2019/20 — 2020/21
香港科學青苗獎
Hong Kong Budding Scientists Award

資料匯編
Collection of Students' Proposals To Future World Problems/Authentic Problems

教育局課程發展處資優教育組
Gifted Education Section
Curriculum Development Institute
Education Bureau

目錄

前言

教育局資優教育組於二零零五年開始籌辦第一屆「香港科學青苗獎」計劃及相關的培訓活動，目的在現有的平台以外，為學生提供一個以科學領域為背景的全面培育機會。

起初構思「香港科學青苗獎」的計劃時，我們已了解到本地有各式各樣的科學比賽，因此計劃的設計，除注重培育科學資優生的潛能外，同時亦注入與其他比賽不同的元素，包括情意教育，避免資源重疊。計劃首先要求參加比賽的學生，進行相關文獻的整理和研究，發揮他們的創意，為一個「未來世界難題／現實難題」提供不同的解決方案，從中訓練他們資料搜集、分析、綜合、評鑑及應用科學知識的能力。之後，學生需要訪問本地一位從事科學研究的學者。我們希望學生可透過面對面的訪談，了解成功科學家的奮鬥過程，他們／她們的科學研究對社會的貢獻，學習他們／她們那種百折不撓的態度和精神，並且能夠深入認識科學的本質。我們相信，受人尊崇的成功科學家所應具備的素質，不單包括豐富的學科知識，而且還須具備良好的解決問題能力和道德修養。最後，評判更會提問學生有關解決方案的詳細資料，參與的學生便要磨練自己的應對及表達能力。

整個「香港科學青苗獎」計劃，歷時大半年，每一個環節都與下一個環節緊緊相扣。我們希望參與計劃的學生，視整個計劃為一個學習的歷程，並且能夠虛心聽取別人（指導教師及評判）的意見，不斷檢討現況，改進自己。

教育局籌辦這個比賽，不但給予學生多一個機會發掘及發展自己在科學方面的潛質，同時亦希望藉此機會，將比賽的題目，學生比賽時的經歷與評判學者的專業意見，整理成有高度參考價值的教材。我們期望教師們能夠參考本資源套，於學校層面推展相類的活動；或於校本課程中引入本計劃的理念，調適現有課程，讓更多的學生能夠受惠。

教育局課程發展處資優教育組

本資源套所收錄的學生作品僅供參考。如對本資源套有任何意見和建議，歡迎以郵寄、電話、傳真或電郵方式聯絡教育局課程發展處資優教育組：

地　址：九龍塘沙福道19號教育局九龍塘教育服務中心東座3樓E328室
電　話：3698 3472
傳　真：2490 6858
電郵地址：gifted@edb.gov.hk

比賽規則

I. 初賽

A. 參賽學生需要遞交一個「未來世界難題／現實難題」的解難方案及一個「科學家專訪報告」

1. **「未來世界難題／現實難題」的解難方案**

參賽校隊需要從3條「未來世界難題／現實難題」中選擇一題，提交解難方案；而方案需包括：

- 簡介：簡單介紹所選難題的背景；
- 解決方案：建議解難方案，並提出理據作解釋；需輔以插圖、圖片、圖表與相片等幫助說明所建議的解難方案；
- 討論：討論解決方案的利與弊；
- 總結及建議：作總結、討論所提出的方案的限制，以及建議如何改善實驗設計及方法等；及
- 參考資料。

備註： 比賽主辦單位期望遞交的解難方案，會有實驗設計，包括實驗步驟、實驗結果、實驗分析與結論。學生宜把實驗的過程及結果拍照或錄影。

- 解難方案需以學校報名時所選擇的語言（中文或英文）撰寫；
- 小學組的報告字數不得多於1,500字；中學組不得多於2,000字；
- 圖像、圖表與模型相片的總數，不得超過15張；同時，所用的圖像、圖表與模型／實驗的相片，必須符合版權法的「合理使用」；
- 所提出的解難方案必須原創（original），並且未曾於本地、國內及／或國際的其他比賽中匯報；
- 超出所限字數的解難方案將會被扣分；及
- 解難方案所包括的圖像、圖表或模型相片的附註解說，不會計算在解難方案的字數總和。

2. **「科學家專訪報告」**

- 參賽校隊須訪問一位本地的科學家，然後遞交整理好的專訪報告。科學家專訪報告須包括學生的反思部分 —— 例如受訪科學家對社會的貢獻及學生從科學家身上學到的事情等；
- 受訪的科學家須正從事科學研究，並曾在權威的科學期刊，發表學術論文及；
- 科學家專訪報告使用的語言需與遞交的解難方案所選用的語言相同；小學組不超過1,000字，中學組不超過1,500字。

(因應教育局的停課安排，本屆香港科學青苗獎的準決賽及決賽取消，獲獎名單根據書面報告的水平而決定。)

II. 準決賽

A. **匯報及問答環節**

參賽校隊須自行於準決賽當天早上自行設置預備參賽用的展板。學生首先向評判介紹自選的難題及解難方案（時限5分鐘）。然後，需要就評判對自己的解難方案的提問作解答時限5分鐘）。

1. 這個問答的環節，會根據參賽校隊遞交解難方案所使用的語言，以廣東話或英語提問學生及回答評判的提問；
2. 解難方案的口頭答辯的評分著重：
   - 學生對題目之了解；
   - 學生回應評判之表現；
   - 學生能否運用科學概念回答評判之提問；
   - 學生的解難能力與彼此間的合作。
3. 在中、小學校隊中，各選出表現最好的7隊進入決賽。

III. 決賽暨頒獎禮

A. 決賽（匯報解難方案）：

1. 參賽學生需要向評判匯報自己的解難方案；
2. 中、小學組每隊校隊的匯報時間為8分鐘；
3. 匯報後，參賽學生需解答評判團的提問，問答時間為15分鐘。

B. 頒獎禮

比賽題目(未來世界／現實難題)

1. **與衣服有關的科學探究**

   識別一個在炎熱天氣下與衣服有關的問題，然後建議一個運用科學與科技的解難方案。你的建議必須實用、具經濟效益、符合科學原則，並有科學證據支持。評分標準亦包括計劃書內的建議是否具創意。請給予所要探究的難題一個探究題目（Title of Investigation）。

2. **香港的海洋污染**

   新聞不時報導有關本港海洋污染問題，引起市民的關注。香港的天然資源有限，香港特別行政區政府竭力避免海洋環境受到任何污染。試建議一個方案以處理其中一種香港的海洋污染問題。解決方案必須實用、具經濟效益，符合科學原則，並有證據支持。評分標準亦包括解難方案內的建議是否具創意。請給予所要探究的問題一個探究題目（Title of Investigation）。

3. **其他**

   試描述一個你們感興趣並與科學相關的「未來世界難題」／重要「現實難題」。遞交的解難方案，應把重點放在科學和科技層面上。另外，解難方案必須實用、具經濟效益、符合科學原則，並有證據支持。評分標準亦包括解難方案內的建議是否具創意。請給予所要探究的難題一個探究題目（Title of Investigation）。

Problems of the Heat

(Future World Problems / Authentic Problems):

1. **Scientific Investigations related to clothing**

   Identify a clothing problem during hot weather. Suggest in your proposal how to tackle the problem with science and technology. The suggestion(s) in your proposal should be practical, cost-effective, scientific and evidence-based. The marking criteria of the proposal also include creativity. Please also suggest a Title for your scientific investigation(s).

2. **Marine Pollution in Hong Kong**

   From time to time news about marine pollution in Hong Kong concern Hong Kong people. The natural resources in Hong Kong are limited and the Hong Kong Government strives to avoid its environment from any marine pollution.
   Suggest in your proposal how to tackle one kind of marine pollution in Hong Kong. The suggestion(s) in your proposal should be practical, cost-effective, scientific and evidence-based. The marking criteria of the proposal also include creativity. Please also suggest a Title for your Investigation(s).

3. **Others**

   Describe a science related future world problem or important real-life problem in which your school team has interest.
   Suggest in your proposal how to tackle the problem. The suggestion(s) in your proposal should be practical, cost-effective, scientific and evidence-based. The marking criteria of the proposal also include creativity. Please also suggest a Title for your Investigation(s).

小學組

香港科學青苗獎

冠軍

2019/20 — 2020/21

未來世界難題: 淡水資源珍貴 • 應節約用水

「惜」煙水北循人

參賽學校: 北角循道學校

參賽同學：林智華
王昊鈞
張學賢
冼奕妍
李思殷

指導老師: 姚明華老師
麥俊老師

目錄

(一)摘要

觀看測試影片，
請掃描二維碼或按此

研究目的：

淡水資源短缺，為了節省洗澡用水，我們設計了節水花灑。

方法：

我們運用 3D 模型圖設計及打印花灑，作實物測試。運用流體的特性、「伯努利」定律 、「文氏管」原理，構思花灑出水孔及手柄入水孔的設計，找出節水的花灑設計。

結果 ：

花灑設計以減少出水孔面積、花灑出水孔越小（出水孔的總面積相同）、收窄手柄內管、在手柄入水位置加上節流器（節流器的孔越小，流量越少），均可節水。在手柄加設加氣裝置，可增加水流速度，達到分散水點的效果。

我們設計的花灑能達到「一級用水效益級別」的標準，流量≤9(公升/分鐘)，三個用戶的流量分別是：6.3 、4.9 、5.3 (公升/分鐘)，可媲美市面上的花灑。

(二) 引言

水是地球珍貴的資源，雖然水佔地球約 70%，但是可食用的淡水不足 3%，因此淡水資源十分缺乏。在 2018-19 年，香港每年用 1010.753 百萬立方米的水，食水短缺更是將來面對的一大挑戰。所以我們希望能從家居節水做起，洗澡是其中一項耗水量多的項目，水務署估計每人每天約用 70 公升水洗澡，為了節省洗澡用水，我們便決定設計節水花灑。

(三) 探究問題

我們探究花灑的出水孔數量、面積及手柄入水孔設計與流量之關係。我們運用物理學原理，透過實驗測試花灑的節水情況。我們希望構思一個節水花灑。

標稱流量：f(公升／分鐘)	用水效益級別	在用水效益標籤上展示的標誌
$f \leq 9.0$	第 1 級	1 滴水點
$9.0 < f \leq 12.0$	第 2 級	2 滴水點
$12.0 < f \leq 16.0$	第 3 級	3 滴水點
$f > 16.0$	第 4 級	4 滴水點

圖 1：資料來源：水務署(2020)。〈香港水務署淋浴花灑標稱流量與用水效益級別對照表〉。取自 https://www.wsd.gov.hk

(四) 科學原理

水由水龍頭輸出到花灑，然後由花灑出水孔排出，水會流動。

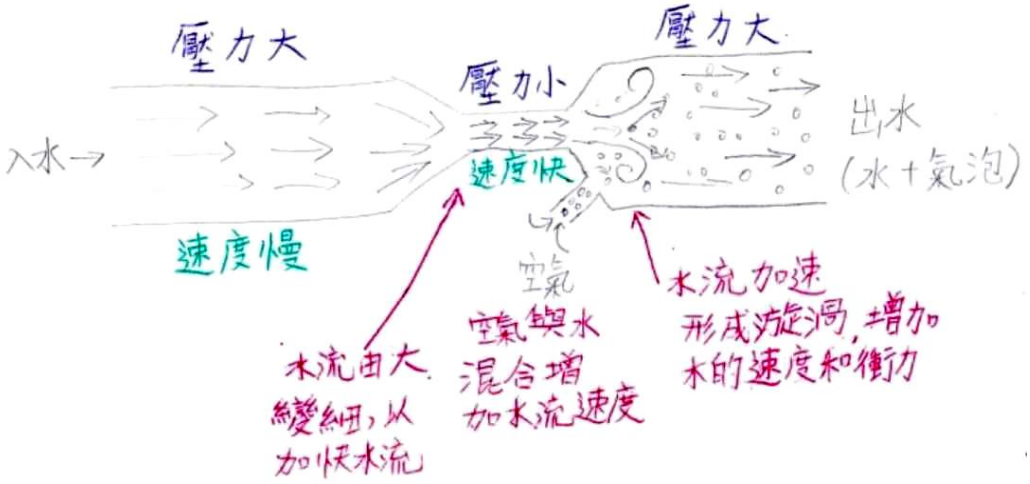
(I) 流體的特性：

- 流體沒有固定形狀，可以隨意變形
- 當外加壓時，流體便會產生運動

(II) 根據「伯努利」定律 (Bernoulli's Principle)，流速與壓力的關係：

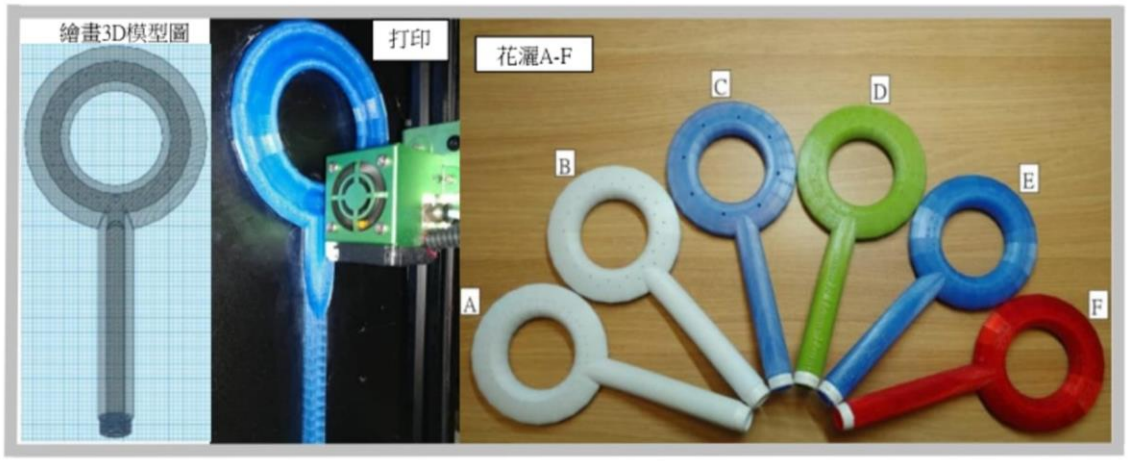
- 流速快，壓力小； 流速慢，壓力大
- 壓力差產生推力

(III) 文氏管（Venturi tube）是一個圓錐管（大→小→大），流體流過時，由於管的面積改變，流速和壓力亦會改變，因而產生壓力差。



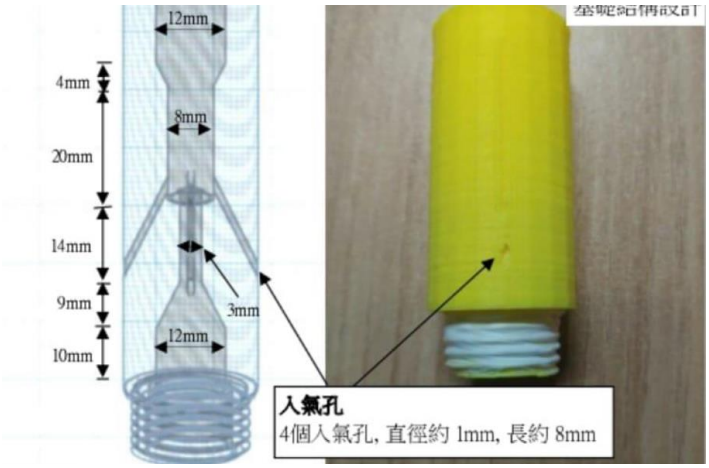
(五) 測試設計

(I) 用 Tinkercad 繪畫 3D 模型圖，用 3D 打印(打印物料: PET-G Filament)製作花灑作實物測試。 花灑外型一致，以改變花灑出水孔大小和內管設計作變項的公平測試。



(II) 手柄入水位置的設計，可方便更換不同的節流器。

(III) 加氣裝置是在手柄加設氣孔把空氣吸進花灑。



(六) 測試步驟

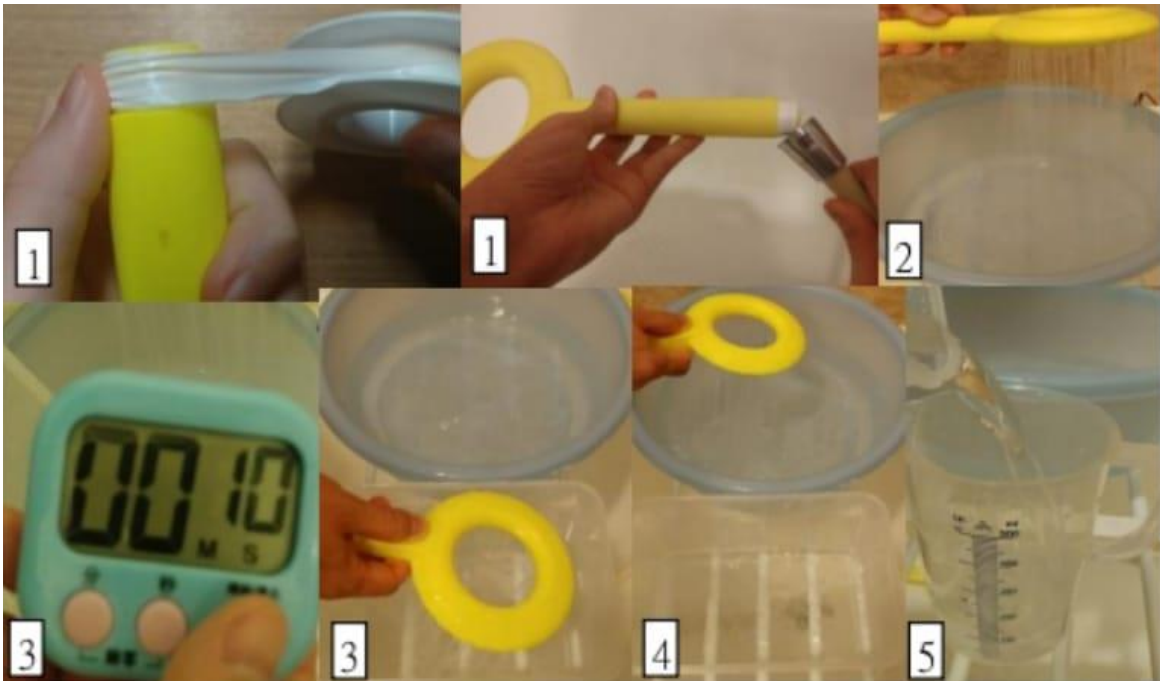
測試每款花灑的流量：

工具：

- 水桶/盆兩個
- 量杯一個 (準確至 10 毫升)
- 計時秒錶一個
- 水喉膠布一卷

測試步驟：

1. 用適量水喉膠布圍繞花灑頭接駁位置，把花灑接駁到花灑喉;
2. 把花灑冷水開至最大，待水流穩定;
3. 快速把花灑移到水盆，並計時 10 秒;
4. 快速把花灑移離水盆，關上水龍頭;
5. 用量杯量度所收集的水容積(Q);
6. 以該容積乘以 6 (即 f=Qx6) 來計算流量 (f) (公升/分鐘)。



