INVESTIGATION OF RADIATION SENSITIVITIES OF SOME NATURAL AND SYNTHETIC ANTIOXIDANTS BY ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY

ABSTRACT

Antioxidants are found in the natural compositions of foods or added to those as supplement to prevent the oxidations and lipid peroxidation chain reactions. Shelf lives of the foods are prolonged by irradiating them with high energy radiations to kill the present microorganisms and/or to inhibit their reproductions. Similar sterilization process is also used in pharmaceutical and cosmetic industries. Although radiation produces positive effects by killing present microorganisms it also produces negative effects by creating changes in the molecular structures of irradiated substances. Therefore, identifying the effects of radiation on antioxidants is important from their antioxidant characteristics point of view. In this respect, radiosensitivities of three natural; ascorbic acid (AA), sodium ascorbate (SA), dℓ-tartaric acid (dℓ-TA) and two synthetic; butylated hydroxytoluene (BHT) and tertiary butylhydroquinone (TBHQ) antioxidants have been studied in the present thesis. Radiosensitivities of the interested antioxidants were evaluated by studying the kinetic and structural features of the radical species produced in these antioxidants after radiation the latters at different radiation doses. Electron Spin Resonance (ESR) spectroscopy, which is commonly used to investigate species having unpaired electron, was used to determine the characteristic features of the radiation induced species in the irradiated antioxidants.

Samples were irradiated at room temperature and irradiated antioxidants were indicated ESR spectra with many resonance peaks. Microwave saturation behaviors of the resonance peak intensities were studied at room (290 K) and 130 K, firstly. Variations of peak intensities with applied microwave power were investigated starting from the lowest microwave power on the resonance peaks whose intensities were measurable without any ambiguity. Variations of the peak intensities over the temperature range of 120 K – 400 K were also studied at microwave power value which is not causing saturation. Activation energies of the species responsible from experimental spectra were calculated using the results of annealing studies performed at high temperatures. Appropriate radical models were proposed for the radical species produced in irradiated antioxidants basing on the experimental data derived from microwave saturation, variable temperature, and annealing studies. Spectrum simulation calculations were performed basing on the proposed models and spectroscopic parameter values of the

involved species were calculated. Radical formation mechanism(s) were proposed for each antioxidant by taking into account the molecular formula of the latters. Furthermore, dosimetric capacities of the investigated antioxidants were also investigated by constructing their dose-response curves over a wide dose range.

From performed evaluations it was concluded that investigated antioxidants obey the following order from radiation sensitivity point of view: BHT > dℓ-TA > AA > TBHQ > SA.

Keywords: ESR, antioxidant, free radical, irradiation, dose, annealing, radiation sensitivity