

# Studi kelayakan lilin dan karbon sebagai material fantom radiologi diagnostik dengan parameter koefisien atenuasi = Feasibility study of wax and carbon as phantom material of diagnostic radiology with attenuation coefficient parameter

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## Abstrak

Dalam penelitian ini, beberapa jenis lilin (gondorukem, cecek, beeswax, parafin) dan Karbon digunakan sebagai konstituen dari bahan phantom setara jaringan. Jaringan Tubuh yang menjadi ruang lingkup penelitian adalah lemak, otot, hati, serta materi putih dan abu-abu materi di otak. Studi kelayakan material dilakukan dengan uji HU. nilai menggunakan CT scan dengan tegangan rendah 80 kVp dan tinggi 130 kVp, dan menguji koefisien atenuasi menggunakan mesin x-ray dengan tegangan 70 kVp dan pada kondisi file standar RQA 5 dengan tegangan 82 kVp. Dari hasil uji nilai HU, diperoleh komposisi dan perbandingan bahan penyusun phantom material yaitu bahan ekuivalen lemak [10 (cecek) : 10 (karbon) : 80 (parafin)], otot [10 (cecek) : 10 (karbon) : 80 (gondorukem)], hati [60 (cecek) : 40 (tepung beras)], otak putih [16 (cecek) : 16 (karbon) : 68 (gondorukem)], dan materi abu-abu otak [20 (cecek) : 20 (karbon) : 60 (gondorukem)]. Dalam pengujian koefisien redaman massa, nilai  $\mu/r$  diperoleh dengan perhitungan koefisien atenuasi linier ( $\mu$ ) dan densitas massa ( $\rho$ ) dari hasil pengukuran. Akibatnya, bahan ekuivalen jaringan memiliki nilai  $\mu/r$  pada tegangan 70 kVp ( $= 39,36 \text{ keV}$ ) untuk lemak  $0,205 \text{ cm}^2/\text{g}$ ; otot  $0,232 \text{ cm}^2/\text{g}$ ; materi putih otak  $0,225 \text{ cm}^2/\text{g}$ ; otak abu-abu materi  $0,229 \text{ cm}^2/\text{g}$ ; dan hati  $0,253 \text{ cm}^2/\text{g}$  dengan kesalahan literatur masing-masing jaringan sebesar 15,7%; 15,6%; 18,8%; 17,4%; dan 8,4%; serta pada tegangan 82 kVp ( $= 57,82 \text{ keV}$ ) untuk lemak  $0,163 \text{ cm}^2/\text{g}$ ; otot  $0,187 \text{ cm}^2/\text{g}$ ; materi putih otak  $0,179 \text{ cm}^2/\text{g}$ ; materi abu-abu otak  $0,170 \text{ cm}^2/\text{g}$ ; dan hati  $0,185 \text{ cm}^2/\text{g}$  dengan kesalahan literatur masing-masing jaringan sebesar 18,6%; 10,5%; 15,1%; 18,9%; dan 11,9%. Secara keseluruhan, bahan ekuivalen jaringan dari pengujian memiliki nilai  $\mu/r$  yang lebih rendah dan tidak sangat dekat dengan nilai  $\mu/r$  jaringan berdasarkan referensi.

.....In this study, several types of wax (gondorukem, cecek, beeswax, paraffin) and carbon were used as constituents of tissue equivalent phantom material. Body tissues that are the scope of research are fat, muscle, liver, and white matter and gray matter in the brain. The feasibility study of the material was carried out with the HU test. values using a CT scan with a low voltage of 80 kVp and a high of 130 kVp, and testing the attenuation coefficient using an x-ray machine with a voltage of 70 kVp and on standard file conditions RQA 5 with a voltage of 82 kVp. From the results of the HU value test, the composition and comparison of the ingredients for the phantom material are obtained, namely the equivalent of fat [10 (cecek) : 10 (carbon) : 80 (paraffin)], muscle [10 (cecek) : 10 (carbon) : 80 (gondorukem) ], liver [60 (cecek) : 40 (rice flour)], white brain [16 (cecek) : 16 (carbon) : 68 (gondorukem)], and brain gray matter [20 (cecek) : 20 ( carbon): 60 (gondorukem)]. In testing the mass attenuation coefficient, the value of  $\mu/r$  is obtained by calculating the linear attenuation coefficient ( $\mu$ ) and mass density ( $\rho$ ) from the measurement results. Consequently, the tissue equivalent material has a value of  $\mu/r$  at a voltage of 70 kVp ( $= 39.36 \text{ keV}$ ) for  $0.205 \text{ cm}^2/\text{g}$  fat; muscle  $0.232 \text{ cm}^2/\text{g}$ ; brain white matter  $0.225 \text{ cm}^2/\text{g}$ ; gray brain material  $0.229 \text{ cm}^2/\text{g}$ ; and liver  $0.253 \text{ cm}^2/\text{g}$  with a literature error of 15.7% for each tissue; 15.6%; 18.8%; 17.4%; and 8.4%; and

at a voltage of 82 kVp (= 57.82 keV) for fat 0.163 cm<sup>2</sup>/g; muscle 0.187 cm<sup>2</sup>/g; brain white matter 0.179 cm<sup>2</sup>/g; brain gray matter 0.170 cm<sup>2</sup>/g; and liver 0.185 cm<sup>2</sup>/g with a literature error of 18.6% for each tissue; 10.5%; 15.1%; 18.9%; and 11.9%. Overall, the tissue equivalent material from the test has a lower /r value and is not very close to the network /r value based on the reference