(七) 實驗假設

1) 改變出水孔的效果：

- 花灑出水孔的數目或面積越小，流量越少

2) 改變手柄入水孔的效果：

- 收窄內管，能減少流量
- 加節流器，減少入水量
- 加入加氣裝置，能分散水點

(八)「一級用水效益標籤」花灑測試

我們從市面購買一個貼有水務署「一級用水效益標籤」的花灑，為確保測試的信度，我們邀請了三個不同的用戶進行測試。

花灑資料	出水孔直徑: 1mm 出水孔數量: 60 手柄：節流器裝置 「一級用水效益標籤」 標稱每分鐘流量少於 8.8 公升  
用戶	流量（公升/分鐘）
甲	**8.1**
乙	**8.7**
丙	**9.5**

分析：

不同用戶使用同一個花灑，流量不同。

每個住宅的水壓和水喉管的設計都不同，本測試以同一用戶使用不同款式的花灑，進行流量的比較，例如在甲用戶中，比較花灑 A 和花灑 B 的流量，從而得出那一款的花灑流量較少。

如家中的水壓較大，花灑的流量會較多。

用戶丙的測試結果與標稱「少於 8.8 公升」不符，多了 0.7 公升/分鐘。

(九) 改變花灑出水孔的效果

測試(一)

實驗目的: 在出水孔總面積相同的情況下，減少出水孔的大小，以減少流量

獨立變數: 出水孔的大小及數量

控制變數: 出水孔的總面積不變 (56.52mm², πr^2*出水孔數目， π 取值為 3.14)

花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 	花灑 B 出水孔直徑: 1.5mm 出水孔數量: 32 手柄內管直徑: 12mm 	花灑 C 出水孔直徑: 3mm 出水孔數量: 8 手柄內管直徑: 12mm 
用戶	流量（公升/分鐘）	流量（公升/分鐘）	流量（公升/分鐘）
甲	10.8	10.6	14
乙	15.3	15	16.4
丙	11.9	8	9.3

分析：

在出水孔總面積相同的情況下，花灑出水孔越小，流量越少。

花灑 A、B、C 的出水孔總面積一樣，增加花灑出水孔數量，同時減少每個出水孔的面積，出水的阻力較大，流量較少。因花灑 B 部分出水孔閉塞，使流量減少。而用戶丙在測試時，因樓上或樓下用水，令家中的水壓不穩，結果不一致。

盡量減少每個出水孔的面積。

我們設計了 0.6mm 的 200 孔的花灑，因打印限制，大部份出水孔閉塞，用手動開孔又大於 0.6mm，設計不理想。

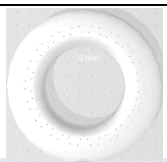
因此，我們採用花灑 A 的設計。

測試(二)

實驗目的: 在出水孔的大小不變的情況下，減少出水孔的數量，以減少流量

獨立變數: 出水孔數量(花灑 A :花灑 D=2:1)，出水孔總面積(花灑 A :花灑 D 2:1)

控制變數: 出水孔的大小

花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm  	花灑 D 出水孔直徑: 1mm 出水孔數量: 36 手柄內管直徑: 12mm 
用戶	流量（公升/分鐘）	流量（公升/分鐘）
甲	10.8	10
乙	15.3	14.7
丙	11.9	11.7

分析：

花灑出水孔總面積越少，流量越少。

花灑 D 的出水孔總面積是花灑 A 的一半，但流量卻相差很少(用戶甲：0.8 公升/分鐘，用戶乙： 0.6 公升/分鐘，用戶丙： 0.2 公升/分鐘)，跟我們的預測流量會減半有很大的出入。

花灑出水孔總面積越少，水壓較大，增加流量。

根據「伯努利」定律，因為花灑 D 的出水孔面積較花灑 A 小，令出水水壓較花灑 A 大，增加水流速度，增加流量。

水壓太大，花灑有滲漏。

雖然花灑 D 較花灑 A 節水，但因花灑 D 出水水壓較大，有滲漏，設計不理想。如果能夠提高 3D 打印密度，我們使用花灑 D 的設計再作改良，應該能減少較多流量。

同時，我們目測花灑 A 出水的覆蓋面較大。因而繼續採用花灑 A 的設計。

(十) 改變花灑手柄入水孔的效果

測試(三)

實驗目的: 收窄手柄內管直徑，以減少流量

獨立變數: 手柄內管的直徑

控制變數: 出水孔的大小和數量

花灑資料	花灑A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 	花灑E 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm收窄至4mm 
用戶	流量（公升/分鐘）	流量（公升/分鐘）（比較花灑A流量減少）
甲	10.8	9.1 (15.7%)
乙	15.3	4.9 (68%)
丙	11.9	5.3 (55.5%)

分析：

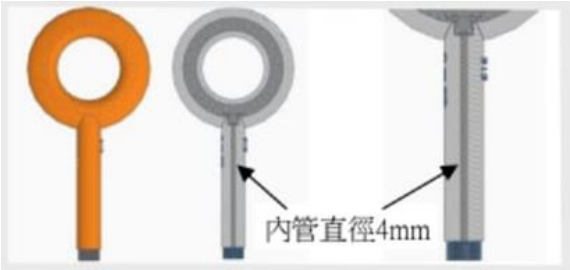
手柄內管直徑越窄，流量越少。

花灑E較花灑A節水，由於花灑E的手柄由12mm收窄至4mm，根據「伯努利」定律，壓力大，流速慢，令到出水量亦減少。

水壓越大，水流速度越慢。

花灑E手柄內管收窄，減少入水的空間，但出水孔的水流速度慢。因花灑E水壓大 ，用戶甲測試花灑E時，出現輕微滲漏情況。

此外，我們設計了手柄內管直徑4mm的花灑，根據「伯努利」定律，內管直徑太小，壓力太大，流速太慢。另外，因3D打印的花灑密度不足，花灑有滲漏，不能做測試。



雖然花灑E能有效節水，但出水孔的水流速度慢，並有輕微滲漏情況，測試的效果不是最理想的，我們還需要改良設計。

測試(四)

實驗目的: 在手柄內管入口加節流器，以減少流量。

獨立變數: 在手柄內管入口加不同大小的節流器

控制變數: 出水孔的大小和數量

花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 節流器內管直徑: 4mm 	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 節流器內管直徑: 3mm 	花灑 A 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 節流器內管直徑: 2mm 
用戶	流量(公升/分鐘)	流量(公升/分鐘) （比較花灑A流量減少）	流量(公升/分鐘) （比較花灑A流量減少）	流量(公升/分鐘) （比較花灑A流量減少）
甲	10.8	9.4(13%)	8.1(25%)	6.3(41.7%)
乙	15.3	12.6(17.6%)	9.4(38.6%)	5.7(62.7%)
丙	11.9	11.2(5.9%)	9.6(19.3%)	6.2(47.9%)

分析：

加節流器能有效減少流量。

在花灑 A 手柄內管加節流器，節流器內管直徑越小，越能有效減少流量。

使用內管直徑 2mm 的節流器，有輕微滲漏情況。

雖然節流器內管直徑越小，越能有效減少流量，但使用內管直徑 2mm 的節流器，有輕微滲漏情況。因此，我們沒有測試內管直徑 1mm 的節流器。

而在設計加氣裝置時，我們在手柄收窄的部分，以 3mm 的節流器為基礎。

測試(五)

實驗目的: 手柄加設加氣裝置設計，增加水流速度，分散水點，減少流量

獨立變數: 手柄內管加設加氣裝置設計

控制變數: 出水孔的大小和數量

花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 F 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 加氣裝置設計
		
用戶	流量(公升/分鐘)	流量(公升/分鐘)
甲	10.8	7.8
乙	15.3	11.5
丙	11.9	6.2

花灑資料	花灑 G 出水孔直徑: 1mm 出水孔數量: 72 手柄內管直徑: 12mm 加氣裝置設計 手柄內管直徑收窄為 2.5mm 
用戶	流量(公升/分鐘)
乙	6.4

分析：

加氣裝置能增加水流速度，分散水點。

花灑 F 應用了「文氏管原理」設計加氣裝置，水流經過裝置，水管由大變細，增加水流速度，形成旋渦；「加氣孔」讓空氣進入，與水混合，出水時有氣泡，分散水點。

加氣裝置設計有節流器，能減少流量。

加氣裝置的設計中，有收窄手柄內管的部分，收窄部分直徑為 3mm，能減少流量，但花灑 F 不及花灑 A 配 2mm 的節流器節水。

收窄加氣裝置內管直徑，能減少流量。

因為用戶乙的流量(11.5 公升/分鐘)未能達到一級用水效益級別，為了減少流量，我們把加氣裝置內管直徑收窄為 2.5mm，減少入水量。

用戶乙使用花灑 G 能有效減少流量。

(十一) 結論

綜合各項測試結果，我們得出以下結論：

1. 出水孔總面積相同，減少每個出水孔的面積，流量減少。
2. 減少出水孔數量，流量減少；增加出水孔數量，出水的覆蓋面較大。
3. 收窄手柄內管，能減少流量。
4. 手柄入水位置加上節流器，節流器的孔越小，流量越少。
5. 加氣裝置的設計是在手柄上加上氣孔同時收窄內管，水流力量把空氣吸進花灑，能減少流量及增加水流速度。空氣與水融合，形成氣泡式水流，分散水點，出水的覆蓋面較大。

最節水的花灑設計：

用戶	花灑設計	流量(公升/分鐘)
甲	花灑 A 配合節流器內管直徑: 2mm	6.3
乙	花灑 E	4.9
丙	花灑 E	5.3

(十二) 應用

我們設計的花灑是接駁到家居的自來水水喉進行測試，目的是希望測試結果更真實，設計能適用於普遍的家庭。如果想**最節水**可用花灑 A 配合 2mm 的節流器或花灑 E。如果想**增加水流速度及分散水點**，可用花灑 F 或花灑 G。此外，我們應盡量縮短沐浴時間，達到節水目標。

(十三) 反思

我們設計節水花灑，減少使用淡水資源。我們分析了此解難方案的優點和限制：

優點：

1. 達到節水目標，珍惜地球淡水資源。
2. 可以運用 3D 打印技術，按照家中的水壓等情況，度身訂造適合的花灑。
3. 一個花灑的打印成本約$22，市面上最平的約$39 ，報告中測試「一級用水效益標籤」的花灑是$79.9。

限制：

1. 不同住宅的水壓不同，難有統一的流量。
2. 測試時，因樓上或樓下用水，令家中的水壓不穩，收集數據不穩定。
3. 運用 3D 打印技術打印花灑，孔的直徑不能少於 1mm，密度不足，而且打印需時。

改善：

1. 在實驗室設定出水的水壓，能確保水壓不變；同時，不用找不同用戶進行多次測試，以節省測試時間。
2. 利用其他方法設計和製作花灑，解決 3D 打印的限制，增加設計的靈活性，從而設計出一個更節水的花灑。

建議：

1. 在花灑上設計一個裝置提醒我們縮短沐浴時間。
2. 加添花灑的功效，例如：在手柄內管空間內加維他命、活性碳等。

感想：

製作這份報告並不容易，要有科學精神才能有成果。原來一個小小的花灑蘊藏著讓人意想不到的物理學原理，它豐富了我們的科學知識，得益不淺，真是一個「小寶箱」。環保與我們生活細節息息相關，大家必須坐言起行。

(十四) 附件

觀看測試影片，

請掃描二維碼或按此

一級用水效益標籤花灑測試結果數據

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

花灑資料			出水孔直徑: 1mm 出水孔數量: 60孔 手柄: 節流器裝置 
用戶「甲」測試	10秒水容積(mL)	第一次	1270
		第二次	~~1260~~
		第三次	1260
		第四次	1340
		第五次	~~1410~~
		第六次	1390
		第七次	1360
		第八次	1400
		第九次	1400
		第十次	1280
		第十一次	1390
		第十二次	1380
	10秒平均水容積(mL)		1347
	流量 (公升/分鐘)		**8.1**
用戶「乙」測試	10秒水容積(mL)	第一次	1610
		第二次	~~1030~~
		第三次	1390
		第四次	1500
		第五次	1270
		第六次	1600
		第七次	1410
		第八次	~~1640~~
		第九次	1500
		第十次	1430
		第十一次	1380
		第十二次	1490
	10秒平均水容積(mL)		1458
	流量 (公升/分鐘)		**8.7**
用戶「丙」測試	10秒水容積(mL)	第一次	1650
		第二次	~~1550~~
		第三次	1550
		第四次	1600
		第五次	1630
		第六次	1550
		第七次	1550
		第八次	1580
		第九次	1580
		第十次	1550
		第十一次	1650
		第十二次	~~1680~~
	10秒平均水容積(mL)		1589
	流量 (公升/分鐘)		**9.5**

測試一結果數據

獨立變數	出水孔的大小及數量
控制變數	出水孔的總面積不變 ($18\pi mm^2$)

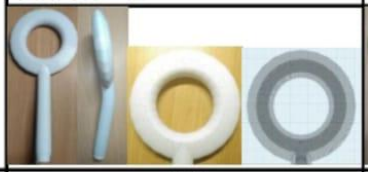
註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

		花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 B 出水孔直徑: 1.5mm 出水孔數量: 32孔 手柄內管直徑: 12mm	花灑 C 出水孔直徑: 3mm 出水孔數量: 8孔 手柄內管直徑: 12mm
					
用戶「甲」測試	10秒水容積(mL)	第一次	1770	1750	2300
		第二次	~~1730~~	~~1740~~	2400
		第三次	1750	1780	~~2200~~
		第四次	1830	1770	2250
		第五次	1790	1750	2300
		第六次	1820	1760	~~2400~~
		第七次	1810	1780	2350
		第八次	1840	1770	2260
		第九次	1800	1780	2310
		第十次	~~1840~~	1790	2350
		第十一次	1830	~~1800~~	2360
		第十二次	1820	1790	2370
	10秒平均水容積(mL)		1806	1772	2325
	流量 (公升/分鐘)		**10.8**	**10.6**	**14**
用戶「乙」測試	10秒水容積(mL)	第一次	~~1990~~	2530	2700
		第二次	2690	2500	2640
		第三次	2365	~~2400~~	2580
		第四次	2640	2460	2700
		第五次	2390	2450	~~2340~~
		第六次	2460	2500	2660
		第七次	2600	2560	~~2900~~
		第八次	2600	2440	2850
		第九次	2690	~~2700~~	2750
		第十次	2530	2530	2850
		第十一次	2610	2490	2800
		第十二次	~~2840~~	2470	2750
	10秒平均水容積(mL)		2558	2493	2728
	流量 (公升/分鐘)		**15.3**	**15**	**16.4**
用戶「丙」測試	10秒水容積(mL)	第一次	~~1950~~	~~1300~~	1550
		第二次	1960	1350	~~1480~~
		第三次	2010	1360	1570
		第四次	1980	1360	1570
		第五次	1990	1350	1580
		第六次	1980	1300	~~1590~~
		第七次	1950	1300	1570
		第八次	1960	1350	1550
		第九次	1970	~~1380~~	1550
		第十次	2010	1300	1490
		第十一次	2000	1350	1550
		第十二次	~~2010~~	1360	1490
	10秒平均水容積(mL)		1981	1338	1547
	流量 (公升/分鐘)		**11.9**	**8**	**9.3**

測試二結果數據

獨立變數	出水孔的數量 (2:1), 出水孔的總面積 (2:1)
控制變數	出水孔的大小

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

			花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 D 出水孔直徑: 1mm 出水孔數量: 36孔 手柄內管直徑: 12mm
		花灑資料		
用戶「甲」測試	10秒水容積 (mL)	第一次	1770	1650
		第二次	~~1730~~	~~1630~~
		第三次	1750	1675
		第四次	1830	1630
		第五次	1790	1650
		第六次	1820	1660
		第七次	1810	1660
		第八次	1840	1670
		第九次	1800	1670
		第十次	~~1840~~	1650
		第十一次	1830	~~1600~~
		第十二次	1820	1670
	10秒平均水容積(mL)		1806	1659
	流量 (公升/分鐘)		**10.8**	**10**
用戶「乙」測試	10秒水容積 (mL)	第一次	~~1090~~	~~2070~~
		第二次	2690	2450
		第三次	2365	2450
		第四次	2640	2450
		第五次	2390	2450
		第六次	2460	2450
		第七次	2600	2360
		第八次	2600	~~2270~~
		第九次	2690	2500
		第十次	2530	2430
		第十一次	2610	2450
		第十二次	~~2840~~	2440
	10秒平均水容積(mL)		2558	2443
	流量 (公升/分鐘)		**15.3**	**14.7**
用戶「丙」測試	10秒水容積 (mL)	第一次	~~1950~~	2000
		第二次	1960	2050
		第三次	2010	~~1800~~
		第四次	1980	2000
		第五次	1990	2050
		第六次	1980	1980
		第七次	1950	1890
		第八次	1960	2000
		第九次	1970	~~2010~~
		第十次	2010	1800
		第十一次	2000	1850
		第十二次	~~2010~~	1950
	10秒平均水容積(mL)		1981	1957
	流量 (公升/分鐘)		**11.9**	**11.7**

測試三結果數據

獨立變數	手柄內管的直徑
控制變數	出水孔的大小和數量

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

		花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 E 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 收窄至4mm
				
用戶「甲」測試	10秒水容積(mL)	第一次	1770	1560
		第二次	~~1730~~	1550
		第三次	1750	1570
		第四次	1830	~~1470~~
		第五次	1790	1520
		第六次	1820	1510
		第七次	1810	~~1580~~
		第八次	1840	1490
		第九次	1800	1500
		第十次	~~1840~~	1500
		第十一次	1830	1550
		第十二次	1820	1480
	10秒平均水容積(mL)		1806	1523
	流量 (公升/分鐘)		**10.8**	**9.1**
用戶「乙」測試	10秒水容積(mL)	第一次	~~1090~~	~~750~~
		第二次	2690	850
		第三次	2365	770
		第四次	2640	790
		第五次	2390	790
		第六次	2460	810
		第七次	2600	820
		第八次	2600	780
		第九次	2690	870
		第十次	2530	870
		第十一次	2610	~~880~~
		第十二次	~~2840~~	800
	10秒平均水容積(mL)		2558	815
	流量 (公升/分鐘)		**15.3**	**4.9**
用戶「丙」測試	10秒水容積(mL)	第一次	~~1950~~	900
		第二次	1960	~~950~~
		第三次	2010	940
		第四次	1980	890
		第五次	1990	880
		第六次	1980	900
		第七次	1950	860
		第八次	1960	890
		第九次	1970	870
		第十次	2010	870
		第十一次	2000	~~860~~
		第十二次	~~2010~~	880
	10秒平均水容積(mL)		1981	888
	流量 (公升/分鐘)		**11.9**	**5.3**

