DEVELOPMENT AND INTEGRATIVE EVALUATION OF POLYMER-ENCAPSULATED, AMINE-FUNCTIONALIZED IRON-BASED MRI CONTRAST MATERIALS

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BACKGROUND: Superparamagnetic nanoparticles, including magnetite, maghemite, and various ferrite nanoparticles (NPs), are emerging as promising alternatives to traditional magnetic resonance imaging (MRI) contrast agents due to their increased specificity and biocompatibility. Despite the growing demand for these precisely tuned magnetic NPs in biomedical applications, their synthesis remains a significant challenge.

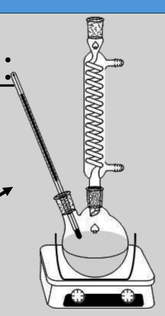
OBJECTIVES:

- To develop a novel method for synthesis and characterize novel, iron-based biocompatible nanoparticle-based contrast agent (CA)
- To investigate the optimal parameters for the synthesis and biodistribution parameters of the nanoparticles

MATERIALS & METHODS:

1

Ferrite precursors:
$Fe(NO_3)_3$
and
$Me(NO_3)_2$
Where Me = metal^{2+}

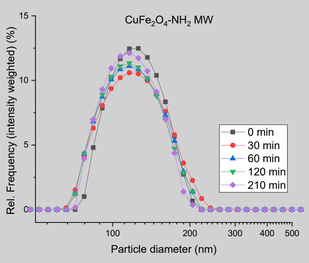


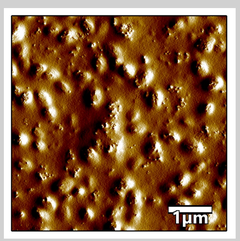
Reflux Synthesis: 12 h

MW Synthesis: 4 mins

2

In vitro





Complete characterization of the NPs, including HR-TEM, FTIR, XRD, AFM and DLS

3

In vitro magnetic characterization and in vivo biodistribution with 3T MRI system

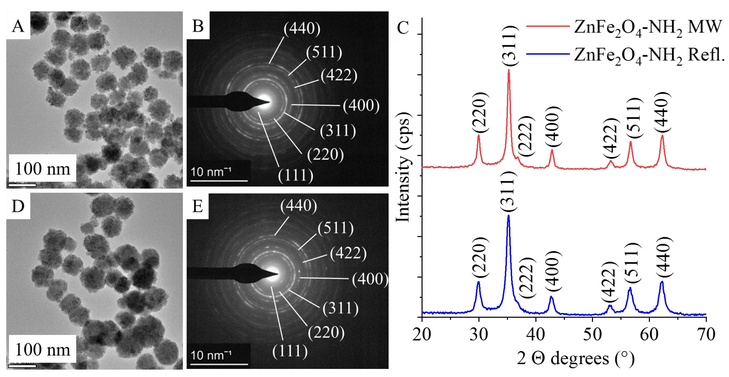
In vivo

RESULTS I:

In vitro measurements to prove the quality of the novel synthesis method, for both Zn^{2+} and Cu^{2+} ferrites

Results are highly depending on the doping metal.

