PHYSICAL EXTRACTION OF FLAGELLA VIA ULTRASONICATION FROM *BACILLUS SUBTILIS* 168 WITH VARIOUS CONTROL ELEMENTS

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Saya telah menyemak semua pembetulan/pindaan yang dilaksanakan oleh Encik/Puan/Cik Leong Kah Yan

mengemui disertainya sebagaimana yang dipersetujui oleh Panel Pemeriksa di Viva Vocenya.

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PHYSICAL EXTRACTION OF FLAGELLA VIA ULTRASONICATION FROM *BACILLUS SUBTILIS* 168 WITH VARIOUS OF CONTROL ELEMENTS

by

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A dissertation submitted in the partial fulfillment of the requirements for the degree of Bachelor of Technology (B.Tech) in the field of Bioprocess technology School of Industrial Technology
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DECLARATION BY AUTHOR

This dissertation is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	Caption
+	Plus
-	Minus
±	Plus-Minus
%	Percentage
º C	Degree Celsius
&	And
=	Equal
>	More Than

Abbreviation	Caption
mL	Milliliter
L	Liter
g	Gram
Kg	Kilogram
mm	Millimeter
OD	Optical Density
NA	Nutrient Agar
NB	Nutrient Broth
rpm	Revolutions Per Minute
USA	United States of America
Na	Sodium

Cl	Chloride
C	Carbon
O	Oxygen
Mg	Magnesium
Si	Silicon
P	Phosphorus
S	Sulphur
K	Potassium
Ca	Calcium
N	Nitrogen
Zr	Zirconium
Pt	Platinum
CDW	Cell Dry Weight

PENGEKSTRAKAN FIZIKAL FLAGELLA MELALUI PELBAGAI KAWALAN ELEMEN DARI *BACILLUS SUBTILIS* 168 DENGAN MENGGUNAKAN KAEDAH ULTRASONIK

ABSTRAK

Flagella biasanya dikenal sebagai ekor bakteria. Struktur utama protein dalam *flagella* ialah *flagellin*. Banyak penyelidik membuktikan bahawa *flagella* berpotensi menjadi biodegradasi *nanotube* yang penting dalam penyaluran ubat, elektronik atau semikonduktor. Kini, kurang penyelidikan mengenai pemisahan dan penulenan flagella. Dalam penyelidikan ini, morfologi *flagella* dan badan basal untuk *Bacillus subtilis* 168 dikaji dengan pengimbasan mikroskop electron dan penghantaran mikroskop elektron. Berdasarkan kajian ini didapati bahawa perbezaan antara flagella dan tubuh sel ialah nitrogen (N), magnesium (Mg) dan Sulfur (S) dengan spektroskopi sinar-X. Berdasarkan statistik eksperimen ini, hasil menunjukkan pengaruh yang signifikan dalam jangka masa sonikasi dan daya pengeluaran sonikator terhadap kepekatan kandungan *flagellin* selepas sonikasi. Tubuh sel *Bacillus subtilis* 168 dipecahkan bermula daripada 20% kuasa output sonikator. Kuasa pengeluaran sonikator yang paling memuaskan ialah 20% kerana tubuh sel tidak pecah dan kepekatan flagellin meningkat mengikut masa. Kajian lepas menunjukkan aplikasi flagella dalam industri elektronik dapat digunakan dalam sel solar sensitif Dye (DSSCs), *nanowire* mikrob untuk menyalurkan elektron dalam sel mikrob dan berpotensi menjadi *nanowire* dan diserap ke dalam selulosa konduktif untuk membentuk selulosa konduktif yang telus dan fleksibel. Harga untuk menghasilkan *flagella* dalam project ini ialah RM 832.20/g and lebih murah berbanding satu lapisan karbon *nanotubes*. Kesimpulannya, *flagella* mempunyai potensi besar dalam pengeluaran alat elektronik pada masa akan datang. Pengekstrakan *flagella* secara

fizikal boleh menjadi kaedah yang baik untuk menjimatkan kos dan mencegah kerosakan flagella dalam kajian lebih lanjut.

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ABSTRACT

Flagella was commonly known as the tail of bacteria. The major structural protein of bacterial flagella is called flagellin. Flagella have a potential to become biodegradable nanotube and important for drug delivery, electronic or semiconductor. There are still lack of research about flagella separation and purification. In this research, the morphology of the flagella and basal body for *Bacillus subtilis* 168 was investigated by scanning electron microscope and transmission electron microscope. The characterization of flagella was found that difference between flagella and cell body is nitrogen (N), magnesium (Mg) and Sulphur (S) by energy-dispersive X-ray spectroscopy. Statistically designed experiment revealed significant effects of sonication duration and sonicator output power on the concentration of flagellin after sonication. The cell body of *Bacillus subtilis* 168 was started to breaked from 20 % sonicator output power. The 20 % sonicator output power is most suitable because the cell body was not break and the flagellin concentration increase with time increase. The applications of flagella in electronic industry through the previous studies shows flagella used in Dye-sensitized solar cell (DSSC), microbial nanowires in microbial cell and possibly become nanowires embedded to conductive cellulose to form transparent and flexible conductive cellulose. The estimation cost of production of flagella is RM832.20 per g which is cheaper than the single walled carbon nanotubes. In conclusion, flagella have a massive potential in the production of electronic device in future. Physical extraction of flagella could be a good way to save cost and prevent the damage of flagella for further study.