測試四結果數據

獨立變數	入水量
控制變數	出水孔的大小及數量

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

		花灑資料	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 節流器: 4mm	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 節流器: 3mm	花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 節流器: 2mm
						
用戶「甲」測試	10秒水容積(mL)	第一次	1770	1540	1340	1070
		第二次	~~1730~~	1525	1360	1070
		第三次	1750	1560	1350	~~1090~~
		第四次	1830	1570	1360	1080
		第五次	1790	1540	1350	1070
		第六次	1820	~~1520~~	1350	1050
		第七次	1810	1570	1370	1060
		第八次	1840	1580	~~1320~~	1030
		第九次	1800	~~1590~~	~~1380~~	1040
		第十次	~~1840~~	1560	1360	~~1020~~
		第十一次	1830	1580	1340	1060
		第十二次	1820	1570	1350	1030
	10秒平均水容積(mL)		1806	1560	1353	1056
	流量 (公升/分鐘)		**10.8**	**9.4**	**8.1**	**6.3**
用戶「乙」測試	10秒水容積(mL)	第一次	~~1090~~	2120	1560	930
		第二次	2690	2070	1560	960
		第三次	2365	2140	1530	~~910~~
		第四次	2640	1970	1550	950
		第五次	2390	~~1900~~	1560	990
		第六次	2460	2090	1540	930
		第七次	2600	2150	1640	910
		第八次	2600	2080	1630	910
		第九次	2690	~~2190~~	~~1630~~	1030
		第十次	2530	2120	1530	920
		第十一次	2610	2140	~~1680~~	960
		第十二次	~~2840~~	2140	1600	~~1150~~
	10秒平均水容積(mL)		2558	2102	1570	949
	流量 (公升/分鐘)		**15.3**	**12.6**	**9.4**	**5.7**
用戶「丙」測試	10秒水容積(mL)	第一次	~~1950~~	~~1150~~	~~1200~~	1050
		第二次	1960	1850	1650	1050
		第三次	2010	1860	1600	~~1000~~
		第四次	1980	1880	1580	1050
		第五次	1990	1890	1550	1000
		第六次	1980	1880	1560	1040
		第七次	1950	1860	1600	1030
		第八次	1960	1860	~~1650~~	~~1050~~
		第九次	1970	~~1900~~	1650	1000
		第十次	2010	1870	1580	1050
		第十一次	2000	1890	1600	1040
		第十二次	~~2010~~	1860	1580	1030
	10秒平均水容積(mL)		1981	1870	1595	1034
	流量 (公升/分鐘)		**11.9**	**11.2**	**9.6**	**6.2**

測試五結果數據

獨立變數	入水量
控制變數	出水孔的大小及數量

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

花灑資料			花灑 A 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm	花灑 F 出水孔直徑: 1mm 出水孔數量: 72孔 手柄內管直徑: 12mm 手柄: 內管「加氣裝置設計」
				
用戶「甲」測試	10秒水容積(mL)	第一次	1770	~~1270~~
		第二次	~~1730~~	1290
		第三次	1750	1300
		第四次	1830	1290
		第五次	1790	1320
		第六次	1820	1310
		第七次	1810	1330
		第八次	1840	1290
		第九次	1800	1320
		第十次	~~1840~~	~~1350~~
		第十一次	1830	1290
		第十二次	1820	1310
	10秒平均水容積(mL)		1806	1305
	流量 (公升/分鐘)		**10.8**	**7.8**
用戶「乙」測試	10秒水容積(mL)	第一次	~~1990~~	1950
		第二次	2690	2030
		第三次	2365	1790
		第四次	2640	1860
		第五次	2390	~~2060~~
		第六次	2460	1810
		第七次	2600	~~1640~~
		第八次	2600	1980
		第九次	2690	1780
		第十次	2530	2050
		第十一次	2610	2020
		第十二次	~~2840~~	1880
	10秒平均水容積(mL)		2558	1915
	流量 (公升/分鐘)		**15.3**	**11.5**
用戶「丙」測試	10秒水容積(mL)	第一次	~~1950~~	1050
		第二次	1960	1050
		第三次	2010	~~950~~
		第四次	1980	1100
		第五次	1990	1050
		第六次	1980	1080
		第七次	1950	1090
		第八次	1960	990
		第九次	1970	980
		第十次	2010	980
		第十一次	2000	950
		第十二次	~~2010~~	~~1090~~
	10秒平均水容積(mL)		1981	1032
	流量 (公升/分鐘)		**11.9**	**6.2**

測試五結果數據（花灑 G）

獨立變數	入水量
控制變數	出水孔的大小及數量

註: 除去最大及最小的測試數據, 取其餘下10次測試結果得出平均水容積(mL)

花灑資料			花灑 G
			 手柄內管「加氣裝置設計」收窄位置為 2.5mm
用戶「乙」測試	10 秒水容積（mL）	第一次	~~1000~~
		第二次	1010
		第三次	1050
		第四次	1050
		第五次	1060
		第六次	1070
		第七次	1070
		第八次	1070
		第九次	1070
		第十次	1080
		第十一次	1090
		第十二次	~~1100~~
	10 秒平均水容積（mL）		1062
	流量（公升／分鐘）		**6.4**

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亞軍

2019/20 — 2020/21
香港科學青苗獎

與衣服有關的科學探究

「環保除臭即棄雨衣物料研究」

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引言

香港夏天多雨，人們不時需要帶雨具出外，但戶外工作人士往往難以一邊拿起雨傘一邊工作。市面上有不少即棄塑膠雨衣，但棄置時會產生較難分解的廢物，並不環保；另一方面，夏天的炎熱潮濕天氣導致人們產生容易流汗，如正值下雨時需穿上不透風的雨衣，汗液便不易蒸發，細菌分解汗液後，會產生難聞的氣味，並把氣味困在雨衣下。有見及此，我們希望研發一種生物可降解同時又能吸除臭味的物料，再利用這種物料去製造即棄雨衣，以解決上述的問題。

原理

我們觀察大自然中的植物，葉片長期暴露於戶外，但並未因下雨而導致霉爛，因為不少葉片上都有表皮蠟質層，可以防止雨水滲入葉肉或令水分被陽光熱力蒸發。因此我們希望可利用這天然的防水物質去製造可被生物降解的防水布料。

選用葉片方面，我們從校園的種植花園中留意到有幾棵菠蘿，從網上資料發現原來菠蘿葉有堅韌的纖維 (Kasim, Selamat, Daud, Yaakob, Putra & Sivakumar; 2016)，因此我們嘗試利用菠蘿葉作為製造天然即棄雨衣的材料。防臭方面，由於已有科學論據證明咖啡渣具有吸臭除味的功效 (City College of New York; 2012)，原因是咖啡因中的氨具吸附引發臭味的硫化物的能力，因此我們打算將咖啡渣粉末混入布料中，令布料有除臭功能。

根據以上的資料，我們決定利用菠蘿葉和咖啡渣製造天然除臭防水布，並測試其防水效能和受力程度。

準備物料

甲、葉片的處理：

1. 利用金屬湯匙將菠蘿葉底層和葉肉內的纖維磨走。
2. 把剩下的葉面表皮蠟質層放在室溫下風乾。

乙、咖啡渣的處理：

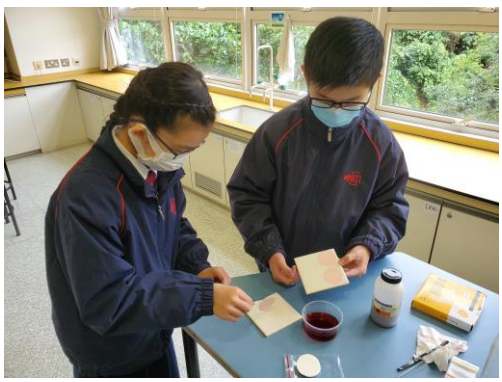
1. 將調製咖啡後剩下的咖啡渣放在通風的桌面上風乾。

丙、菠蘿葉布的製作：

1. 將兩片葉的葉底朝向葉底合併，蠟質表面向外。
2. 利用防水超能膠將兩片葉黏合，並在黏合時預留縫隙。
3. 將咖啡渣粉末倒進縫隙中並封好，防止咖啡渣粉沫漏出。
4. 將葉片連接，形成較大面積的菠蘿葉布。

丁、製作氯化鈷試紙

1. 先將氯化鈷加水製成溶液
2. 把濾紙浸進氯化鈷溶液中，再放在小瓷磚上。
3. 把這些沾了溶液的濾紙放進焗爐中烘乾，製成氯化鈷試紙。

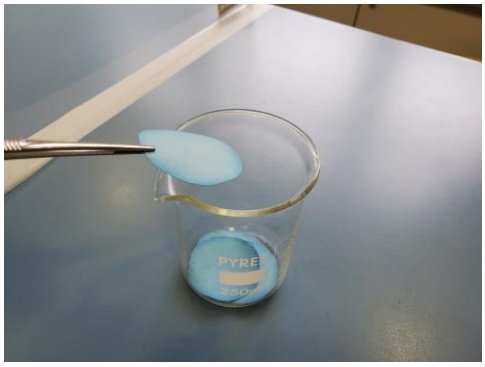


實驗設計和步驟

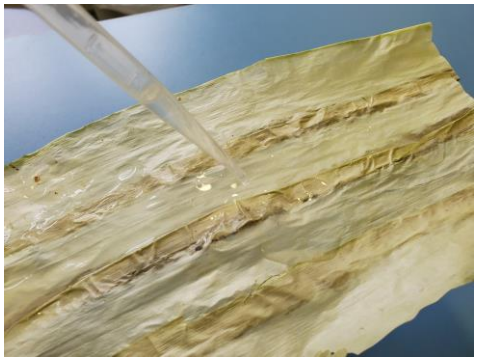
由於即棄雨衣必須具有防水的功能，而且物料亦須能承受強風，因此我們便在這兩方面進行測試。

甲、 防水測試

1. 先把數張氯化鈷試紙放進燒杯底部，而燒杯必須完全乾爽沒有水分。



2. 把菠蘿葉布平放在燒杯上。利用滴管在布面上滴下大量水滴去模擬真實落雨的情況。

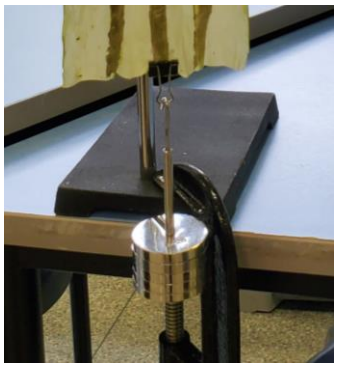


3. 當布面上的水多到溢出時，便可觀察燒杯中的氯化鈷試紙會否因接觸到水而變成粉紅色，以斷定布料是否可防止水分通過。

乙、 拉力測試

1. 用紙夾把菠蘿葉布夾在彈簧秤上，再把彈簧秤掛在鐵架上。

2. 把每塊重 100 克的金屬片逐塊勾在菠蘿葉布的下端。



3. 由於市面上出售的即棄雨衣一般重約 70 克，因此經仔細衡量後，我們決定以 500 克為最大的測試重量，即約 4.9 牛頓的拉力，看看布料是否能承受。
4. 再作出相同的測試，不過這次把菠蘿葉布橫放，測試橫向纖維受力情況如何。

實驗結果及分析

甲、 防水測試

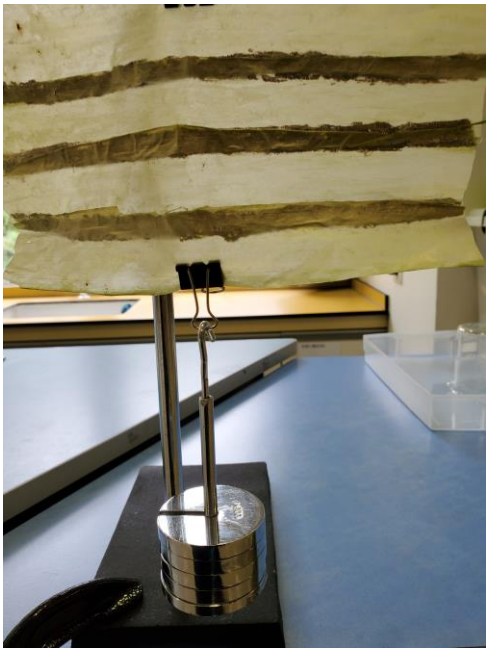
滴在布面上的水	氯化鈷試紙顏色
2 mL	藍色
4 mL	藍色
6 mL	藍色
8 mL	藍色
10 mL	藍色(水從布料邊溢出)

數據顯示，把 0 mL 至 10 mL 的水滴在布面上，燒杯中的氯化鈷試紙仍然是藍色，表示沒有水滲進燒杯中，即測試的布料具有防水的功能。滴了 10 mL 後因水的重量關係令水從布面的旁邊溢出，這並不影響布料防水的能力。

乙、 拉力測試

施加在布料上的拉力 (g)	施加在布料上的拉力 (N)	布料狀況
100 g	0.98 N	沒有破損
200 g	1.96 N	沒有破損
300 g	2.94 N	沒有破損
400 g	3.92 N	沒有破損
500 g	4.90 N	沒有破損

把 500 克的金屬片勾在布料下，不論布料纖維直向或橫向均沒有被扯斷，證明可承受最少 500 克(4.9 牛頓)的拉力。



困難及誤差

在整個探究及實驗過程中，我們遇到了不少困難。因一些設備和技術上的限制，會令實驗結果出現誤差。以下我們將詳細論述我們需要面對的困難和誤差的成因。

1. 菠蘿葉布的製作問題

   我們在整個探究過程中遇到最大的困難就是如何把菠蘿葉製作成菠蘿葉布。首先，我們須要把菠蘿葉底部的纖維去除，只剩下表皮蠟質層。我們用金屬湯匙把葉子纖維刮走時要十分小心，試過多次因力度不當而把蠟質層都刮破了。此外，在把每片葉子用防水超能膠黏貼起來時亦須很小心和仔細,接縫必須完全黏合，以防止裡面的咖啡渣粉末漏出。

2. 拉力測試的角度問題

   在進行拉力測試時，我們只能把菠蘿葉布進行直向和橫向重力測試，以證實布料的堅韌程度足以承受日常使用時的風力。可是，由於風力的方向可以是四方八面的，因此在此部份的限制是我們不能把布料的所有方向都進行拉力測試。但我們相信布料的橫向承受力是其最脆弱的地方,只要這部分能承受多於500克的拉力，理論上布料便可承受一般的風力而不會破損。

3. 咖啡渣的除臭功能問題

   我們在這菠蘿葉布裡加入了咖啡渣粉末，目的是把人體發出的難

聞氣味吸走。可是因缺乏合適的儀器去進行測試，因此只能依靠科學文獻記載咖啡渣的吸臭功能去推論此即棄雨衣也有此功能。

總結

這個探究結果讓我們發現原來菠蘿葉是很有利用價值的。我們能利用它去製造防水布料，加上咖啡渣後更可有除臭的功能。原來只要細心留意身邊的事物，一些看似沒有用途的東西是可創造成新穎及有意義的產品的。我們在這探究過程中得益不少，除學會如何利用環保物料去製造防水布料外，亦學會如何設計實驗和準備實驗用的物品如氯化鈷試紙等。希望我們將來真的能使用這布料製造出真正的即棄雨衣，為環保出一分力。

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季軍

2019/20 — 2020/21
香港科學青苗獎

東華三院鄧肇堅小學

沙灘清潔車

學生姓名：葉嘉雋、繆一朗、王博彥

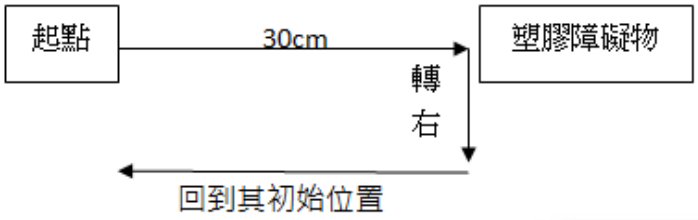
指導老師：賴俊彥、李麗冰

探究問題

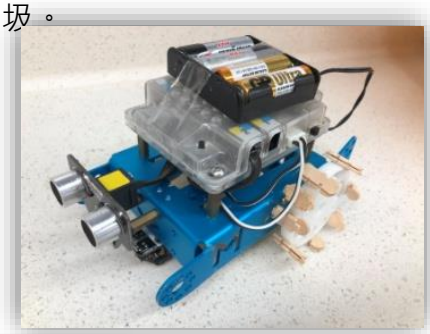
設計及製作一個可探測及收集海洋垃圾的裝置（沙灘清潔車）

探究意念

根據環保署數字，香港每年平均收集到 15,000 公噸的海洋垃圾，且數字有逐年上升的趨勢。而世界自然基金會（WTF）發現 40%放置在坑渠的儀器中，有一半陸上垃圾循坑渠流進大海，一旦街道的垃圾跌進坑渠，垃圾亦會經此而落海。除了積極清理海上垃圾，減少源頭也很重要，因此我們設計及製作一個可探測及收集垃圾的裝置 - 沙灘清潔車，以減少海洋垃圾。



沙灘清潔車程式概念圖

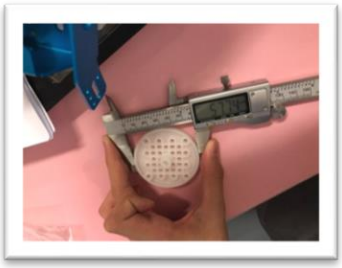


科學原理

沙灘清潔車是由 mbot 車、測距儀及濾沙網組成。沙灘清潔車中的測距儀及超音波感應器兩組元件所組成，測距儀包括超音波發射、接收器，超音波發射器會發出超音波至障礙物。由於波動反射原理，超音波去程和回程長度是一樣。當超音波發射器與障礙物(塑膠垃圾)的距離將會少於預設的超音波來回長度，此時將會觸發感應器，mbot 會停止前進，意識到它發現了垃圾，然後使用前方的濾沙網並向右移動使確保垃圾在濾沙網上。然後回到其初始位置。

