CHAPTER 6

CONCLUSION
Onion being a versatile vegetable showed significant antioxidant activity *in vitro* with outer living layers exhibiting more phenolic content and flavonoid content and showing variable distribution of flavonoids (quercetin) in different scales. The outer living layers exhibit higher free radical scavenging activity, reducing capacity and hydroxyl radical scavenging activity; statistical analysis also showed these activities of outer layers to be significantly correlated with TPC of outer layers. Since the inhibition of α-amylase has been suggested as a strategy for diabetes control, our study demonstrates a higher inhibitory activity of outer layers of onion against porcine pancreatic α-amylase as compared to inner layers, stating that this fraction of onions has a strong anti diabetic effect.

The difference in phenolic content and antioxidant activity of outer layers with respect to different sizes of onion could be explained on the basis of their lesser moisture content correlated to the higher phenolic content. Also, outer layers of smaller onion showed higher scavenging activities than outer layers of larger onion with no significant difference with quercetin (taken as standard), this observation further provides evidence for difference in phenolic content and antioxidant activity in different stages of development and in different layers of onion. Thus, the present study demonstrates difference in antioxidant properties during different stages of development of onion and also in different layers of the edible part of the onion.

Many *in vitro* and *in vivo* studies have demonstrated that several parameters of erythrocyte function and integrity are negatively affected by increased oxidative stress. Because of their high susceptibility to oxidation, erythrocytes have been used as a metabolically simplified model system to investigate oxidative damage in biomembranes. The present study demonstrates *in vitro* protective effect of onion extract on lipid peroxidation, reduced glutathione (GSH), and erythrocyte hemolysis, with respect to different layers (the outermost living layers just beneath the dry outer scales of onion and the inner layers), in an effort to categorize the antioxidant efficacy in different parts of the onion. In conclusion, it can be stated that the outer living layer (the transitional layer with the first living cells below the dry onion peel) is a better resource for food ingredients and easily accessible source for nutraceutical compounds.
Onions have been found to be effective in the prevention and treatment of a number of diseases and have antidiabetic, anti-biotic effects, cardioprotective effects, anti-cancer, and anti-infectious properties [Corzo-Martínez et al., 2007], therefore, research on the physiological effects of red onion on disease prevention in vivo is warranted. Our study demonstrates that aqueous extracts of onion may provide protection against HgCl₂ induced oxidative damage by possibly reducing lipid peroxidation and increasing the antioxidant defence mechanism in rats. Onion extract protects the erythrocytes in vivo from its oxidation induced damage through its strong antioxidant activity by the following mechanisms:

- Normalizing erythrocyte PMRS activity, thus, maintaining a redox state in the plasma by reducing extracellular oxidants. The polyphenols (flavonoids mainly quercetin) present in onion exert their antioxidant activity by their ability to enter the erythrocytes and donate electrons to PMRS. This property is a compensatory/protective mechanism that operates to maintain the ascorbate level in plasma and thereby minimize oxidative stress.

- Maintaining protein redox status by mitigating various protein oxidation products (PCO, AOPP and P-OOH levels) and plasma sialic acid levels since structural changes in proteins are considered to be among the molecular mechanisms leading to endothelial dysfunction and development of many chronic diseases including aging.

- Up regulating or preserving PON1 activity and by reducing LDL oxidation, our results provide evidence of the positive effect of onion extract on PON1 activity and prevention of LDL oxidation during periods of oxidative insult, with improvement in the antioxidant capability of rats, suggesting its value as a dietary antioxidant food. The findings may explain the anti-atherosclerotic effect of onion and also foods containing quercetin and catechins.

The age-dependent effect of the PON1 genotype has been investigated, showing the association of human longevity with PON1 status [Lescai et al., 2009]. In addition, quercetin has been shown previously to exert anti ageing and rejuvenation effects [Chondrogianni et al., 2010]. Given the anti-oxidant properties of onion and
quercetin and the link between ageing and oxidative stress, the quercetin–mediated protection of PON1 levels by onion extract may also be a putative anti aging strategy. Tissue and physiological dysfunction occurs as the oxidative stress increases [Blackwell et al., 2004]. Although many studies on the quercetin levels of onion and on disease prevention in relation to quercetin content have been conducted, the effect on the oxidative stress biomarkers on tissues (brain and liver) caused by red onion consumption as a dietary source of quercetin is insufficient; our study demonstrates a protective effect against lipid peroxidation (MDA) and protein oxidation (PCO content) in tissues (brain and liver) against oxidative stressed rats. The results also revealed their positive effect on enzymatic (CAT, SOD and Gpx) and non enzymatic (GSH) antioxidants and on plasma membrane redox status of tissues.

The protective effect of different layers of onion on oxidative stress biomarkers in alloxan induced diabetic rats was investigated in comparison with quercetin. Administration of onion extracts (OLE and ILE) to diabetic rats caused marked hypoglycemic activity by progressive reduction in the blood glucose levels in alloxan-induced diabetic rat model which indicates antidiabetic potentials of the extract. Supplementation of onion extracts (OLE and ILE) caused marked reduction in lipid peroxidation and increased GSH content of erythrocytes, antioxidative activity of plasma and decreased plasma sialic acid level. The strong lowering effect of outer layers against biomarkers of oxidative stress in diabetic rats in vivo as compared to inner layers, states that this fraction of onions has a strong anti diabetic effect.

The present study thus provides enough evidence for the strong biological antioxidant activity of the onion extracts against biomarkers of oxidative stress in plasma, erythrocytes and tissues.