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CHITOSAN FROM *Litopenaeus vannamei* SHRIMP SHELLS: A GREEN PRE-TREATMENT BIO-COAGULANT FOR AQUACULTURE WASTEWATER SOLID RECOVERY FOR BIO-FERTILIZER APPLICATION

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Aquaculture wastewater is one of the contaminants that might lead to eutrophication in the waterbody due to its high content of turbidity, total suspended solid (TSS) and nutrients. Currently, one of the best practices in solid and liquid separation in wastewater treatment is coagulation-flocculation technology. However, the usage of chemicals-based coagulants/flocculants contribute to the production of toxic sludge. This study was conducted to extract and characterize a chitosan bio-coagulants from *Litopenaeus vannamei* shell and demonstrates its coagulation-flocculation performances in treating aquaculture effluent. This study aims to optimize the coagulation-flocculation process using response surface methodology with Box-Behnken design. Additionally, the mechanism was concluded using correlation of fourier transformed infrared spectroscopy result, microscopic image of floc, zeta potential and particle size analysis. The recovered solid obtained was characterized and its potential as bio-fertilizer was observed on the growth of *Amaranthus* spp. The results showed that chitosan exhibited low moisture and ash content. It also demonstrated high deacetylation degree, water and fat binding capacity. Moreover, the presence of hydroxyl and amino groups were also detected in chitosan. Chitosan showed a good performance in removing turbidity (80.41%) and TSS (83.55%) of aquaculture wastewater. Optimum removal in aquaculture wastewater was obtained at

chitosan dosage 20 mgL^{-1}, pH 7, rapid mixing rate 160 rpm at 2 minutes, slow mixing rate 50 rpm at 20 minutes and sedimentation time of 25 minutes which successfully eliminated 92.73% turbidity, 88.22% TSS, 32.46% nitrite, 48.36% ammonia and 41.51% phosphate, respectively. The chitosan was categorized as cationic type based on its major functional group and its zeta potential charge. Charge neutralization and bridging were found as coagulation-flocculation mechanism based on correlation analysis. Moreover, the recovered solid from aquaculture wastewater contain high macronutrients contents of N (249,500 $mgkg^{-1}$), P (42,305 $mgkg^{-1}$) and K (6,899.9 $mgkg^{-1}$) and the levels of heavy metals were considered low. The growth of *Amaranthus* spp. showed a significant result when treated with recovered solid as compared to untreated media. Therefore, this study suggested that obtained results can be used in wastewater treatment as well as acting as a green technology to recover sludge and reduce the environmental impact.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

KITOSAN DARIPADA KULIT UDANG *Litopenaeus vannamei*: PRA-RAWATAN HIJAU MENGGUNAKAN BIO-PENGENTAL UNTUK PEMULIHAN PEPEJAL AIR SISA AKUAKULTUR BAGI APLIKASI BAJA-BIO

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Air sisa akuakultur merupakan pencemar yang menyebabkan eutrofikasi dalam air kerana mengandungi jumlah kekeruhan, pepejal terampai dan nutrien yang tinggi. Salah satu amalan terbaik pada masa ini bagi memisahkan pepejal dan cecair dalam rawatan air sisa ialah teknologi pengentalan-penggumpalan. Namun penggunaan pengental berasaskan bahan kimia menghasilkan enap cemar yang toksik. Kajian ini dilakukan untuk mengekstrak dan mencirikan bio-pengental kitosan daripada kulit *Litopenaeus vannamei* dan menunjukkan prestasi pengentalan-penggumpalan dalam merawat efluen akuakultur. Kajian ini bertujuan untuk mengoptimumkan proses pengentalan-penggumpalan menggunakan kaedah sambutan permukaan dengan rekabentuk Box-Behnken. Disamping itu, mekanisma pengentalan-penggumpalan disimpulkan menggunakan korelasi antara keputusan spektroskopi inframerah transformasi fourier, imej mikroskopik flok, potensi zeta dan analisis saiz zarah. Pepejal pulih daripada rawatan ini dicirikan dan potensinya sebagai baja-bio dikaji pada pertumbuhan pokok *Amaranthus* spp. Berdasarkan keputusan, kitosan menunjukkan kandungan kelembapan dan abu yang rendah. Kitosan juga menunjukkan darjah deasetilasi, kadar pengikat air dan lemak yang tinggi. Selain itu, kehadiran kumpulan hidroksil dan amino juga telah dikesan pada kitosan. Kitosan juga menunjukkan prestasi yang baik dalam mengurangkan kekeruhan (80.41%) dan TSS

(83.55%) dalam air sisa akuakultur. Penyingkiran optimum dalam air sisa akuakultur diperolehi pada dos kitosan 20 mgL^{-1}, pH 7, kelajuan pengadukan pantas 160 rpm dalam masa 2 minit, kelajuan pengadukan perlahan 50 rpm dalam masa 20 minit dan masa pemendapan 25 minit yang mengurangkan kekeruhan masing-masing sebanyak 92.73%, 88.22% TSS, 32.46% nitrit, 48.36% ammonia dan 41.51% fosfat. Kitosan dikategorikan dalam jenis kationik berdasarkan kumpulan berfungsi major dan cas zeta potensi. Peneutralan cas dan penyambungan didapati merupakan mekanisma bagi proses pengentalan-penggumpalan berdasarkan analisis korelasi. Tambahan pula, pepejal daripada air sisa akuakultur mengandungi kandungan makronutrien N (249,500 $mgkg^{-1}$), P (42,305 $mgkg^{-1}$) dan K (6,899.8 $mgkg^{-1}$) yang tinggi dan paras logam berat yang rendah. Pertumbuhan *Amaranthus* spp. menunjukkan hasil yang ketara apabila dirawat dengan pepejal pulih berbanding media yang tidak dirawat. Oleh yang demikian, kajian ini mencadangkan bahawa keputusan yang diperolehi mampu digunakan dalam rawatan air sisa dan bertindak sebagai teknologi hijau untuk memperoleh semula enap cemar dan mengurangkan impak kepada alam sekitar.