製作材料及過程

我們運用 mBot 中的超音波感應器和雪條棍製作裝置，利用 mBot 感應海洋垃圾。



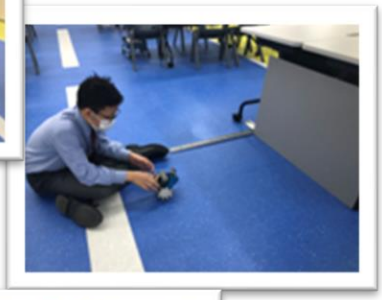
探究方向

1.我們使用 mBot 中 的感應器(距離)和 mBlock 編碼製定感應條件。

2.mBlock 編碼：我們預先設定超音波來回發射器的距離，並記錄為常數。觸發感應器的編碼於以

下情況才會執行： 1.信號燈是紅色時，及 2.超音波測定的距離少於常數。

沙灘清潔車主程式



3.研究裝置的最佳效果

- 測試裝置的感應範圍
- 測試不同表面為感應目標會否影響裝置的感應
- 測試垃圾車在不不同表面的地面上的行走效果
- 測試不同孔大小的濾網為濾沙器會否影響過濾的效果
- 測試不同物料為濾沙器會否影響過濾的效果

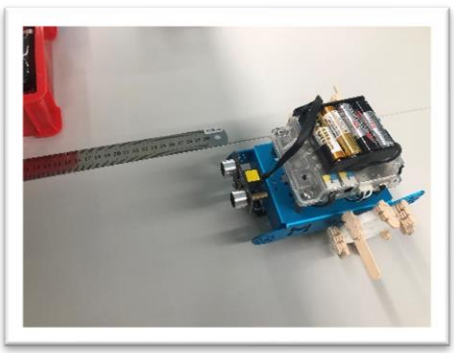
測試步驟及結果

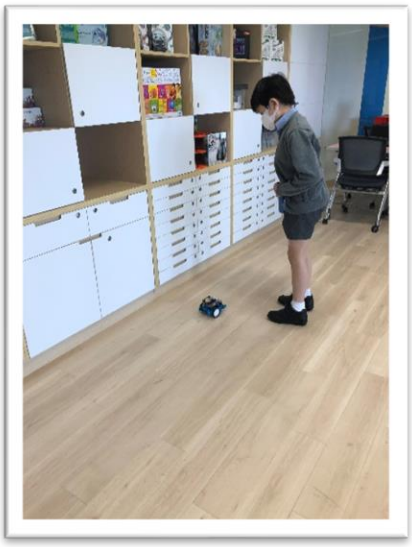
- 測試裝置的感應範圍及效果

mbot 預設 30 厘米感應距離，由 1 米開始，測試 mblock 是否行到感應障礙物便停下來及轉右。然後我們使用不同表面的障礙物測試 mbot 是否能有同樣效果。

不同表面的障礙物	mbot 行走的狀態		
	能否由 1 米距離開始向前行走	能否在遇到 30 厘米障礙物停下來	能否在停下來後轉右
堅硬的平面	可以	可以	可以
向前傾斜的平面	可以	可以	可以
人體	可以	可以	可以
凹凸面	可以	可以	可以

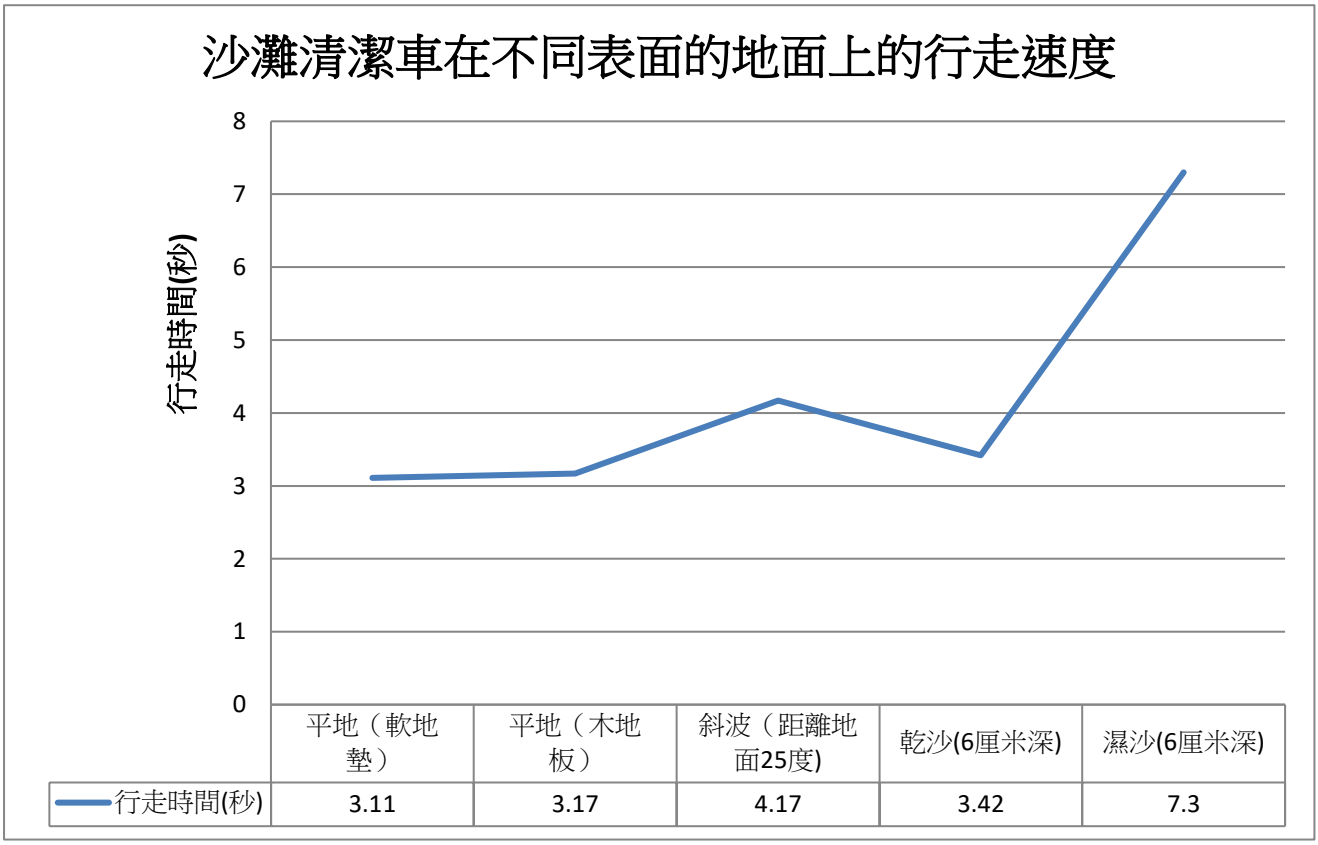
結果：障礙物的表面不會影響超音波的探測距離。





- 測試沙灘清潔車在不同表面的地面上的行走效果

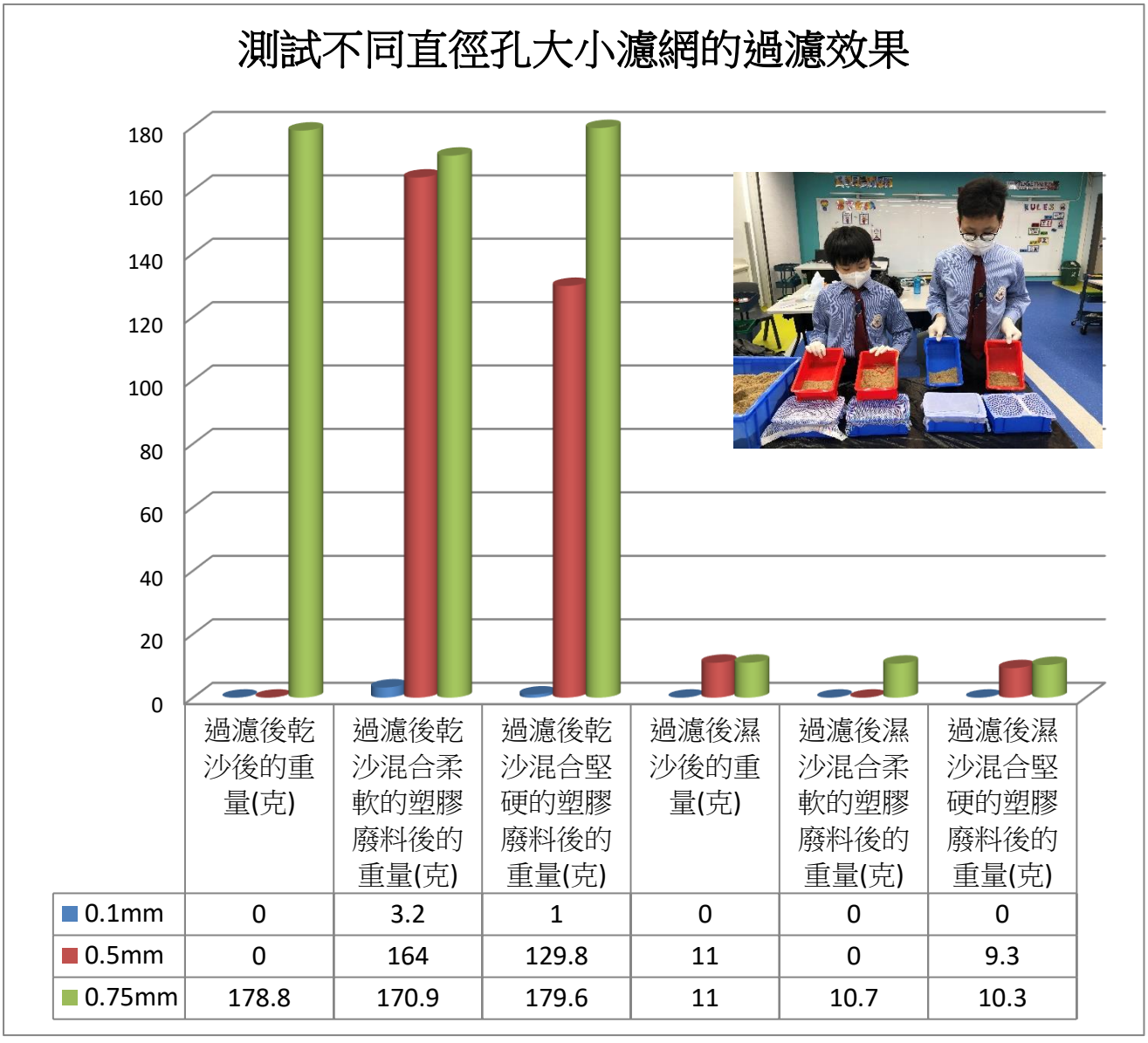
設定行走距離 50 厘米。由於在沙灘中工作，我們加上車輪外徑上的雪條木片，以防止沙進入車輪的空隙阻礙清潔車前進。由於車身的重量也會使車容易陷於沙中，我們也加長了其中一節的雪條木片，以助翻動前方的沙和托起車身，經過改裝後也讓車在沙中行得更暢順。



結果：沙灘車清潔在不同地面前行都順暢，沒有停止行駛。但在平地的行駛速度最快，當地面傾斜或有沙，車輪遇到的阻力增加，因此速度會減慢。

- 測試不同直徑孔大小的濾網為濾沙器會否影響過濾的效果

進行三次過濾乾沙(200 克)/濕沙(200 克乾沙+50 克水)的測試：第一次測試將 200 克的乾沙/濕沙，經過相同物料但相同面積及不同直徑的孔的濾網，放置三分鐘，計算過濾後乾沙/濕沙後的重量，過濾後乾沙/濕沙後的重量越重，過濾效果越好。第二次測試將柔軟的塑膠廢料（2 平方厘米膠片膠紙）和乾沙/濕沙混合，第三次測試將堅硬的塑膠廢料（2 平方厘米膠片膠片）和乾沙/濕沙混合，重覆以上同樣步驟過濾。



	過濾後乾沙後的重量(克)	過濾後乾沙混合柔軟的塑膠廢料後的重量(克)	過濾後乾沙混合堅硬的塑膠廢料後的重量(克)	過濾後濕沙後的重量(克)	過濾後濕沙混合柔軟的塑膠廢料後的重量(克)	過濾後濕沙混合堅硬的塑膠廢料後的重量(克)
0.1mm	0	3.2	1	0	0	0
0.5mm	0	164	129.8	11	0	9.3
0.75mm	178.8	170.9	179.6	11	10.7	10.3

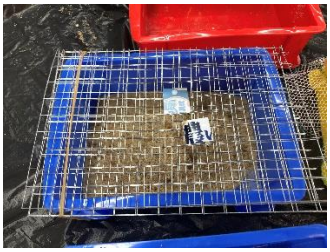
結論 ： 無論在乾沙或濕沙的情況下，濾網孔的直徑越大，過濾沙的重量越多。

- 測試不同物料為濾沙器會否影響過濾的效果

進行三次過濾乾沙(200 克)/濕沙(200 克乾沙+50 克水)的測試：第一次測試將乾沙/濕沙，經過不同物料但相同面積及相同疏度的孔的濾網，放置三分鐘，計算過濾後乾沙/濕沙後的重量，過濾後乾沙/濕沙後的重量越重，過濾效果越好。第二次測試將柔軟的塑膠廢料（2 平方厘米膠紙）和乾沙/濕沙混合，第三次測試將堅硬的塑膠廢料（2 平方厘米膠片）和乾沙/濕沙混合，重覆以上同樣步驟過濾。

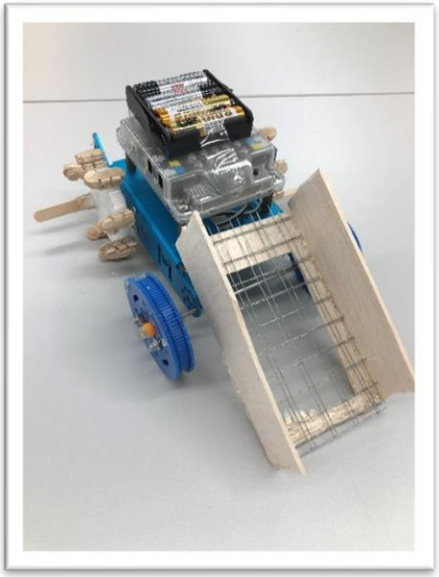
過濾後乾沙後的重量(克)						
不同物料	乾沙	乾沙混合柔軟的塑膠廢料	乾沙混合堅硬的塑膠廢料	濕沙	濕沙混合柔軟的塑膠廢料	濕沙混合堅硬的塑膠廢料
尼龍網(疏孔)	137.7	164	129.8	11	11.6	11.2
金屬(疏孔)	199	199.6	199.1	95	94.7	93.4
棉布(疏孔)	11.9	23.5	21.5	6	5.7	5.9
不織布(疏孔)	28.8	170.9	179.6	11	10.2	9.3

結果：物料的柔軟度越高，能過濾的沙越少。金屬物料的濾沙器能過濾最多的沙，因此濾沙效果最好。




反思和應用

我們設計了這款「沙灘清潔車」，無論行駛在沙地、平地或斜波都能順利行走，透過結合感應距離和過濾網去達到過濾垃圾的效果，而過濾塑膠的性能也在行駛中進行，因此我們認為可以應用在不同的沙灘中，協助清潔沙灘，減少海岸垃圾。



不過實際應用中也要將車的大小按實際沙灘的面積範圍而調整。而製作車的物料也要考慮更多環境的因素，因此我們建議可增加更多模擬不同環境（防水、防震等）的實驗。另外我們也想在處理垃圾方案更多元化，不只限制於塑膠垃圾，所以我們也可以在實驗中增加不同過濾物的實驗。我們希望未來也繼續改善這款車，令它更耐用和容易操作。

參考資料

https://plasticschange.hk/cowfinalreport_chi/

世界自然基金會香港分會，「育養海岸」發布最新本港生態及海洋垃圾調查報告—塑膠垃圾佔逾六至八成嚴重威脅海洋生態，促政府立法引入更多「生產者責任計劃」

https://www.wwf.org.hk/whatwedo/oceans/tackling_marine_litter/

世界自然基金會香港分會，解決海洋垃圾問題

https://www.hk01.com/%E5%91%A8%E5%A0%B1/255019/%E6%B5%B7%E6%B4%8B%E5%9E%83%E5%9C%BE-%E6%B8%9B%E5%BB%A2%E6%94%BF%E7%AD%96%E6%AC%A0%E5%A6%A5%E7%95%B6-%E6%B7%A8%E7%81%98%E6%B7%A8%E6%B5%B7%E7%84%A1%E6%AD%A2%E4%BC%91

01 周報 ，【海洋垃圾】減廢政策欠妥當　淨灘淨海無止休

https://www.hk01.com/%E5%91%A8%E5%A0%B1/255222/%E6%B5%B7%E6%B4%8B%E5%9E%83%E5%9C%BE-%E7%94%B1%E6%B8%85%E7%90%86%E5%88%B0%E6%B8%9B%E5%BB%A2-%E9%A6%99%E6%B8%AF%E7%9A%84%E5%BB%A2%E7%89%A9%E6%94%BF%E7%AD%96%E6%88%90%E5%8A%9F%E5%97%8E

01 周報 ，【海洋垃圾】由清理到減廢　香港的廢物政策成功嗎？

殿軍

優才(楊殷有娣)書院 - 小學部

2019/20 — 2020/21
香港科學青苗獎

現實難題主題:香港的海洋污染

研究題目: 探究辣木籽能否有效淨化海水中污染物，以協助本港處理受污染的海水

指導老師: 鄧兆華老師

參賽學生: 趙朗天、陳樂芝、李煦月、林卓毅、林嘉晴

目錄

背景資料/產生原理

水資源污染是一直是香港社會備受關注的議題，針對海水中的不同類型的污染物質，我們想利用生物可降解的天然物質去進行海水過濾淨化，以減少現時利用化學處理污水過程中有可能帶來的副作用或補足其不足之處。同學恰巧在家中發現洗髮水中的辣木籽萃取成份聲稱有吸附有機污染物及殺菌之功能，所以我們便想利用辣木籽去進行過濾海水不同污染物的實驗，希望得出有用的結果以改善海水污染的問題。

科學原理

經網上搜尋資料後，一些關於辣木籽的研究指出這種物質中含有許多低分子水溶性蛋白質，部分為帶有正電荷的聚電解質，會在溶液裡呈正電荷。同時，我們發現一些微粒，如泥沙、黏土、微塑膠粒和細菌等都帶負電荷。以細菌為例。許多細菌表面都會帶有負電荷，例如污水中常見的大腸桿菌。因為細菌最外層的細胞壁有磷壁酸, 而外層的磷基在溶液中呈負電性。

另外，現時香港污水處理廠主要會利用化學強化一級處理受污染的海水，而最常用到的化學物質就是明礬和三氯化鐵，它們可以吸附水裡懸浮的極性雜質，並形成沉澱，使水澄清。但是明礬本身有含有微毒，被人體進食後，基本是不能再被排出體外的，影響神經系統。而三氯化鐵可損害眼睛及皮膚，導致敏感及灼傷。

探究問題

我們想研究辣木籽作為天然及可生物降解的物質, 能否有效過濾海水中的污染物及雜質, 以優化本港污水處理的過程。我們將會探究辣木籽能否有效改善水樣的:

A. pH 值
B. 重金屬含量
C. 鈣、鎂離子含量 (硬水值)
D. 混濁度
E. 總溶解固體
F. 細菌量

實驗設計

我們將製作 3 份加入不同辣木籽份量的水樣本作實驗組,分別是設置 A， B 和 C。另外亦製作一份不加入辣木籽的原水樣本作對照組。

	A	B	C	對照組
水份量	150mL	150mL	150mL	150mL
辣木籽量	1g	3g	5g	0g
過濾處理	有	有	有	有

實驗組和對照組之製作過程:

1. 為增加數據之可信度，學生去到香港不同的水域取得水樣本，裝於收集瓶中，地點包括: 東域的泥涌及城門河與沙田海交界; 中域的清水灣 2 號泳灘及鯉魚門燈塔對出海域

2. 用研缽和研杵把辣木籽壓碎， 並磨成粉狀。
3. 用不同的量度儀器把各材料的份量量度:
   利用量筒量度 150mL 水樣本
   利用電子磅分別量度 1g、3g 及 5g 辣木籽
4. 利用玻璃棒把各材料按實驗設計把它們混合於燒杯中。
5. 混合好的實驗組(A、B 及 C) 和對照組以保鮮紙包好杯口，靜候一晚讓其沉澱。
6. 以濾紙過濾實驗組(A、B 及 C) 和對照組的水樣本中的固體沉澱物，分別以燒杯/膠杯收集。
7. 過濾後的實驗組和對照組將會用來進行不同的水質測試。

實驗所需材料及用具

- 香港各海域之水樣本
- 辣木籽
- 量筒
- 收集瓶
- 電子磅
- 玻璃棒
- 研缽和研杵
- 燒杯
- 膠杯
- 保鮮紙
- 濾紙
- 漏斗
- pH 試紙
- 總溶解固體檢測儀
- 重金屬試劑
- 鈣、鎂離子測試劑
- 濁度儀
- 培養箱
- 營養瓊脂及瓊脂平板
- 試管
- 微量移液器

實驗方法

詳列於實驗結果中。

實驗結果

是次結果將採用城門河與沙田海交界之數據，變數表及其他海域之數據則設於附件中。

(A) 水樣本 pH 值之探究

探究問題: 加入辣木籽後會對水樣的酸鹼度帶來甚麼變化?

