Polyphenols extracted from sage have been introduced during the sol-gel synthesis of a bioactive glass (40 SiO_2-54CaO-6P_2O_5, mol%) for the production of poly(ε-caprolactone)/bioactive glass composites. A significant increase in the radical scavenging ability measured against $DPPH^{\bullet}$ (1,1 diphenyl-2-picrylhdrazyl) and $ABTS^{\bullet+}$ (2,2-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid cation) has been observed for functionalized glass composites (when compared with nonfunctionalized glass composites) (Dziadek et al., 2016). A summary of the antioxidant activity of bioactive glasses and its evaluation method is reported in Table 2.2.

2.7 BONE CANCER TREATMENT

Tumors are generally easier to heat than the surrounding normal tissue, since the blood vessels are poorly developed and have an irregular structure leading to areas where the blood supply is deficient. If the tumor is exposed to higher temperatures, for example, by a localized hyperthermia treatment, the blood flow inside a tumor will not be able to regulate the temperature by dissipating the heat. Thus, tumors are more vulnerable to heat when compared with the normal tissue. High temperatures (>43–45°C) can destroy cancer tissues, while the surrounding healthy tissues with normal, efficient blood-cooling systems can readily survive a temporary rise in temperature. Therefore, using heat to kill tumoral cells can be an effective cancer treatment. One method to produce localized heat is magnetic induction hyperthermia, where a magnetic material is implanted in the tumor and then the body is exposed to external magnetic fields.

Magnetic materials can generate heat in alternating magnetic fields due to various magnetic loss mechanisms. The amount of heat generated depends on the material structure and magnetic field conditions (intensity and frequency of magnetic field). The tissue surrounding the magnetic implant is heated primarily by thermal conduction from the implant which is maintained at a higher temperature than the body, but not so high or intense as to cause widespread damage to healthy tissues.

Several magnetic materials have been developed for the treatment of cancer by magnetic induction hyperthermia. Bioactive glass-ceramics containing a magnetic crystalline phase are particularly important as they can be used for the treatment of bone tumors, by killing the cancer cells and promoting bone regeneration. After surgical removal of the bone tumor, the defect can be filled with these bioactive magnetic materials. Owing to their bioactive properties, they will reinforce the weakened bone. When the patient is exposed to carefully controlled oscillating magnetic fields, these materials will heat up, destroying any residual cancer cells adjacent to the implant site. The temperature developed in the tissue surrounding the magnetic implant depends on the thermal properties of that living tissue (thermal conductivity, heat capacity, blood flow, etc.).

The following paragraphs present some examples of bioactive and magnetic glass-ceramics and composites that have potential to be used for magnetic induction hyperthermia.