Hyperthermia Application of Magnetic Nanoparticles Embedded Nanostructured Lipid Carriers (NLC)

Gülnur Şehnaz Korkmaz, Nihal Aydoğan*

Chemical Engineering Department, Hacettepe University, Beytepe 06800, Ankara, Turkey

anihal@hacettepe.edu.tr

Nanostructured lipid carriers (NLC) are second generation lipid-based nanoparticles, which are developed after solid lipid nanoparticles (SLN). To overcome the drawbacks of SLN such as, drug expulsion and low loading capacity. NLC are prepared with a blend of solid and liquid oil, that consist less ordered crystal structure with great imperfections and thus leading to high drug loading capacity and prevent drug expulsion [1]. Also, it is possible to use lipid nanoparticles and inorganic nanoparticles together for different purposes. Studies of inorganic nanoparticles have demonstrated that, they enhance the treatment effects of drugs or they are applicable for photo-thermal and hyperthermia applications in cancer treatment [2]. For this purpose, magnetic nanoparticles embedded NLC were synthesized and their use in hyperthermia therapy was investigated.

In this study, the NLC were synthesized via solvent diffusion method in which, stearic acid and oleic acid were used as solid and liquid lipids, ethanol-acetone mixture as organic phase and Pluoronic F-127 as an emulsifier. Oleic acid coated iron oxide nanoparticles (MNPs), which show superparamagnetic behavior, are synthesized via a well known co-precipitation method and MNPs are added to NLC during the synthesis. The optimum amount of MNPs in NLC was determined as 1% w/w. The nanostructures in NLC were determined via TEM as multiple oil in fat in water (o/f/w) type with oil nanocompartments. Particles have two different size distributions; the size of NLC without MNPs were 57±16 nm and 124±17 nm with spherical shape and the size of NLC with MNPs were 65±15 nm and 125±21 nm (Figure.1-a). Furthermore, it can be proposed that when magnetic nanoparticles were embedded in NLC, their magnetic behavior of MNPs change due to matrix effect and they show a tendency to stay together (Figure 1-b). When Alternative Magnetic Field (AMF) applied to the particles, temperature changes were observed and hyperthermia properties of particles were investigated. For this purpose, different parameters were studied such as lipid concentration, magnetic field magnitude and application time period. Also, specific absorption rate (SAR) values were calculated, which is defined as the amount of heat released by a unit weight of material per unit time during AMF. SAR values are relatively higher when compared to literature. In addition, time dependence of temperature increase was studied and after 30 minutes, ΔT obtained as 13.9°C. These NLC were also used as drug delivery agent by using a simulating drug. The drug release performance of these NLC were studied with applied AMF for different time periods. Drug release capacity of NLC was increased with increasing application time period of magnetic field. Results show that the synthesized nano-carriers can be used in hyperthermia and can be considered as drug delivery agents as well.

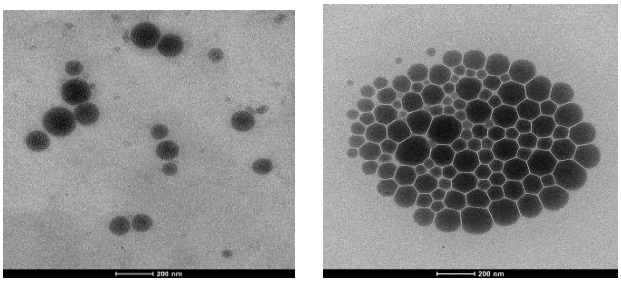

Figure *1*-TEM images of *a) NLC b*) *NLC* with *MNP*

[1]R.H.Muller,M. Radtke, S.A.Wissing, Adv. Drug Deliver. Rev. 54 (Suppl.1) (2002) S131–S155.

[2] G.P. Raaphorst, M.L. Freeman, W.C. Dewey, Radiat. Res. 79 (1979) 390–402.