實驗方法: pH 試紙

結果

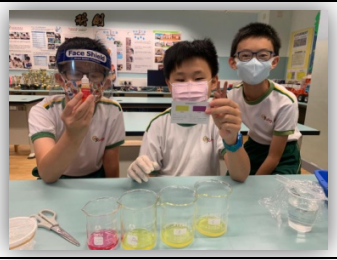
取水地點	對照組的 pH 值	實驗組的 pH 值			實驗過程 (圖片)
		A	B	C	
城門河與沙田海交界	9	6	6	5	

(B) 水樣本重金屬份量之探究

探究問題: 加入辣木籽後會對水樣的重金屬的份量帶來甚麼變化?

實驗方法: 重金屬指示劑 (紫紅色為含有、橙色為含有微量、黃色為不含)

結果

取水地點	對照組的重金屬份量	實驗組的重金屬份量			實驗結果 (圖片)
		A	B	C	
城門河與沙田海交界	含有	不含	不含	不含	

(C) 水樣本鈣、鎂離子份量之探究

探究問題: 加入辣木籽後會對水樣的鈣、鎂離子份量帶來甚麼變化?

實驗方法: 鈣、鎂離子指示劑 (紅紫色為大量、紫色為少量、藍紫色為不含)

結果

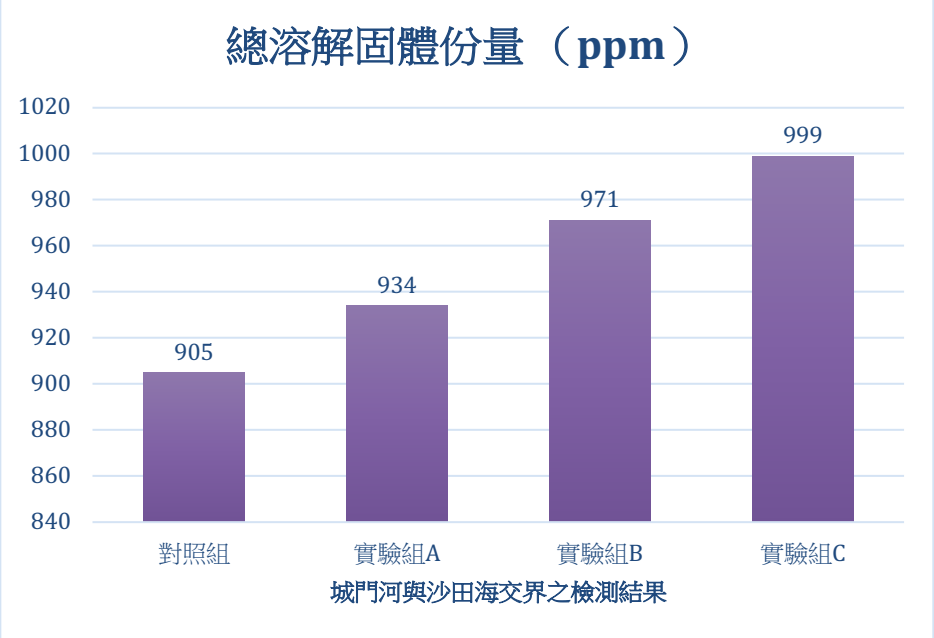
取水地點	對照組的鈣、鎂離子份量	實驗組的鈣、鎂離子份量			實驗結果 (圖片)
		A	B	C	
城門河與沙田海交界	大量	少量	不含	不含	

(D) 水樣本總溶解固體份量之探究

探究問題: 加入辣木籽後會對水樣的總溶解固體的份量帶來甚麼變化?

實驗方法: 總溶解固體檢測儀

結果

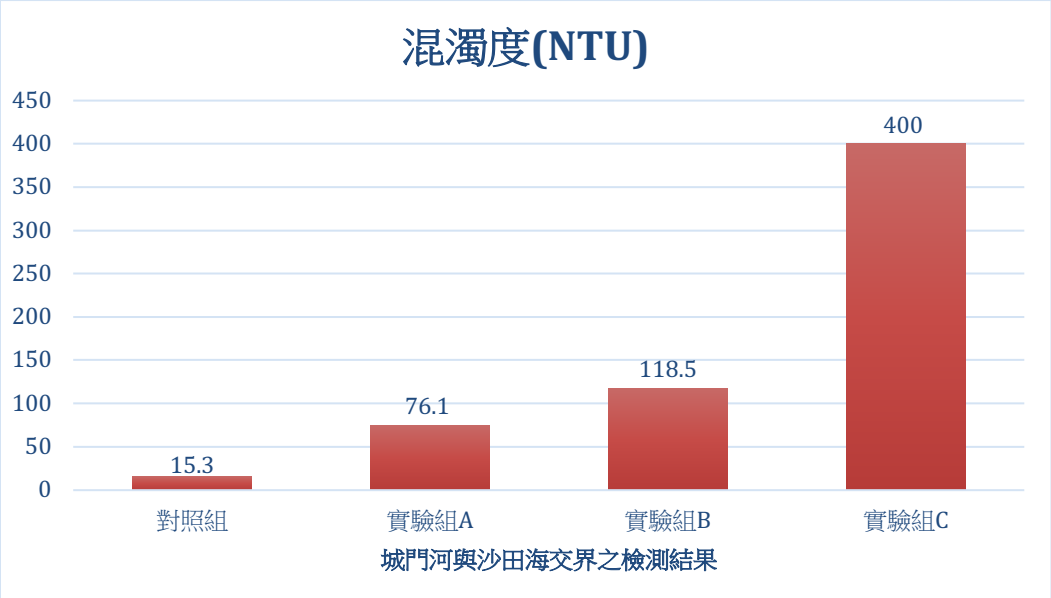


(E) 水樣本混濁度之探究

探究問題: 加入辣木籽後會對水樣的混濁度帶來甚麼變化?

實驗方法: 濁度儀

結果



(F) 水樣本細菌量之探究

探究問題: 加入辣木籽後會對水樣的細菌量帶來甚麼變化?

實驗方法: 於實驗室中，連續稀釋各地點之水樣本(對照及 3 個實驗組)至 10^{-4}，從各組抽取 50 μL 分別加入標明稀釋倍數的養瓊脂平板; 密封好的平板倒置並於 37 攝氏度的培養箱過夜，隔日觀察並計算菌落。

結果

取水地點	對照組的菌落數(CFU)	實驗組的菌落數 (CFU)			實驗過程 (圖片)
		A	B	C	
城門河與沙田海交界	154	102	87	76	

討論

綜合以上多項測試，結果顯示辣木籽能降低水樣的 pH 值，適當的比例能調整海水酸鹼度至中性(pH=7)。我們發現辣木籽能有效去除水體中含有的重金屬、鈣及鎂離子，結果表示其過濾重金屬效能甚高，亦能改善硬水水質至軟水水質。而另外，辣木籽亦有效移除水樣中的細菌，我們推測辣木籽中的蛋白質吸附走了細菌，並在過濾後移除了。

可是，研究亦發現加入辣木籽後反而增加了水樣的混濁度及總溶解固體量，對於改善以上兩項水質指標並無幫助。在實驗過程中我們亦觀察到擺放過久(>2 日)的實驗組會有發臭的問題，推測這是被吸附的細菌在利用營養豐富的蛋白質滋生，因此我們發現辣木籽與水樣的比例和保存時間都有舉足輕重的影響。

限制

是次探究飽受新冠肺炎影響，我們初時無法在兩日內完成所有測試，有樣本發出難聞的氣味、混濁度亦有異常、細菌亦過量滋生等，這令到初期的結果出現有大的誤差，經改善後，測試得以如期公平進行。

另外，學校缺乏標準的無菌實驗室及器材，因此種菌樣本有可能出現誤差。學校亦缺乏專業的測試水質器材，如光譜儀，有欠準確性。

總結

經過一連串的測試，我們總結出用辣木籽對淨化水體的利弊之處:

優點	缺點
1. 有效去除重金屬、鈣、鎂離子	1. 溶於水體後會增加混濁度及總溶解固體量
2. 有效調低水體的 pH 值，避免水質過鹼	2. 過濾後的水體靜待時間過長或會引致怪味的產生
3. 少量的成份已能達到很高的除菌能力	3. 溶於水後或會影響水體的味道
4. 全天然及可生物降解， 不會長時間殘留於水體中	4. 辣木籽蛋白質豐富，若大量流出自然水體有可能引起紅潮
5. 可食用，不會影響人體系統	5. 打磨成粉末之處理或增加成本
6. 價格低廉，約 500g/ $30HKD	6. 經過濾後沉積的辣木籽粉末會增加本港堆填/燃燒處理的負擔

應用(建議)

透過各種水質測試後，我們發現辣木籽有著作為淨化水質的特點，既無毒亦能有效吸走不同的雜質，可謂價廉物美。我們建議在本港污水處理的過程中，例如化學強化一級處理前，可以加入辣木籽作為天然過濾物質去吸附重金屬和細菌等; 又或是在二級處理後用辣木籽粉吸走大量添加的微生物，這能減少化學物品的使用，希望我們能善用多些天然物質去補足現時污水處理的過程，為市民及海洋生物帶來潔淨的海水。

參考資料

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附件

由於報告字數及圖片所限，於本港其它三個水域之水樣本對以下測試的結果及每種測試之變數表亦未能盡錄，因此以附件形式呈上。將附列以下各測試之結果:

A. pH 值
B. 重金屬含量
C. 鈣、鎂離子含量 (硬水)
D. 混濁度
E. 總溶解固體
F. 細菌量

(A) 水樣本 pH 值之探究

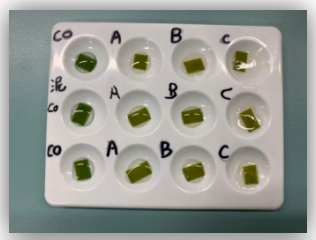
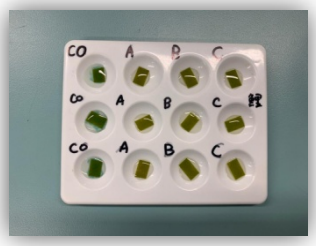
探究問題: 加入辣木籽後會對水樣的酸鹼度帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數
因變數	pH 值 （pH 試紙之顏色）

實驗方法: pH 試紙

結果

取水地點	對照組的 pH 值	實驗組的 pH 值			實驗結果 (圖片)
		A	B	C	
泥涌	9	7	7	6	
清水灣 2 號泳灘	8	7	7	5	
鯉魚門燈塔對出海域	9	7	7	7	

(B) 水樣本重金屬份量之探究

探究問題: 加入辣木籽後會對水樣的重金屬的份量帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數、重金屬指示劑的份量
因變數	重金屬的指示劑之顏色

實驗方法: 重金屬指示劑 (紫紅色為含有、橙色為含有微量、黃色為不含)

結果

取水地點	對照組的重金屬份量	實驗組的重金屬份量			實驗結果 (圖片)
		A	B	C	
泥涌	含有	微量	不含	不含	
清水灣 2 號泳灘	含有	不含	不含	不含	
鯉魚門燈塔對出海域	含有	微量	不含	不含	

(C) 水樣本鈣、鎂離子份量之探究

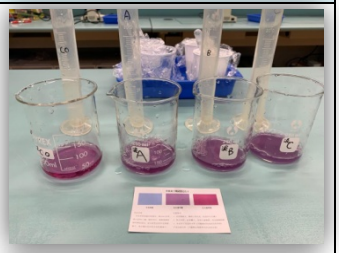
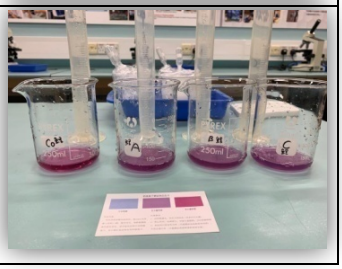
探究問題: 加入辣木籽後會對水樣的鈣、鎂離子份量帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數、鈣、鎂離子指示劑的份量
因變數	鈣、鎂離子指示劑之顏色

實驗方法: 鈣、鎂離子指示劑 (紅紫色為大量、紫色為少量、藍紫色為不含)

結果

取水地點	對照組的鈣、鎂離子份量	實驗組的鈣、鎂離子份量			實驗結果 (圖片)
		A	B	C	
泥涌	大量	少量	少量	少量	
清水灣 2 號泳灘	大量	少量	少量	少量	
鯉魚門燈塔對出海域	大量	少量	少量	少量	

(D) 水樣本總溶解固體份量之探究

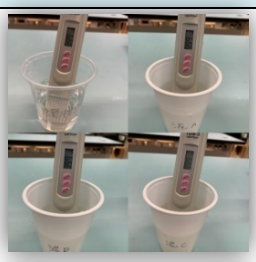
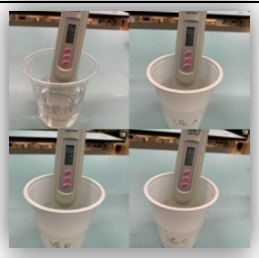
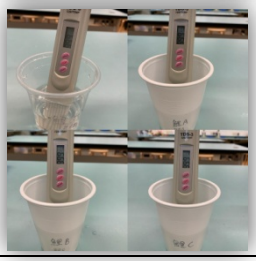
探究問題: 加入辣木籽後會對水樣的總溶解固體的份量帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數
因變數	總溶解固體的讀數 (ppm)

實驗方法: 總溶解固體檢測儀

結果

取水地點	對照組的總溶解固體份量 (ppm)	實驗組的總溶解固體份量(ppm)			實驗結果 (圖片)
		A	B	C	
泥涌	999	999	999	999	
清水灣 2 號泳灘	999	999	999	999	
鯉魚門燈塔對出海域	999	999	999	999	

(E) 水樣本混濁度之探究

探究問題: 加入辣木籽後會對水樣的混濁度帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數
因變數	混濁度之讀數 (NTU)

實驗方法: 濁度儀

結果

取水地點	對照組的混濁度(NTU)	實驗組的混濁度(NTU)			實驗結果(圖片)
		A	B	C	
泥涌	3.3	45.0	57.0	98.3	
清水灣 2 號泳灘	23.8	68.3	127.5	400	
鯉魚門燈塔對出海域	12.4	36.2	45.1	54.0	

(F) 水樣本細菌量之探究

探究問題: 加入辣木籽後會對水樣的細菌量帶來甚麼變化?

