The study, presented here, focuses on the impact of synthesis parameters on the co-precipitation process of superparamagnetic iron oxide nanoparticles. Particle diameters between 3 and 17 nm and saturation magnetizations from 26 to 89 Am² kg⁻¹ were achieved by variation of iron salt concentration, reaction temperature, ratio of hydroxide ions to iron ions and ratio of Fe³+/Fe²+. All synthesis assays were conceived according to the “design of experiments” method. The results were fitted to significant models. Subsequent validation experiments could confirm the models with an accuracy >95%. The characterization of the chemical composition, as well as structural and magnetic properties was carried out using powder X-ray diffraction, transmission electron microscopy, Raman and Mössbauer spectroscopy and superconducting quantum interference device magnetometry. The results reveal that the particles' saturation magnetization can be enhanced by the employment of high iron salt concentrations and a molar ratio of Fe³+/Fe²+ below 2:1. Furthermore, the particle size can be increased by higher iron salt concentrations and a hyperstoichiometric normal ratio of hydroxide ions to iron ions of 1.4:1. Overall results indicate that the saturation magnetization is directly related to the particle size.