

ABSTRAK

Latar Belakang: Adhesi intraperitoneal pascaoperasi merupakan komplikasi yang sering terjadi dan dapat meningkatkan morbiditas, memperpanjang masa rawat, serta menambah kebutuhan tindakan operasi ulang. Hidrogel berbasis asam hialuronat (AH) dan kitosan (CS) berpotensi menjadi barier antiadhesi, sedangkan *Moringa oleifera* (MO) memiliki aktivitas antiinflamasi dan antioksidan yang dapat mendukung penyembuhan peritoneum.

Tujuan: Membuktikan efektivitas hidrogel kombinasi AH–CS–MO dalam mencegah adhesi pascaoperasi intraperitoneum pada tikus Wistar.

Metode: Penelitian eksperimental dengan rancangan *post-test only control group* dilakukan pada 24 ekor tikus Wistar jantan yang dibagi menjadi 4 kelompok: kontrol sehat, kelompok kontrol negatif yang dilakukan laparotomi dan induksi adhesi tanpa pemberian hidrogel, kelompok kontrol positif mendapat hidrogel AH-CS, sedangkan kelompok perlakuan mendapat hidrogel AH–CS–MO. Setelah satu ekor drop out, sebanyak 23 sampel dianalisis secara statistik dengan nilai $p < 0,05$ dianggap bermakna. Variabel yang dinilai meliputi skor adhesi makroskopis (Leach score), distribusi MDA, ekspresi TNF- α , dan gambaran histopatologi (Abramov scoring system).

Hasil: Terdapat perbedaan bermakna pada seluruh parameter skor adhesi makroskopis antar kelompok, yaitu luas adhesi ($p=0,000$), kualitas adhesi ($p=0,001$), dan pemisahan adhesi ($p=0,000$). Kelompok perlakuan menunjukkan rerata distribusi MDA yang lebih rendah dan mendekati kelompok sehat ($4,00 \pm 1,41$ vs $3,50 \pm 0,80$), dibandingkan kontrol negatif ($10,8 \pm 1,47$). Ekspresi TNF- α juga paling rendah pada kelompok perlakuan ($3,33 \pm 1,21$) dibandingkan kontrol negatif ($11,8 \pm 1,47$). Pemeriksaan histopatologi menunjukkan perbedaan bermakna pada granulasi ($p=0,043$), re-epitelisasi ($p=0,001$), neovaskularisasi ($p=0,044$), fibrosis ($p=0,008$), dan jaringan inflamasi ($p=0,001$).

Simpulan: Hidrogel kombinasi AH–CS–MO efektif menurunkan pembentukan adhesi intraperitoneal, menekan stres oksidatif dan inflamasi, serta memperbaiki gambaran histopatologi penyembuhan jaringan. Formulasi ini berpotensi dikembangkan sebagai biomaterial antiadhesi intraperitoneal.

Kata kunci: adhesi intraperitoneal, hidrogel, *Moringa oleifera*, malondialdehida, TNF- α , tikus Wistar

ABSTRACT

Background: Postoperative intraperitoneal adhesion is a common complication that may increase morbidity, prolong hospitalization, and raise the need for repeat surgical procedures. Hydrogels based on hyaluronic acid (HA) and chitosan (CS) have potential as anti-adhesion barriers, while *Moringa oleifera* (MO) has anti-inflammatory and antioxidant activities that may support peritoneal healing.

Objective: To determine the effectiveness of a combined HA–CS–MO hydrogel in preventing postoperative intraperitoneal adhesions in Wistar rats.

Methods: This experimental study with a post-test only control group design was conducted on 24 male Wistar rats divided into four groups: a healthy control group, a negative control group subjected to laparotomy and adhesion induction without hydrogel administration, a positive control group treated with HA–CS hydrogel, and a treatment group treated with HA–CS–MO hydrogel. After one rat dropped out, 23 samples were statistically analyzed, with $p < 0.05$ considered significant. The evaluated variables included macroscopic adhesion score using the Leach score, MDA distribution, TNF- α expression, and histopathological findings using the Abramov scoring system.

Results: Significant differences were found among groups in all parameters of the macroscopic adhesion score, namely adhesion extent ($p=0.000$), adhesion quality ($p=0.001$), and adhesion separation ($p=0.000$). The treatment group showed a lower mean MDA distribution and values closer to the healthy control group (4.00 ± 1.41 vs 3.50 ± 0.80), compared with the negative control group (10.8 ± 1.47). TNF- α expression was also lowest in the treatment group (3.33 ± 1.21) compared with the negative control group (11.8 ± 1.47). Histopathological examination showed significant differences in granulation ($p=0.043$), re-epithelialization ($p=0.001$), neovascularization ($p=0.044$), fibrosis ($p=0.008$), and inflammatory cell infiltration ($p=0.001$).

Conclusion: The combined HA–CS–MO hydrogel was effective in reducing intraperitoneal adhesion formation, suppressing oxidative stress and inflammation, and improving the histopathological features of tissue healing. This formulation has potential to be developed as an intraperitoneal anti-adhesion biomaterial.

Keywords: hydrogel, intraperitoneal adhesion, *Moringa oleifera*, malondialdehyde, TNF- α , Wistar rats.