變數表

獨立變數	加入不同份量的辣木籽
控制變數	水樣本的份量、過濾處理的次數、水樣本中細菌稀釋倍數、種菌的時間、培養箱的溫度
因變數	於營養瓊脂平板上細菌之菌落數(CFU)

實驗方法: 於實驗室中，連續稀釋各地點之水樣本(對照及 3 個實驗組)至 10^{-4}，從各組抽取 50 μL 分別加入標明稀釋倍數的養瓊脂平板; 密封好的平板倒置並於 37 攝氏度的培養箱過夜，隔日觀察並計算菌落。

結果

取水地點	對照組的菌落數(CFU)	實驗組的菌落數(CFU)		
		A	B	C
泥涌	178	155	142	130
清水灣 2 號泳灘	103	83	73	67
鯉魚門燈塔對出海域	143	123	92	88

科學家專訪獎

科學家專訪報告 – 朱明中教授

基督教宣道會徐澤林紀念小學

朱明中教授，從事物理研究及教學工作多年，今次有機會訪問他的科學家之路，真是一次十分寶貴的經驗，令我們獲益良多。

朱教授的小小背景

朱教授從小便對天文現象十分感興趣。他曾參加學校的天文學會，一有空閒的時間便會去看星。最深刻的是有一次在沙漠看星星，看到了整個銀河和流星，十分壯觀。這樣的經歷除了令他對浩瀚又神秘的宇宙感興趣，亦令他踏上成為科學家的路，想一探這個宇宙的奧秘。

朱教授的研究的苦與樂

朱教授花了很長時間研究中微子。他認為雖然中微子在基本粒子中最神祕、很難於研究，但這種神祕的粒子卻是數量最多的一種。在宇宙中，中微子的數量遠遠多於電子，十分重要。

朱教授在做研究時並沒有想過成功,但亦沒有因為困難而放棄。除了因為興趣，他亦想藉着自己的研究幫助別人。他用了 9 年時間來做研究，終於看見研究的成果，他感到十分滿足。

朱教授的科學家經歷

朱教授在談到他在成為科學家後的經歷時，首先是對他的研究團隊表示十分感激。朱教授告訴我們，做科學研究不可能獨力完成，在他科研的路上一直有不同的人幫助才能夠成功。

正因為需要不同人的幫助，朱教授令我們明白到做科學家除了要學識淵博外，如果有能令別人樂於幫助你和信任你的性格或處事方法，面對的困難也許會較少。他說自己的性格內向，較婉轉,未必能直接說出己見,這有時會成為與人合作時的阻礙;反之，若我們願意開放自己，勇於面對和表達自己的想法，學習與人相處並樂於接受不同國家和文化的時候，在與人合作的路上便會更順利。這樣不但能令團隊合一，別人亦會更願意幫助和扶持，遇到困難的時候便能更容易跨過了。

我們的小小反思

我們以為科學家只要腦筋轉得靈活，懂得思考，但從來沒有想到與人合對科學家進行研究來說十分重要。想到其實我在學校亦正經驗着這些事情：在我們的學校做實驗的時候，很多時都要分組進行，而不合作帶來的除了是實驗無法進行，更會與人發生爭執。很感謝朱教援提醒了我們這一點。

從朱教授的身上我們亦學會不要因為看不到結果或遇上挫敗就放棄，作為科學家要有耐心，也要有幫助人的決心。

學生名單:

(六年級)何正禧、梁詠恩、(五年級)杜汶朗、孔若素、

(四年級)禤心瑤

2019/20 — 2020/21
香港科學青苗獎

科學家專訪報告——何建宗教授

北角循道學校

參賽同學: 林智華
王昊鈞
張學賢
冼奕妍
李思殷

指導老師: 姚明華老師
林悅羔老師

視像訪問日期： 2020 年 3 月 20 日

科學家簡介

受訪科學家：何建宗教授

工作機構：香港極地研究中心創辦人

研究範圍：紅潮、水資源和水質、冰川污染、環境科學

何建宗教授是國際知名紅潮和水質研究專家。他曾在政府環保署的水質政策組工作。之後在香港公開大學當科技學院院長兼環境學教授。他在二十多年前開始已到南北極開荒做藻類研究，於 2018 年創辦了「香港極地研究中心」。他對社會的貢獻令他在 2004 年獲香港特別行政區政府頒授銅紫荊星章，並於 2014 年獲委任為太平紳士。

圖片由何教授提供。

香港淡水資源

何教授指出水是「生命之源」，地球上很多東西都和水有關，例如：海洋、河流、極地等生態系統。可是地球上 97%水都是海水，不可直接飲用。再者，地球只有 3%的淡水資源，而其中 2.7%的水存在南北極，可供人們用的淡水只有 0.3%。這些水不但要供人類飲用，亦要用來耕種，而當中有些在天空和地下水道，所以真正能給我們飲用的只有 0.03%，是不足夠的。而香港市民每人每日約用 200 公升水，為了解決淡水供不應求的問題，香港是世界唯一使用鹹水作為沖廁水的地區。何教授在水務署當水質事務委員會主席時提出了「海水化淡」的概念，藉此增加淡水供應。

極地之旅與「紫荊站」的意義

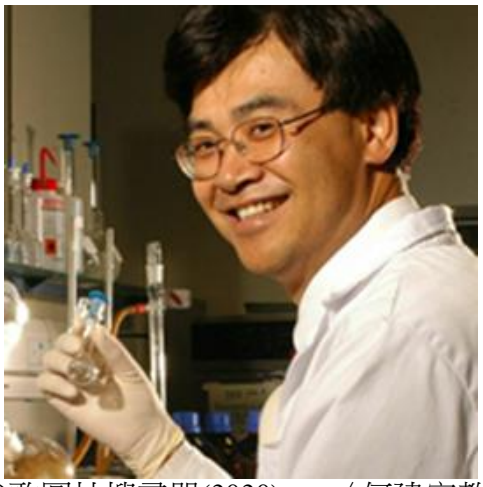
何教授共去了 4 次南極和 17 次北極，「開荒」研究極地藻類。第一次是 1993 年到南極，但因為北極風雪不會太大和設備比較充足，所以往後幾年都是去北極。何教授希望延續極地研究和積極培育新一代科學家，所以他毫不猶疑把自己的退休金投放在屬於香港首個北極科研站「紫荊站」，期望香港科學家在此平台開展極地研究，同時，藉此推動年青人多參與科研工作。他無私的奉獻，令我們十分敬佩。

圖片由何教授提供。

成為科學家的條件

何教授從小喜歡留意和觀察身邊事物，把有用的資料記錄下來，再作研究和分析，他亦喜歡提問和找問題的解決方法，漸漸踏上科學家之路。教授認為做科學家首要對科學有興趣，其次要有求知慾。做科研經常會遇到難題，有時研究了十年，也找不到答案，所以要有一顆恆心才能夠求知、求證。教授的座右銘「答案總比問題多」、「遇山開路，遇水搭橋」，只要堅毅不屈，多想辦法，問題必定可以解決。他亦以「砌金字塔」給我們做比喻：「做學問如『砌金字塔』，

要有穩固的基礎，便要慢慢地把一塊一塊磚頭向上砌，才能完成整座金字塔。每一塊磚頭都很重要，沒有下層的磚頭，怎能有最頂的一塊磚頭呢？」經驗是要不斷累積的，我們要從成功和失敗中汲取經驗，事情才會一次比一次做得更好。另外，要有謙卑的態度，不能自滿。家人的支持和信仰也是他重要的支柱，驅策他向着目標邁進。



谷歌圖片搜尋器(2020) 。〈何建宗教授 - Google 搜尋〉。取自 https://www.google.com.hk/imghp?hl=zh-TW

圖片由何教授提供。

感想與反思

珍惜資源　保護環境

經過這次的訪問，我們明白到全球的淡水資源十分短缺，所以我們應該珍惜水資源。我們亦知道北極的冰川融化速度十分快，因此保護環境極重要。

堅毅努力　屢敗屢戰

何教授在研究時經常遇到困難，他那份堅毅不屈、努力和勇於嘗試的精神很值得我們學習。失敗是成功的考驗，是通往成功的踏腳石，讓我們更加接近成功。

眼觀四面　躬行實踐

何教授教導我們日常生活中要多觀察，並把觀察到的事物記錄下來，方便日後有需要時參考。我們現在有智能電話，相比起教授以前用紙筆記錄方便得多。我們會努力在生活中多觀察，多實踐，希望可以為科研獻上一點點綿力。

科學精神　貢獻社會

何教授對科研的熱誠，令我們明白到成為一位出色的科學家一點也不容易。這次訪問，令我們獲益良多，這些得著讓我們終身受用。最後，教授認為「節水花灑」對環境有莫大的幫助，很支持我們的研究。

將來我們也想成為科學家，研究和發明能保護環境的日常用品，用我們的知識為未來的世界作出貢獻。

圖片由何教授提供。

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優才(楊殷有娣)書院 – 小學部
2019/20 — 2020/21
香港科學青苗獎
科學家專訪報告—周敬流教授

指導老師：鄧兆華

參賽學生：趙朗天、陳樂芝、李煦月、林卓毅、林嘉晴

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研究範圍：遺傳學、演化生物學、合成生物學、發育神經生物學中的細胞訊號傳遞及感官分化

研究成就及方向

周教授的研究工作橫跨生物科學的多個範疇，匯聚化學、物理學、數學、工程學及臨床科學等專業知識。有關合作項目涵蓋分子與細胞生物學、遺傳學與基因組學、發育神經生物學及合成生物學與演化生物學等領域。周教授在以上領域至今已發表文章 180 餘篇。

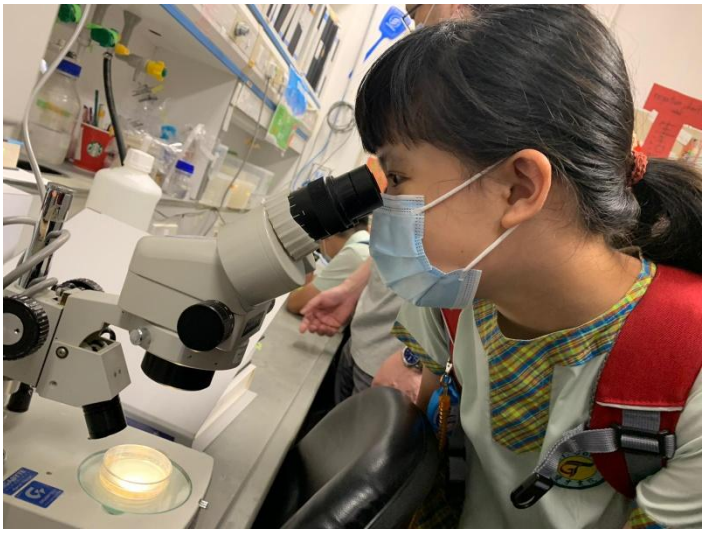
周教授協助開辦的分子生物醫學科學本科生課程備受稱許，並主管生物工程的研究生課程。周教授在科大和其他院校本科生及研究生課程中任教生命科學等廣泛學科，具備豐富的教學經驗。周教授曾獲科大理學院教學獎及祁敖卓越教學服務獎章，以嘉許其卓著成就。

成為生物科學家的原因

周教授自小就對生物有著濃厚的興趣，他年幼時除了養貓狗等寵物，原來還養過其他意想不到的動物。他小時候曾經在水溝中捉到幾尾小魚，及後在家中為其繁殖了十幾缸的後代，足足有上千條之多！原來這不是他最大的 “壯舉”，他亦試過用大大小小的空罐養過上千隻蝸牛。在養殖過程中，他不但認識到蝸牛的生長特性和飲食模式，還觀察到它們繁殖速度飛快，一查之下竟發現蝸牛是雌雄同體的，這個發現打開了他對生物學求知的大門。年少的他抱著滿滿的好奇心，在日後求學路上便踏上了生物科學的研究之路，因此他選擇在大學修讀生物學，畢業後負笈美國德州貝勒醫學院攻讀細胞生物學博士學位。他在美國紐約愛因斯坦醫學院取得分子遺傳學 Belfer 院士後，便加入科大繼續進行與生物科學相關的研究。

科學研究的苦與樂

周教授回想在帶領科研教育的路上，令他最頭痛的就是 “學生不聽話”。原來這是指研究生團隊在實驗中會常犯的小毛病。他補充道，科學研究獨特之處是必須要有嚴密而有系統的過程，而很多時研究的過程時間長，工序繁複，但一次半次的偷工減料或疏忽可能會令之前所有的功夫都付諸流水。他回憶起一次失敗的經驗是因為有學生為了節省時間去吃午飯，在實驗設置中少了一個對照組，先前其它有意義結果的實驗組便前功盡廢了，不但浪費了時間，亦浪費了大量人力物力，最痛苦的就是連任何結論也得不到。而對於周教授來說，科學研究最欣喜的部分是科研的成果可以幫助別人，由他帶領的科學團隊透過對蟲的基因實驗從而找到一些眼疾病人致盲的變異基因，這對於治療這種眼疾病人起到很大的作用，這使他感到很鼓舞。



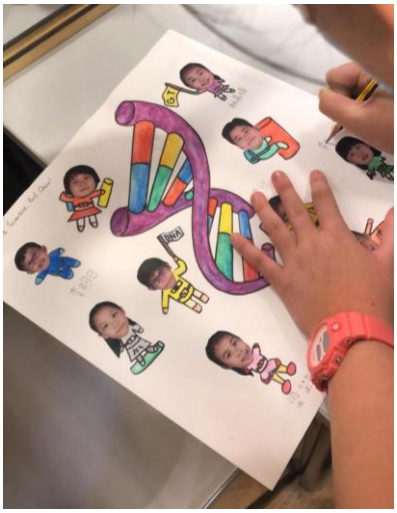
科學家的特質

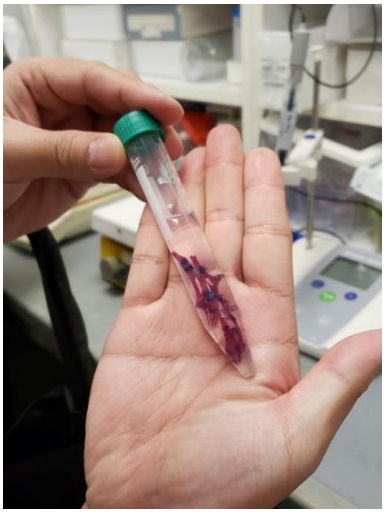
周教授認為要成為科學家的起步之處就是在 “任何地方”，最重要是視乎你有沒有好奇心，你想不想知道身邊不同現象的背後原因。而第一步就是要懂得問: “為甚麼?”。他指出科學這一門學科是幫助我們去了解大自然的規律，而懂得問 “為甚麼?”就是讓學生探索事情的出發點，這樣便有動力去透過翻書、上網搜尋又或者親自做實驗去找答案。另外，他認為科學家須具備的特質是願意 “動手做”。他曾在科大舉辦過中學生科學比賽，要求參賽者設計一個與蝦有關的實驗。當日他才驚覺時下很多中學生連真的蝦都沒有觸摸過，更不用說要小心拿起並用油筆塗黑其雙眼了。學生對於細小的活蝦完全手足無措、無從入手，真是令他哭笑不得。他感慨現時學生都太過於做紙筆練習和操練試題，亦勉勵同學要多些接觸大自然，不要只做課程下的書呆子，要樂於動手做實驗。

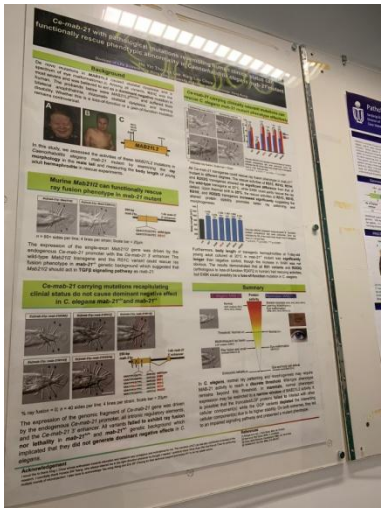
我們的反思

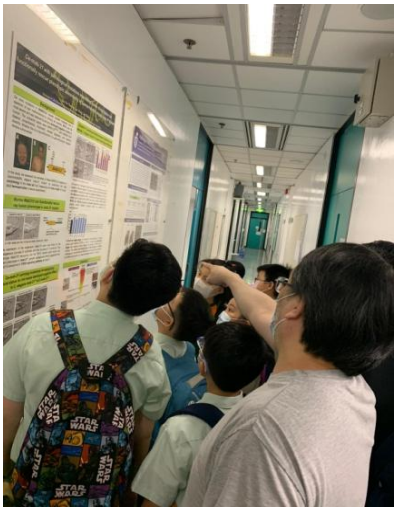
我們非常榮幸可以透過比賽訪問本港科學家 – 周敬流教授，他不但教導我們許多科學的精神，還帶領我們參觀其生物科學實驗室，認識他正在研究的計劃及親眼觀賞到經基因改造前、後的線蟲和其他生物標本，真是大開眼界。

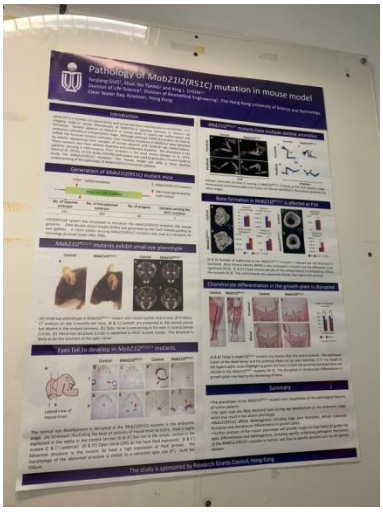
經過這次專訪，我們發現原來科學是一門沒有門檻，也沒有既定的框架的學科，唯一的挑戰就是在於有沒有持之以恆和願意動手做的態度。周教授在訪問最後再三叮囑我們當天回去想三個 “為甚麼?” 的問題，這使我們印象非常深刻。我們了解到要成為一名科學家，必須要一顆熾熱的好奇心，對不懂的事要有打爛沙盤墨到底的精神。（1488 字）











中學組

冠軍

2019/20 — 2020/21
Hong Kong Budding Scientists Award

Inhibitory potential of natural flower teas for management of diabetes

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Wu Sau Ying Zoe 胡琇瑩

Yau Josh 丘祉康

Hou Chin Pang 侯展鵬

Content

Abstract

This research project is to investigate and find out the effective natural inhibitor of α-glucosidase from natural flower teas. It hopes to effectively reduce blood glucose levels, to moderate the effect of diabetes, and to manage diabetes.

In this project, we have successfully extracted the bioactive ingredients (extracted both by water soluble solvent and ethanol solvent) which can inhibit α-glucosidase activities from eight kinds of natural flower teas, and significantly compare them with the common diabetes drug Glucobay (acarbose). Our experimental results show that the water soluble *Osmanthus* fragrans tea extract (0.25g/ml) has a significant inhibitory effect (up to 80%) on α-glucosidase activity, close to the inhibition level of clinical drug Glucobay (acarbose).

Ch.1 Introduction

1.1 Problem

Diabetes is a common metabolic disease in Hong Kong characterized by abnormally high plasma glucose levels, leading to major complications, such as retinopathy and cardiovascular diseases. One of the effective managements of diabetes mellitus to postprandial hyperglycemia (high blood glucose after meal), is to retard the absorption of glucose by inhibition of carbohydrate hydrolyzing enzymes, such as α-glucosidase, in the digestive organs [1-3].

α-Glucosidase is the key enzyme catalyzing the final step in the digestive process of carbohydrates. Hence, α-glucosidase inhibitors such as acarbose can retard the release of glucose from dietary carbohydrates and delay glucose absorption, resulting in reduced plasma glucose levels and suppression of postprandial hyperglycemia (Fig. 1.1.1).

The clinical use of acarbose drugs (Glucobay) are commonly used for the treatment of diabetes mellitus. However, users of acarbose are required to consult with doctors because of its side effects. It would be ideal if we could prevent diabetes or obesity by taking daily natural foods containing health promoting ingredients [3].