$ZnFe_2O_4$ particles

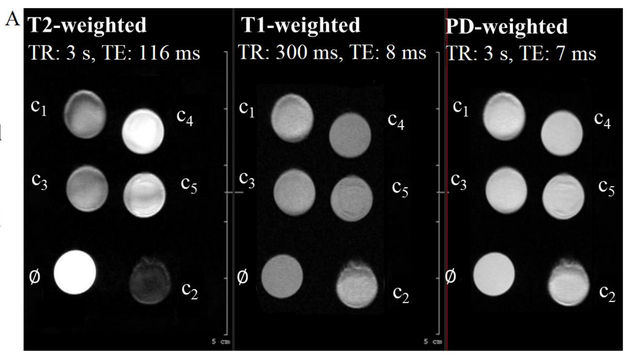


$ZnFe_2O_4$-NH_2 MW

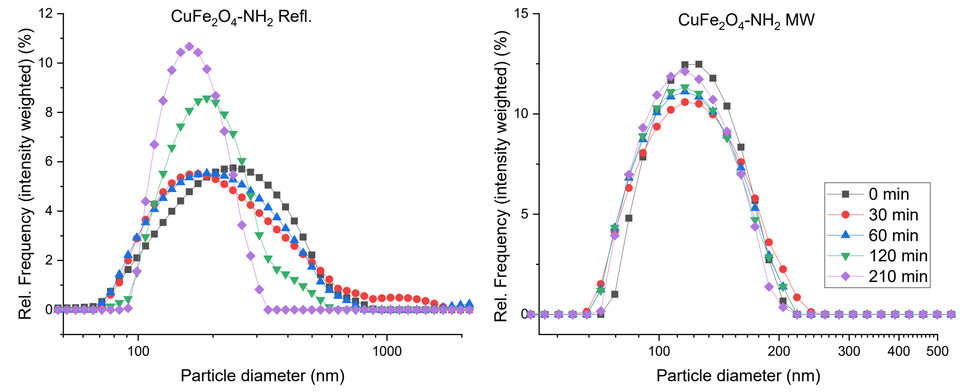
c_1: 0.2 mg/ml
c_4: 0.05 mg/ml

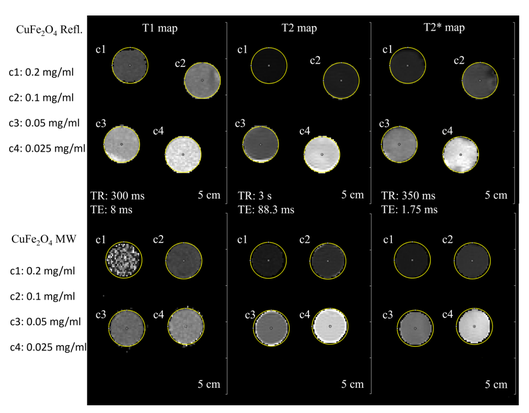
c_3: 0.1 mg/ml
c_5: 0.02 mg/ml

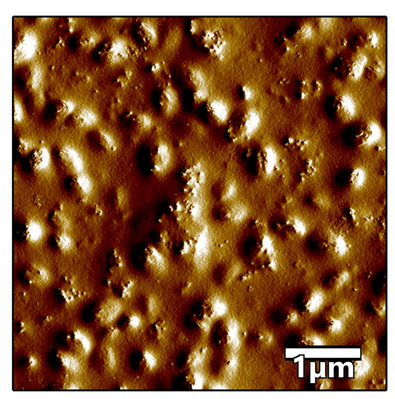
ø: water
c_2: 1.0 mg/ml



$CuFe_2O_4$ particles





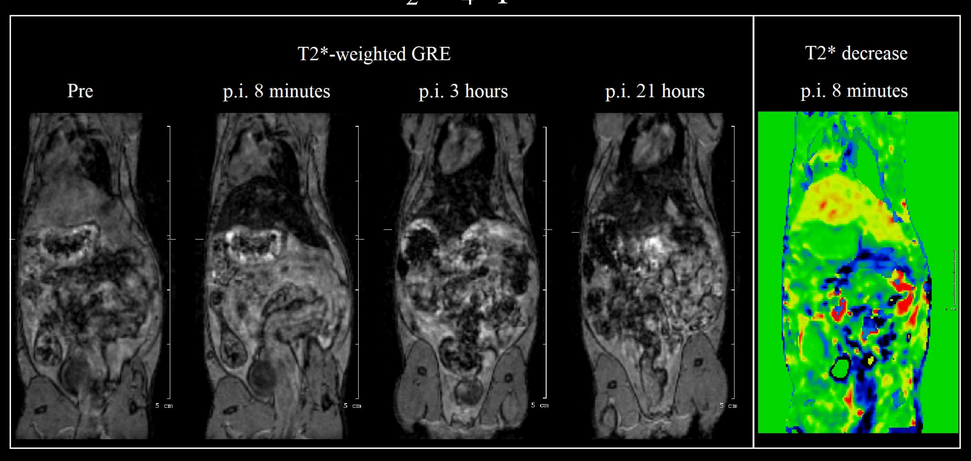


RESULTS II:

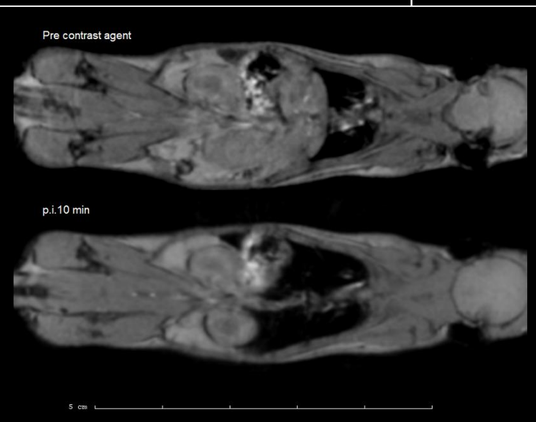
In vitro measurements to prove the quality of the novel synthesis method.

Results are highly depending on the doping metal.

$ZnFe_2O_4$ particles



$CuFe_2O_4$ particles



CONCLUSION:

Our investigation shows that the ferrite NPs are a feasible candidate for a new generational, multimodal MRI CA. Their chemical properties, owning an -NH_2 group holds great options for surface modifications with chelators for isotopes or fluorescent pigments for multimodal molecular imaging purposes. It must be highlighted that the preparation method as well as the nature of the applied precursors play a crucial role in the synthesis of a stable system.

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