EVALUATION OF SYNTHETIC HOUSEHOLD WASTEWATER QUALITY USING *ARTOCARPUS HETEROPHYLLUS* PEEL AS A NATURAL COAGULANT

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I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Penggunaan bahan penggumpal kimia dalam proses rawatan air memberi kesan negatif terhadap alam sekitar. Dalam usaha mengatasi masalah ini, penggunaan bahan penggumpal berasaskan tumbuhan mula diterokai secara meluas oleh penyelidik sebagai penyelesaian alternatif kepada bahan penggumpal kimia. Bahan penggumpal berasaskan tumbuhan telah didapati selamat, mesra alam dan murah. Penyelidikan ke atas penggunaan kulit *Artocarpus heterophyllus* (nangka) sebagai bahan penggumpal dalam merawat air sisa domestik masih belum dibincangkan dalam kesusasteraan sehingga kini. Oleh itu, kajian ini dijalankan untuk pencirian dan mengenal pasti sifat-sifat bahan penggumpal daripada kulit *Artocarpus heterophyllus* dalam pembersihan air sisa rumah sintetik serta memperoleh kondisi terbaik untuk proses penggumpalan menggunakan kaedah permukaan tindak balas (RSM). Bahan penggumpal yang diekstrak daripada kulit *Artocarpus heterophyllus* disediakan melalui proses pengeringan dan pengisaran kulit sehingga menjadi serbuk halus. Analisis untuk mengenalpasti kandungan dalam kulit yang dikeringkan telah dijalankan terlebih dahulu. Bagi eksperimen ujian balang, serbuk kulit *Artocarpus heterophyllus* direndam dalam air suling dan dikacau selama satu jam. Campuran ini ditapis dan cecair yang diperoleh digunakan sebagai bahan penggumpal dalam eksperimen. Cecair koagulan dianalisis dari segi caj permukaan, kumpulan berfungsi dan juga sifat permukaan. Eksperimen ujian balang dijalankan dan dua pembolehubah dikaji termasuk pH air sisa rumah sintetik dan dos bahan penggumpal. Setelah ujian dijalankan, kualiti air sisa yang telah dirawat ditentukan dengan mengukur kepekatan keperluan oksigen kimia (COD), keperluan oksigen biologi (BOD), jumlah pepejal terampai (TSS) dan kekeruhan. Kaedah RSM menggunakan reka bentuk komposit pusat (CCD) telah digunakan untuk mendapatkan parameter yang terbaik bagi keberkesanan dalam pembersihan air sisa rumah sintetik. Kandungan dalam kulit *Artocarpus heterophyllus* menunjukkan kehadiran protein dan karbohidrat yang dikenal pasti sebagai komponen yang menyumbang kepada proses penggumpalan. Pemukaan caj air sisa didapati positif semasa pH berasid manakala negatif apabila ditambah alkali. Koagulan pula menunjukkan nilai -25.2 mV pada pH 6.95 yang berkemungkinan menyebabkan caj neutralisasi. Koagulan didapati memiliki kumpulan seperti hidroksil dan karboksil yang penting dalam keberkesanan proses penggumpalan. Ujian sifat permukan menunjukkan kehadiran lubang yang yang membolehkan partikel-partikel dalam air sisa bercantum. Melalui teknik RSM, didapati parameter terbaik di mana kulit *Artocarpus heterophyllus* paling berkesan adalah pada pH 2.1 dan dos 58 mg/L. Eksperimen pengesahan mendedahkan bahawa peratus penyingkiran kekeruhan, TSS, BOD dan COD masing-masing adalah sebanyak 80.7 %, 77.5 %, 34.3 % dan 34.6 %. Model yang diperolehi daripada CCD menunjukkan nilai-p < 0.05 yang membuktikan model ini dapat digunakan untuk proses pengoptimuman. Model ini juga mempunyai titik maksimum yang berkemungkinan menjadi parameter paling berkesan untuk proses pengoptimuman. Keputusan daripada kajian ini menunjukkan penurunan TSS dan kekeruhan yang tinggi di mana hal ini sangat penting dalam proses perawatan air sisa di peringkat awal. Kajian ini dapat dijadikan sebagai titik permulaan untuk mendalami dan mempelajari bahan penggumpal semulajadi lain yang berpotensi dalam menggantikan bahan penggumpal komersial dalam rawatan air sisa.

ABSTRACT

The use of chemical coagulants in wastewater treatment developed detrimental effects on the environment. In order to overcome this, the application of natural coagulant has been widely explored by researchers as an alternative solution to chemical coagulants. Natural coagulants were considered to be safe, biodegradable and cheap. Research on utilization of *Artocarpus heterophyllus* (jackfruit) peel in purifying household wastewater has yet to be discussed in literature till date. Thus, this study aimed to characterize and identify the coagulant properties of *Artocarpus heterophyllus* peel for synthetic household wastewater purification as well as obtaining the best condition for coagulation process using response surface methodology (RSM) technique. *Artocarpus heterophyllus* peel extract coagulant is prepared by drying and grinding the peel into fine powder. Proximate analysis was performed on the dried *Artocarpus heterophyllus* peel powder. As for the preparation of coagulant, the peel powder was soaked in distilled water and stirred for an hour. The mixture was filtered and the obtained filtrate was used as coagulant in the experiment. The characterization tests of the coagulant were carried out based on analyses of surface charge, functional group and morphology. The coagulation jar test experiment was carried out and two main variables were studied which included pH of synthetic household wastewater and dosage of coagulant. After testing, the water quality of the treated wastewater was determined by measuring the concentration of chemical oxygen demand (COD), biological oxygen demand (BOD), total suspended solids (TSS) and turbidity. The RSM method based on central composite design (CCD) was used to obtain the best condition of parameters that works well in purifying household wastewater. The proximate analysis revealed the presence of protein and carbohydrate in the peel which are among the significant components suggested in assistance of the coagulation process. The surface charge of the synthetic wastewater is positive at pH 2 and later turned to be negative as the pH is increased up to pH 12. The measured zeta potential of the coagulant was -25.2 mV at its original pH, 6.95 possibly causing charge neutralization of opposite charges. This coagulant also comprised of functional groups such as carboxyl and hydroxyl groups in which all of these groups were salient for coagulation efficiency. Morphology analysis revealed that the addition of natural coagulant modified the colloid particles by providing voided pores that allowed the binding mechanism. From the RSM results, the best condition for the *Artocarpus heterophyllus* peel coagulant when pH of wastewater at 2.1 and coagulant dosage of 58 mg/L. The validation experiments revealed the removal of turbidity, TSS, BOD and COD were 80.7 %, 77.5 %, 34.3 % and 34.6 % respectively. The model obtained was significant with p-value < 0.05. It is suggested that this model had a maximum point which is likely to be the best condition and possible for the optimization process. The findings showed a higher reduction in TSS and turbidity by using this natural coagulant which is very important in primary treatment of wastewater. This can serve as a starting point for future studies to explore this new type of natural coagulant as well to replace the commercial chemical coagulants in water and wastewater treatment.

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