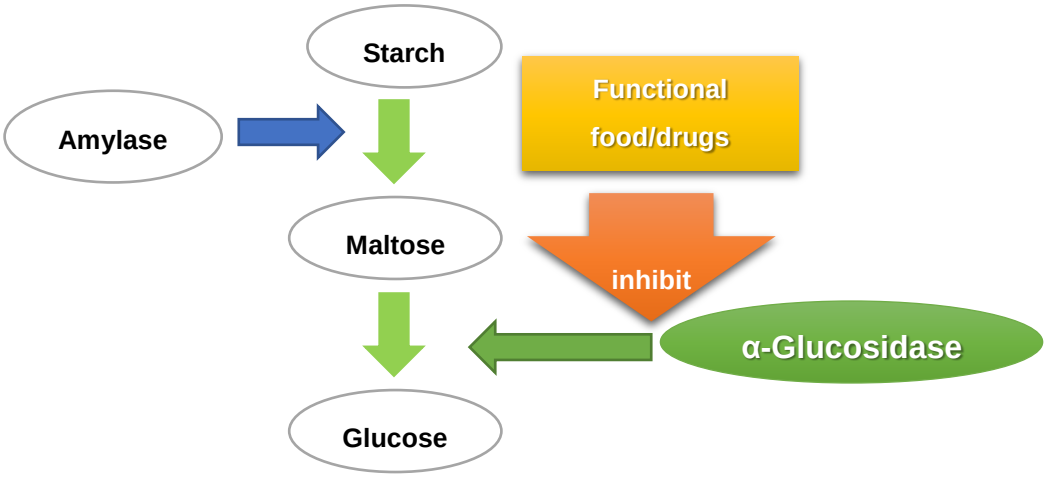


Figure 1.1.1. Mechanism of α-glucosidase inhibitor against increasing blood glucose.

1.2 Possible answers to the problem

In recent years, many efforts have been made to identify effective α-glucosidase inhibitors from natural sources in order to develop a physiologic functional food for use against diabetes [3]. Plant-based foods have been used in traditional health systems to treat diabetes mellitus. The successful prevention of the onset of diabetes consists in controlling postprandial hyperglycemia by the inhibition of α-glucosidase and pancreatic α-amylase activities, resulting in aggressive delay of carbohydrate digestion to absorbable monosaccharide.

In this research project, it is desirable to find a natural food extract containing an inhibitory effect of α-glucosidase activity in natural foods (from eight natural flower tea samples). For people with diabetes, it is ideal to just controlling their diet that it can effectively lower the blood glucose levels and achieve the effect of relieving their diabetes. In the present study, we have screened and evaluated ingredients with α-glucosidase inhibitory activity from eight flower tea extracts and compared them with Glucobay (acarbose) as a positive control. To the best of our knowledge, this is the first report regarding the identification of the natural flower tea extracts as the potent natural inhibitors of the α-glucosidase activity. We aim at investigating the natural flower tea first, and in the future we also hope to use other scientific methods to study more natural foods that can control blood glucose levels.

1.3 Objectives

1. To investigate the effect of α-glucosidase activities from varieties of natural flower teas.
2. To compare and evaluate the α-glucosidase inhibitory activities of the different kinds of flower teas in order to the find out the natural potent α-glucosidase inhibitors.
3. To investigate the effect of α-glucosidase activities in boiled flower teas extracts, whether it can maintain the inhibitory effect.
4. To determine the combined effect of different extracts of eight flower tea samples on α-glucosidase activity inhibition.

1.4 Hypothesis

There are active ingredients (inhibitors) inside the natural flower teas which can inhibit the α-glucosidase activity. Drinking flower tea can effectively reduce blood glucose levels and moderate the effect of diabetes, and finally manage diabetes.

Ch.2 Experimental Methods

2.1 α-Glucosidase inhibitory assay

Prepare 0.5-1g of different kinds of flower teas (Roses, Roselle, *Chrysanthemums*, Butterfly pea, Jiaogulan, *Osmanthus fragrans*, Jasmine, *Calendula*)

↓

Add 5 mL of phosphate buffer into the flower tea respectively

↓

Grinding, pressing and extracting the flower tea separately in water or 50% methanol for 15, 30 & 45 mins

↓

1) Roselle, 2) *Chrysanthemum,* 3) Rose, 4) Butterfly pea, 5) Jasmine, 6) *Calendula,* 7) *Osmanthus fragrans,* 8) Jiaogulan (Various extracts of flower tea), 9) Glucobay solution (+ve control), 10) Phosphate buffer (-ve control)

↓

Add 500μL of phosphate buffer (0.1M) into the test tubes using pipetman respectively

↓

Add 250μL of 4-nitrophenyl α-D-glucopyranoside (substrate)(pNPG) into each test tubes

↓

Add 100μL of test sample into each test tubes

↓

Add 250μL of α-glucosidase solution

↓

Incubated at 37℃ for 30 minutes (3 sets of samples)

↓

Add 1mL of sodium carbonate (1M) into each sample respectively

↓

Enzymatic activity was quantified by measuring the absorbance at 405nm

The effect of the flower tea extracts on α-glucosidase activity was determined according to the method as described [11-12], using α-glucosidase from *Saccharomyces cerevisiae*. The substrate solution p-nitrophenyl glucopyranoside (pNPG) was prepared in 0.1M phosphate buffer, and pH 7.0. 250 μL of α-glucosidase (1.0U/mL) was pre-incubated with 100 μL of the different flower tea extracts (water or 50% methanol)(1.25g/ml) or Glucobay solution (0.025g/ml) for 10min. Then 250 μL of 3.0mM pNPG as a substrate dissolved in 0.1M phosphate buffer (pH 7.0) was then added to start the reaction. The reaction mixture was incubated at 37℃ for 30min and stopped by adding 1mL of 0.1M sodium carbonate (Na_2CO_3) solution. The α-glucosidase activity was determined by measuring the yellow-colored para-nitrophenol released from pNPG at 405 nmon a Spectrophotometer (Genesys 10S UV-VIS). The results were expressed as percentage of the blank control [6].

The percentage of inhibition is calculated as:

$$\text{Percentage of Inhibition} = [\frac{Abscontrol - Absextract}{Abscontrol}] \times 100$$

Statistical Analysis

All experiments were performed at least in duplicate or triplicate. Analysis at every time point from each experiment was carried out in duplicate or triplicate. Means, standard errors and standard deviations were calculated from replicates within the experiments and analyses using Microsoft Excel.

2.2 Extraction of α-glucosidase inhibitor in natural flower teas

The varieties of natural flower teas were purchased from local supermarkets or Chinese pharmacy. 5 grams of flower tea were cut into small pieces; 5 ml of phosphate buffer was added. The mixture was then filtered through a strainer, poured into eppendrof microtubes. The microtubes were centrifuged at 10,000 rpm for one minute, and the supernatant was retained and to get the flower tea extracts containing the α-glucosidase inhibitor.

These eight types of flower teas include (Table 2.1.1 & Fig. 2.2.1):

1.	Rose (*Rosa*)(玫瑰花茶)
2.	Butterfly pea (*Clitoria ternatea*)(蝶豆花茶)
3.	Roselle (*Hibiscus sabdariffa*)(洛神花茶)
4.	Chrysanthemum (*Chrysanthemum*)(菊花茶)
5.	Jiaogulan (*Gynostemma pentaphyllum*)(絞股蘭茶)
6.	Calendula (*Calendula*)(金盞花茶)
7.	Osmanthus fragrans (*Osmanthus fragrans*) (桂花茶)
8.	Jasmine (*Jasminum*)(茉莉花茶)

Table 2.1.1

Figure 2.2.1 Different natural flower teas. (a) Rose; (b) Roselle; (c) Chrysanthemum; (d) Butterfly pea; (e) Jiaogulan; (f) Osmanthus fragrans; (g) Jasmine; (h) Calendula.

2.3 Investigate the effect of α-glucosidase activities from varieties of flower teas and compare with Glucobay solution

Eight different flower tea extracts (Roselle, *Chrysanthemum*, Rose, Butterfly pea, Jasmine, *Calendula, Osmanthus fragrans* and Jiaogulan), (each concentration is 1.25g/ml) and Glucobay solution (0.025g/ml) and phosphate buffer were added into eight test tubes, respectively. Then, α-glucosidase inhibitory assays were performed.

2.4 Investigate the effect of incubation time on the α-glucosidase inhibitory activities

As to test the effect of incubation time on the α-glucosidase inhibitory activities, three identical sets of assay were performed. Eight different kinds of dried flower teas were extracted with 5ml of distilled water at room temperature, and incubated them for 15 30 or 45 minutes. Then, α-glucosidase inhibitory assays were performed.

2.5 Investigate the effect of the α-glucosidase inhibitory activities when using different solvent for extraction

Distilled water and alcohol (50% methanol) were used for comparison. Eight kinds of dried flowers were added to 5 ml distilled water/phosphate buffer or 50% methanol (16 test tubes in total) for extraction. The mixture was filtered and centrifuged to obtain extracts in phosphate buffer; repeat the previous steps but replacing phosphate buffer with 50% methanol. The mixture was filtered and centrifuged to obtain extracts of flower teas in 50% methanol. Then, α-glucosidase inhibitory assays were performed.

2.6 Investigate the inhibitory activities of α-glucosidase in boiled extraction of various flower teas

The room temperature (RT) distilled water and 100 ℃ boiled distilled water were selected for comparison. Eight kinds of dried flowers were added to 5 ml distilled water at room temperature and 100 ℃ boiling (total 16 test tubes) for extraction with different temperature. The mixtures were incubated for 30 or 45 minutes, filtered and centrifuged to obtain boiled extracts of flower teas. Then, α-glucosidase inhibitory assays were performed.

2.7 Investigate the combined effect of different flower teas on the inhibitory activities of α-glucosidase

To investigate the comprehensive combined effect of mixing more than one flower teas extract, eight different flower teas extracts (Roselle, *Chrysanthemum*, Rose, Butterfly pea, Jasmine, *Calendula, Osmanthus fragrans* and Jiaogulan*)* or mixed with two flower tea extract were added to the test tubes. Then, α-glucosidase inhibitory assays were performed. Samples were incubated in 37 ℃ water bath for 30 minutes. Then the reactions were stopped by adding 1mL of 0.1M sodium carbonate (Na_2CO_3) solution. The α-glucosidase activity was determined by measuring the yellow-colored para-nitrophenol released from pNPG at 405 nm. The results were expressed as percentage of the blank control.

Ch.3 Results

3.1 The effect of α-glucosidase activities from varieties of flower tea

We have extracted the potential substance containing the inhibitory effect of α-glucosidase activity from different flower teas; Roselle, *Chrysanthemum*, Rose, Butterfly pea, Jasmine, *Calendula, Osmanthus fragrans* and Jiaogulan, and compared with their the inhibitory effect. According to our experimental results, we found that the extracts of *Chrysanthemum*, Roselle, Butterfly pea and *Osmanthus fragrans* contained the highest inhibitory effect of α -glucosidase activity, and the effect was the best among the others. The inhibition of α -glucosidase activity in *Osmanthus fragrans* flower tea extract is the highest (around 88%), which is close to the inhibition level of the positive control-clinical drug Glucobay (acarbose). It suggested that it should have α-glucosidase inhibitor in the some of the flower tea extracts

Among the eight kinds of natural flower tea extracts, *Osmanthus fragrans* has the highest inhibitory effect α-glucosidase activity. The reactant with *Osmanthus fragrans* extract has the lowest absorbance and the colour of the mixture is lighter than others. It is concluded that *Osmanthus fragrans* has a higher inhibitory effect on α-glucosidase activity, and the inhibitory effect is the best among the other eight samples. *Calendula* extract has the least inhibitory effect on α-glucosidase activity and showed the lowest effect, followed by Jiaogulan, Jasmine, and Rose (Fig. 3.1.1).

Samples	Absorbance (Abs)	%Inhibition
1. Roselle	0.536	74%
2. *Chrysanthemum*	0.848	59%
3. Rose	1.286	38%
4. Butterfly pea	0.504	76%
5. Jasmine	1.325	36%
6. *Calendula*	1.978	4%
7. *Osmanthus fragrans*	0.249	88%
8. Jiaogulan	1.822	12%
9. Glucobay	0.168	92%
10.PB	2.071	0%

Table 3.1.1

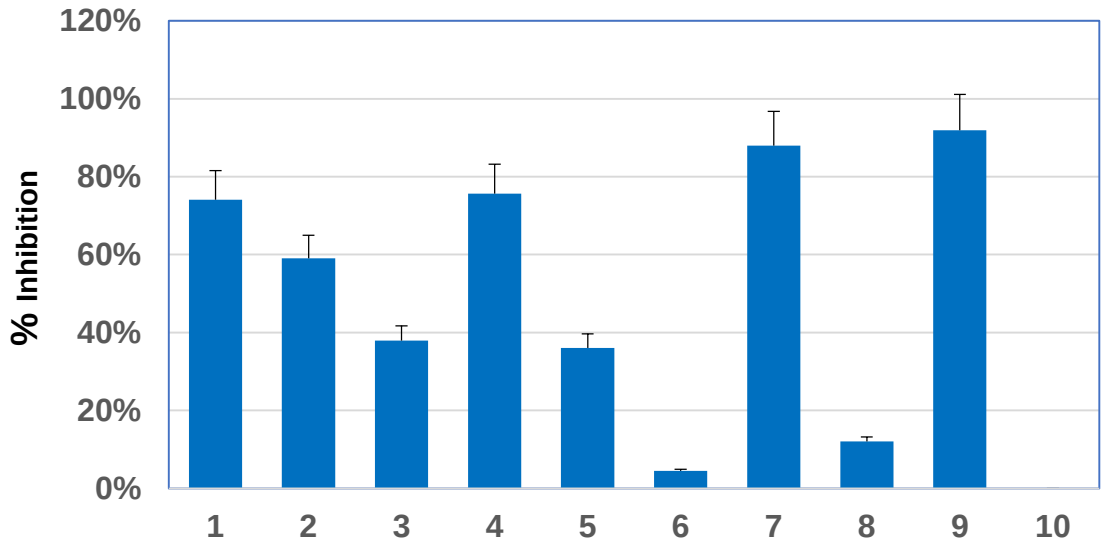


Figure 3.1.1 Graph of the percentage of inhibition of α-glucosidase activities in different flower tea extracts and Glucobay solution (positive control).

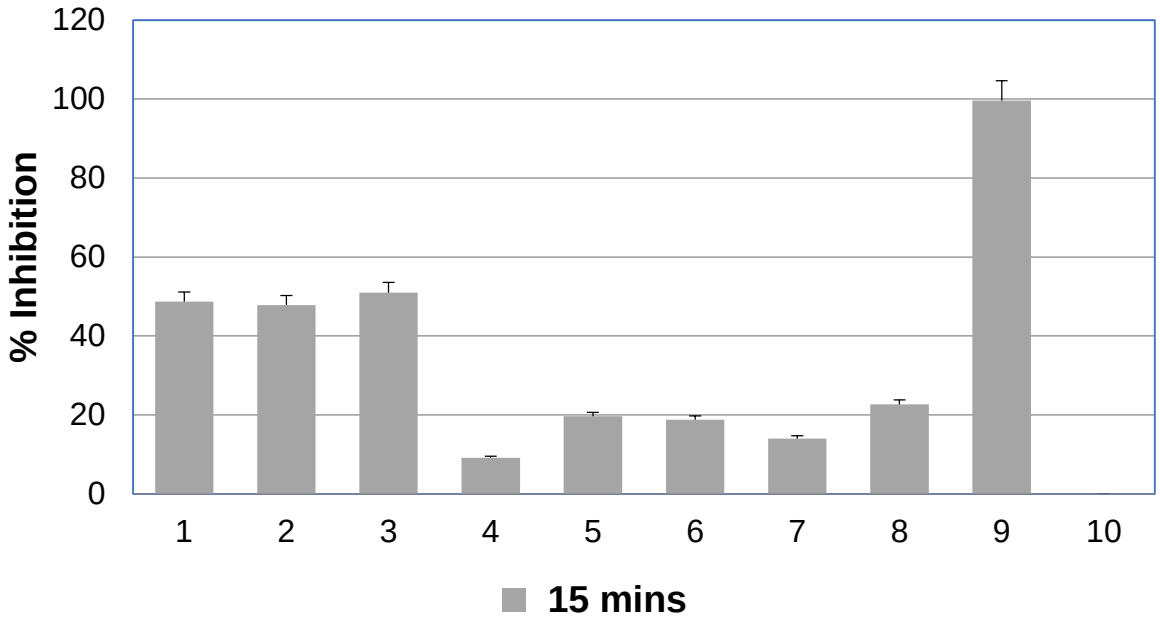
3.2 The effect of incubation time on the α-glucosidase inhibitory activities

The longer the extraction time of incubated flower tea is, the more effective the substances containing the inhibitory effect of α-glucosidase can be released. After soaking

all the dried flower tea samples in room temperature distilled water for 15, 30 and 45 minutes, it was identified that the inhibitory activity of α-glucosidase was more effective after incubation dried flower tea extracts for 45 minutes. The results showed that dried flower tea soaked for 45 minutes could effectively release potential inhibitor of α-glucosidase (Fig. 3.2.1-3.2.2).

Samples	Absorbance (Abs)	%Inhibition 30mins	Absorbance (Abs)	%Inhibition 45mins	Absorbance (Abs)	%Inhibition 60mins
1. Roselle	2.583	49%	2.772	45%	3.532	30%
2. *Chrysanthemum*	2.628	48%	2.764	45%	2.324	54%
3. Rose	4.577	9%	4.673	7%	4.823	4%
4. Butterfly pea	2.469	51%	2.885	43%	2.044	59%
5. Jasmine	4.046	20%	4.174	17%	4.133	18%
6. *Calendula*	4.089	19%	3.922	22%	3.149	37%
7. *Osmanthus fragrans*	2.33	54%	2.358	53%	1.207	76%
8. Jiaogulan	3.893	23%	4.371	13%	4.235	16%
9. Glucobay	0.019	100%	0.019	100%	0.019	100%
10. PB	5.036	0%	5.036	0%	5.036	0%

Table 3.2.1



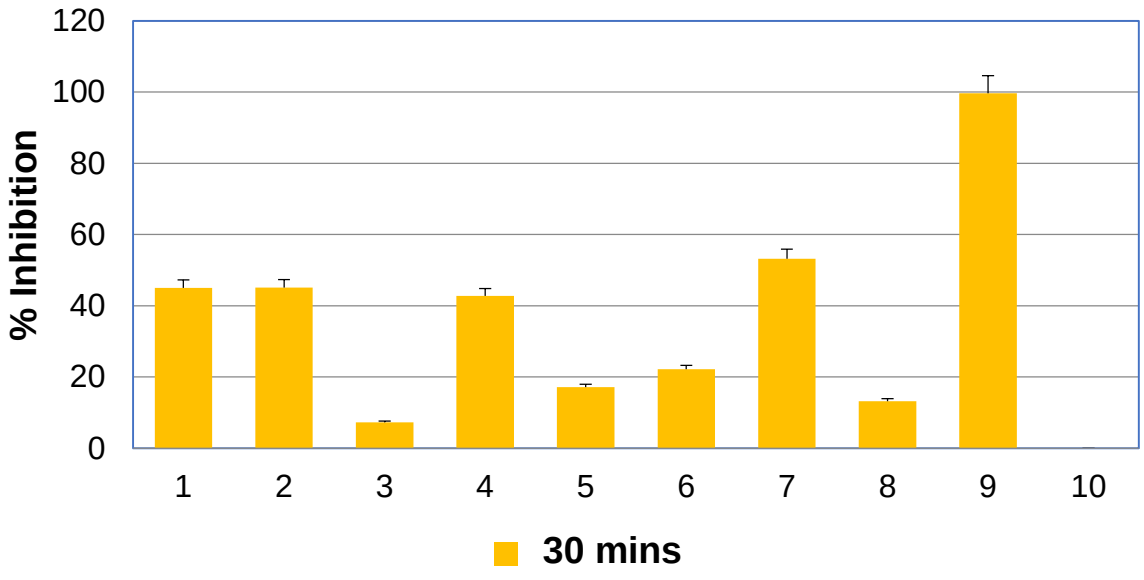


Figure 3.2.1 Graph of the effect of incubation time on the percentage of inhibition of α-glucosidase activities in different flower tea extracts and Glucobay solution (positive control).

