

# Sintesis Nanopartikel MnFe<sub>2</sub>O<sub>4</sub> Menggunakan Ekstrak Buah Lada Hitam (*Piper nigrum* L.) yang Dikonjugasikan dengan Nimotuzumab Bertanda Yodium-131 = Synthesis of MnFe<sub>2</sub>O<sub>4</sub> Nanoparticles Using Black Pepper Fruit Extract (*Piper nigrum* L.) Conjugated with Nimotuzumab Iodine-131

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## Abstrak

Nanopartikel (NP) Mangan ferit (MnFe<sub>2</sub>O<sub>4</sub>) telah menyediakan platform serbaguna untuk mengembangkan sistem nano multifungsi untuk Magnetic Resonance Imaging (MRI) dan modalitas Single Photon Emission Computed Tomography (SPECT). Di sini, kami mengembangkan NP Yodium-131 (<sup>131</sup>I)-bertanda nimotuzumab-MnFe<sub>2</sub>O<sub>4</sub> baru sebagai MRI multimodalitas dan SPECT untuk diagnosis penyakit seperti kanker. Sintesis NP MnFe<sub>2</sub>O<sub>4</sub> dilakukan dengan menggunakan ekstrak *Piper nigrum* (EPN). EPN berperan sebagai bahan sumber basa lemah dan zat penstabil yang menunjukkan adanya alkaloid, polifenol, serta terpenoid yang dikonfirmasi dari uji fitokimia. NP MnFe<sub>2</sub>O<sub>4</sub> kemudian dikonjugasikan ke Epidermal Growth Factor Receptor (EGFR) nimotuzumab melalui PEG-linker heterobifungsional. Radiolabeling NP MnFe<sub>2</sub>O<sub>4</sub> terkonjugasi nimotuzumab dengan Yodium-131 dilakukan dengan metode oksidasi iodobead. NP MnFe<sub>2</sub>O<sub>4</sub> hasil sintesis dikarakterisasi dengan DRS, FTIR, XRD, SEM, TEM, dan EDX. NP MnFe<sub>2</sub>O<sub>4</sub> yang dikonfirmasi memiliki bentuk bulat, dengan ukuran rata-rata sekitar 21 nm dengan bentuk kristal kubik fase tunggal. Nanopartikel menunjukkan sifat magnetisasi 23,4 emu/g sebagaimana dikonfirmasi oleh analisis VSM. Hasil konjugasi MnFe<sub>2</sub>O<sub>4</sub> -nimotuzumab berhasil dilakukan dengan linker SH-PEG-NHS. Nanopartikel <sup>131</sup>I-bertanda nimotuzumab-MnFe<sub>2</sub>O<sub>4</sub> yang disiapkan memberikan kemurnian radiokimia yang sangat baik sebesar 93,57 ± 0,52%. Investigasi biologis di masa depan dari NP MnFe<sub>2</sub>O<sub>4</sub>-nimotuzumab-<sup>131</sup>I baru ini sebagai nanoprobe MRI dan SPECT baik *in vitro* dan *in vivo* masih diperlukan

.....Manganese ferrite (MnFe<sub>2</sub>O<sub>4</sub>) nanoparticles (NPs) has provided versatile platform to develop multifunctional nanosystem for magnetic resonance imaging (MRI) and single-photon emission computed tomography (SPECT) modalities. Herein, we develop novel iodine-131-labeled-nimotuzumab-MnFe<sub>2</sub>O<sub>4</sub> NPs as multimodalities MRI and SPECT nanoprobe for diagnosis of disease such as cancer. The synthesis of MnFe<sub>2</sub>O<sub>4</sub> NPs were done using *Piper nigrum* extract (PNE). PNE plays role as a weak base source material and stabilizing agent which showed the presence of alkaloids, polyphenols, as well as terpenoids as confirmed from the phytochemical test. MnFe<sub>2</sub>O<sub>4</sub> NPs were then conjugated to anti-epidermal growth factor receptor (EGFR) nimotuzumab via heterobifunctional PEG-linker. The radiolabeling of nimotuzumab-conjugated MnFe<sub>2</sub>O<sub>4</sub> NPs with iodine-131 was performed using iodobead oxidizing method. The synthesized MnFe<sub>2</sub>O<sub>4</sub> NPs were characterized by DRS, FTIR, XRD, XRD, SEM, TEM, and EDX. The confirmed MnFe<sub>2</sub>O<sub>4</sub> NPs have a spherical shape, with an average size of about 21 nm with a single-phase cubic crystal form. The NPs showed magnetization properties of 23.4 emu/g as confirmed by VSM analysis. The results of the conjugation of MnFe<sub>2</sub>O<sub>4</sub>-nimotuzumab were successfully carried out with the SH-PEG-NHS linker. The prepared iodine-131-labeled-nimotuzumab-MnFe<sub>2</sub>O<sub>4</sub> NPs gave an excellent radiochemical purity of 93.57 ± 0.52 %. Future biological investigations of this novel iodine-131-labeled-nimotuzumab-MnFe<sub>2</sub>O<sub>4</sub> NPs as MRI and SPECT nanoprobe both *in vitro* and *in vivo* are required.