization of glomerulus and dilation of renal tubules which indicate nephrotoxicity or acute renal failure at hypobaric hypoxia.The changes of these parameters were observed above 12000 ft. of HA and major risks were associated at 18000 ft. and the adverse effects were more intense upto seven days of acclimatization. Co-administration of probiotics in group HA-II and HA-III animals showed normal arrangement of this tissue. The scanning electronic microscopic analysis revealed that the hypoxic state diminished the proliferation of small intestinal epithelia, whereas probiotics supplemented groups showed normal intestinal villi as found in control group. The oral administration of commercial probiotics decreased plasma uremic toxic level as compared to the group HA. This study also revealed that the commercial probiotics decreased the urinary KIM-1 level in the experimental animals whereas urinary KIM-1 level was found to be increased in hypobaric hypoxia conditions as compared to control. Ingestion of probiotics during hypoxic stress prevent the alteration of microbial population and try to maintain the microbial population like normobaric condition. As a result, decreased acid and gas formation and regulates the microbial associated enzymes.

It was notable that, among the four commercial probiotics, VSL#3 showed the better activity against hypobaric hypoxic stress.

From the study it can be concluded that the hypobaric hypoxia directly or indirectly hampered the haematological and physiological parameters along with increase the uremic toxins. Ingestion of probiotics during hypoxic stress reduce the stress by inducing antioxidant defence, nephrotoxicity and established the beneficial functions of gut microbial community as well as improves the overall health. In future, supplementation of probiotics during acclimatization at hypobaric hypoxia can be used as a therapeutics to reduce the hypoxic induced stress at HA.