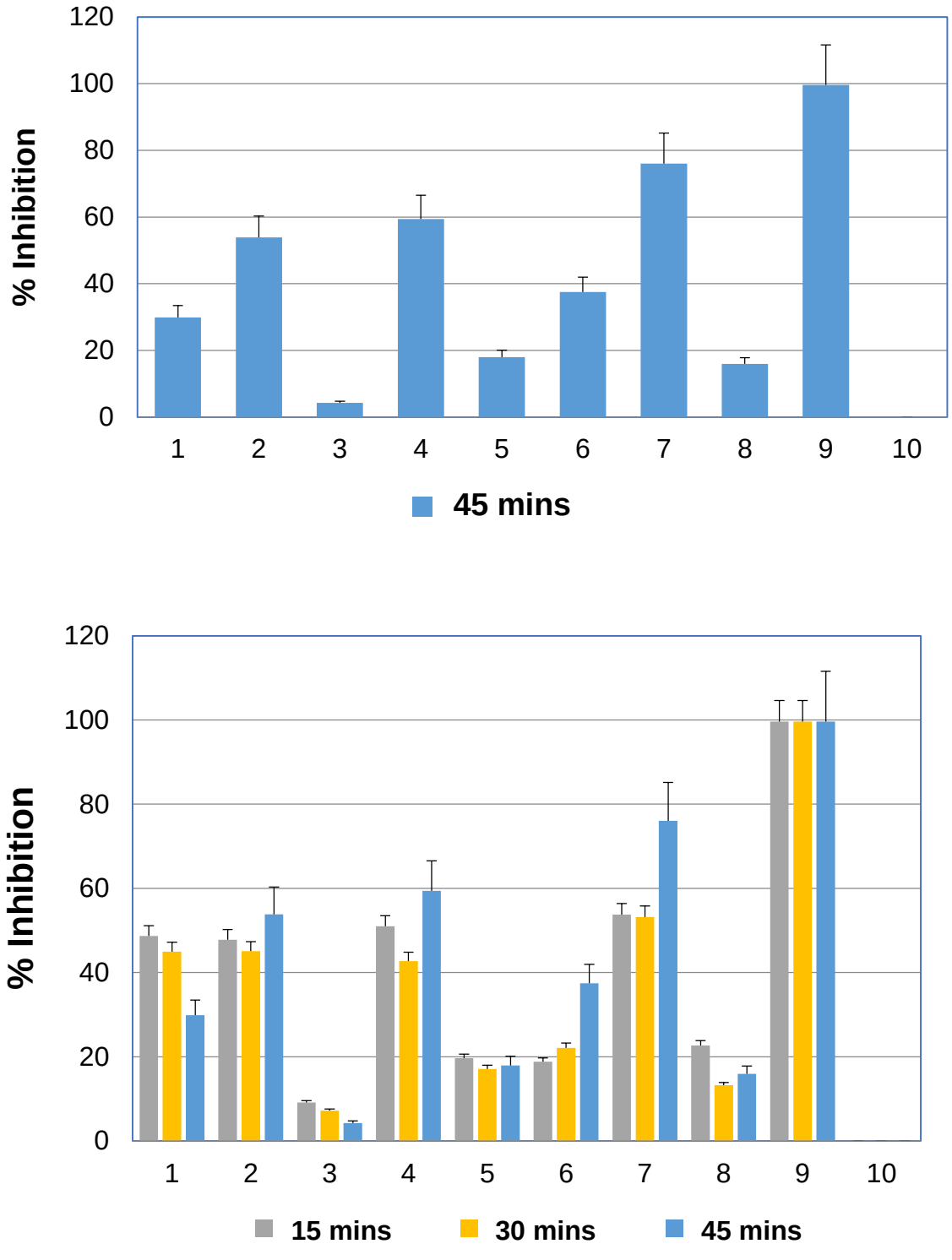


Figure 3.2.2 Graph of the effect of incubation time on the percentage of inhibition of α-glucosidase activities in different flower tea extracts and Glucobay solution (positive control).

3.3 The effect of the α-glucosidase inhibitory activities when using different solvent for extraction

Natural flower tea samples contain different compounds that inhibit the activity of α-glucosidase, such as anthocyanins, polyphenols and flavonoids. The solubility of polyphenols is determined by the type of polar solvents such as methanol, ether, or water. Methanol is considered to be the most effective method to extract polyphenols, and water can also extract soluble phenols and flavonoids. In order to compare the content of compounds soluble in different polar solvents, and to determine the inhibitory activity of α-glucosidase in the flower tea extract, flower tea samples were extracted by distilled water and 50% methanol. After 15 minutes of incubation with distilled water and alcohol (50% methanol) at room temperature for extraction, the results showed that the natural flower tea extracts in water solvent has a better inhibitory effect on α-glucosidase (Fig. 3.3.1- 3.3.2).

Samples	Absorbance (Abs)	% Inhibition (Extracted in water)	Absorbance (Abs)	% Inhibition (Extracted in 50% methanol)
1. Roselle	0.622	70%	0.536	64%
2. *Chrysanthemum*	1.067	48%	1.548	25%
3. Rose	1.131	25%	1.286	38%
4. Butterfly pea	1.57	54%	1.504	27%
5. Jasmine	1.137	45%	0.825	30%
6. *Calendula*	1.439	27%	1.49	27%
7. *Osmanthus fragrans*	0.749	75%	0.522	64%
8. Jiaogulan	1.022	51%	0.978	53%
9. Glucobay	0.046	98%	0.268	87%
10. PB	2.071	0%	2.071	0%

Table 3.3.1

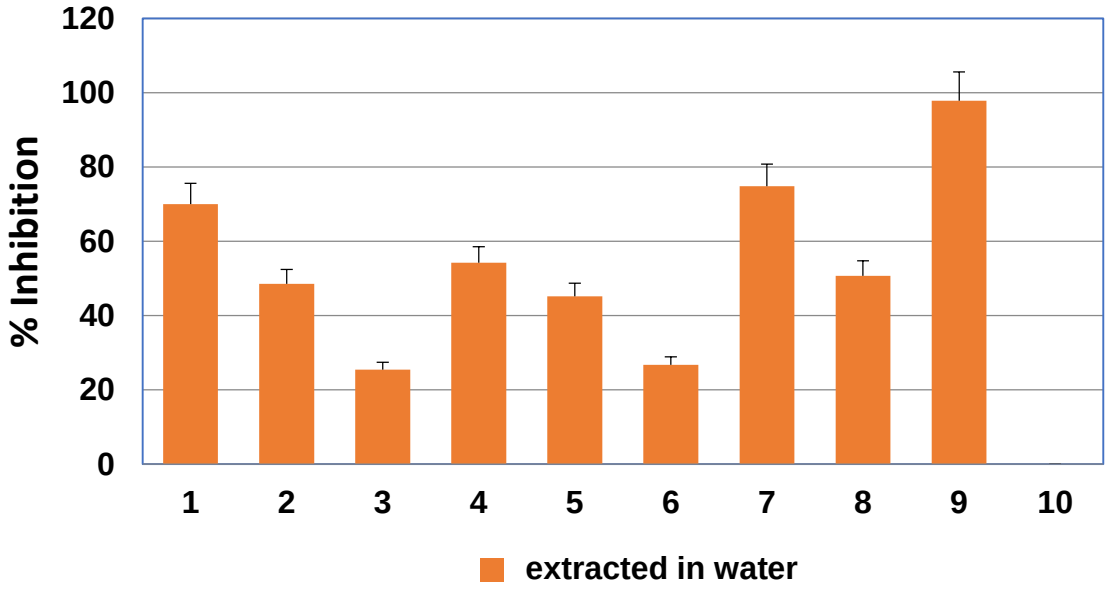


Figure 3.3.1 Graph of the percentage of inhibition of α-glucosidase activities in different flower tea extracted in 50% methanol as compare to extracted in water.

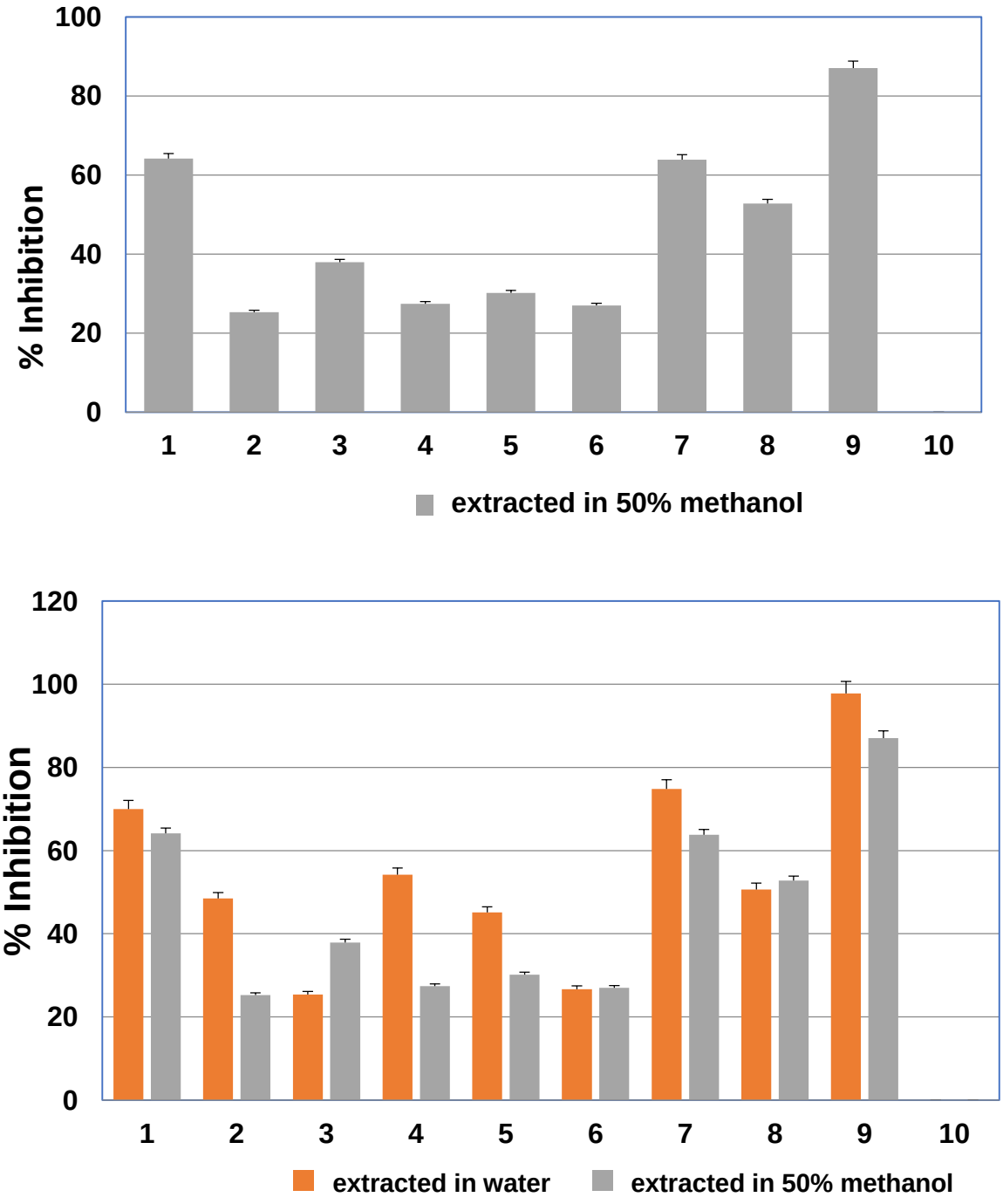


Figure 3.3.2 Graph of the percentage of inhibition of α-glucosidase activities in different flower tea extracted in 50% methanol as compare to extracted in water.

3.4 The inhibitory activities of α-glucosidase in boiled flower tea extract

Comparing the addition of room temperature with 100℃ boiling distilled water to extract various dried flower teas, the results showed that most of the flower tea extracts maintained the original inhibitory effect of the α-glucosidase activity. Only a small number of flower tea samples showed that their inhibitory effect could not be enhanced on the α-glucosidase activity after with 100℃ boiling water extraction. Results showed that both 100℃ boiling distilled water extraction and distilled water extraction at room temperature on dried natural flower teas for 30 minutes could effectively release substances containing the inhibitory effect of α-glucosidase. (Fig. 3.4.1).

Samples	Absorbance (Abs)	% Inhibition (RT water)	Absorbance (Abs)	% Inhibition (100°C water)
1. Roselle	1.815	39%	2.583	49%
2. *Chrysanthemum*	1.446	51%	2.628	48%
3. Rose	2.625	12%	2.469	15%
4. Butterfly pea	2.082	30%	4.577	9%
5. *Jasminum*	2.77	7%	4.046	20%
6. *Calendula*	2.351	21%	4.089	19%
7. *Osmanthus fragrans*	1.144	62%	2.33	54%
8. Jiaogulan	1.898	36%	3.893	23%
9. Glucobay	0.091	97%	0.019	99%
10. PB	2.983	0%	5.036	0%

Table 3.4.1

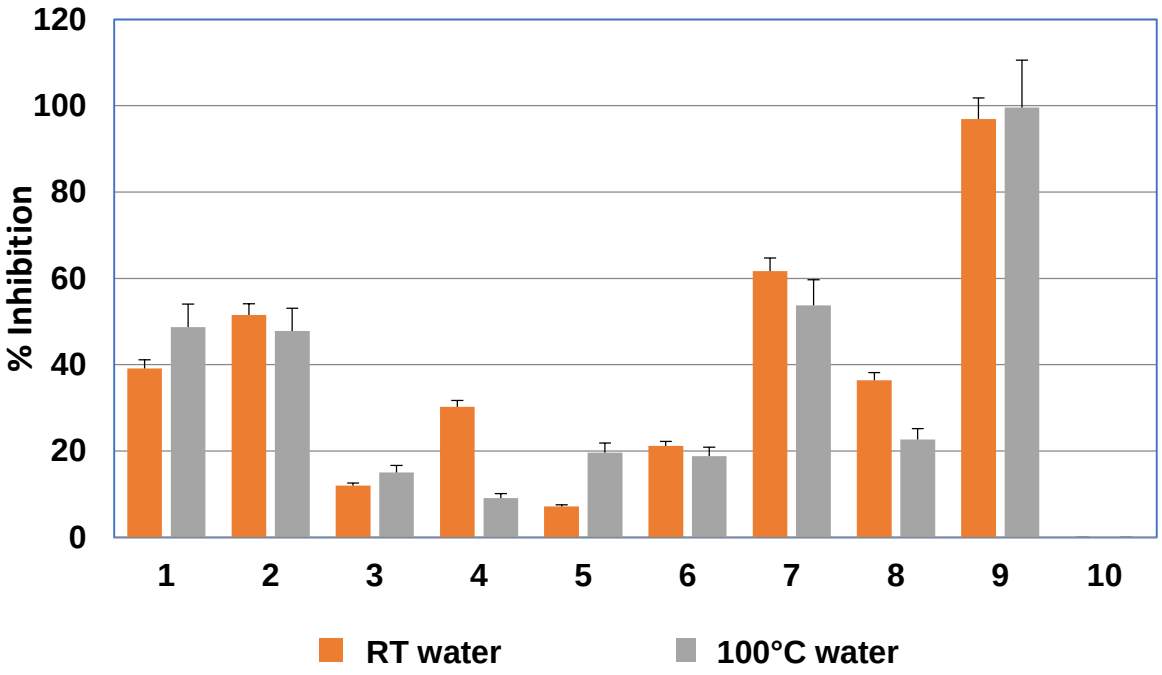


Figure 3.4.1 Graph of the percentage of inhibition of α-glucosidase activities in different flower tea extracted in 100°C distilled water as compare to flower tea extracted in room temperature distilled water (RT water).

3.5 The combined effect of different natural flower teas on the inhibitory activities of α-glucosidase

Various natural flower tea extracts or a mixture of two flower tea extracts were mixed and tested for the comprehensive combined effect on the inhibition of α-glucosidase activities. Single flower tea extract may be not adequate to assess the delay of carbohydrate digestion. Many scientists have investigated the combination of different plant-based foods containing various chemicals that exhibit additive and synergistic interaction in anti-diabetic properties that exert positive health-promoting effects, leading to the development of functional foods [9, 10]

Our results showed that the percentage of inhibition of α-glucosidase activity from the mixed flower tea was greater than the sum of the total inhibitory effect, indicating that the combination of butterfly pea flower and *Osmanthus fragrans* extracts produces a synergistic inhibitory effect on α-glucosidase activity, and also exerted an additive inhibitory effect (Fig. 3.5.1).

Samples	Abs	% Inhibition (without combined)	Samples	Abs	% Inhibition (combined with Butterfly pea)
1. Roselle	1.815	39%	**1. Roselle + Butterfly pea**	1.847	45%
2. *Chrysanthemum*	1.446	52%	***2. Chrysanthemum* + Butterfly pea**	1.614	52%
3. Rose	2.625	12%	**3. Rose + Butterfly pea**	1.745	39%
4. Butterfly pea	2.082	30%	**4. Butterfly pea**	---	---
5. Jasmine	2.77	7%	***5.* Jasmine + Butterfly pea**	2.069	28%
6. *Calendula*	2.351	21%	**6. *Calendula* + Butterfly pea**	1.726	40%
7. *Osmanthus fragrans*	2.144	36%	**7. *Osmanthus fragrans* + Butterfly pea**	1.614	64%
8. Jiaogulan	0.898	36%	**8. Jiaogulan + Butterfly pea**	1.877	34%
9. Glucobay	0.091	97%	**9. Glucobay**	0.107	96%
10. PB	2.983	0%	**10. PB**	2.863	0%

Table 3.5.1

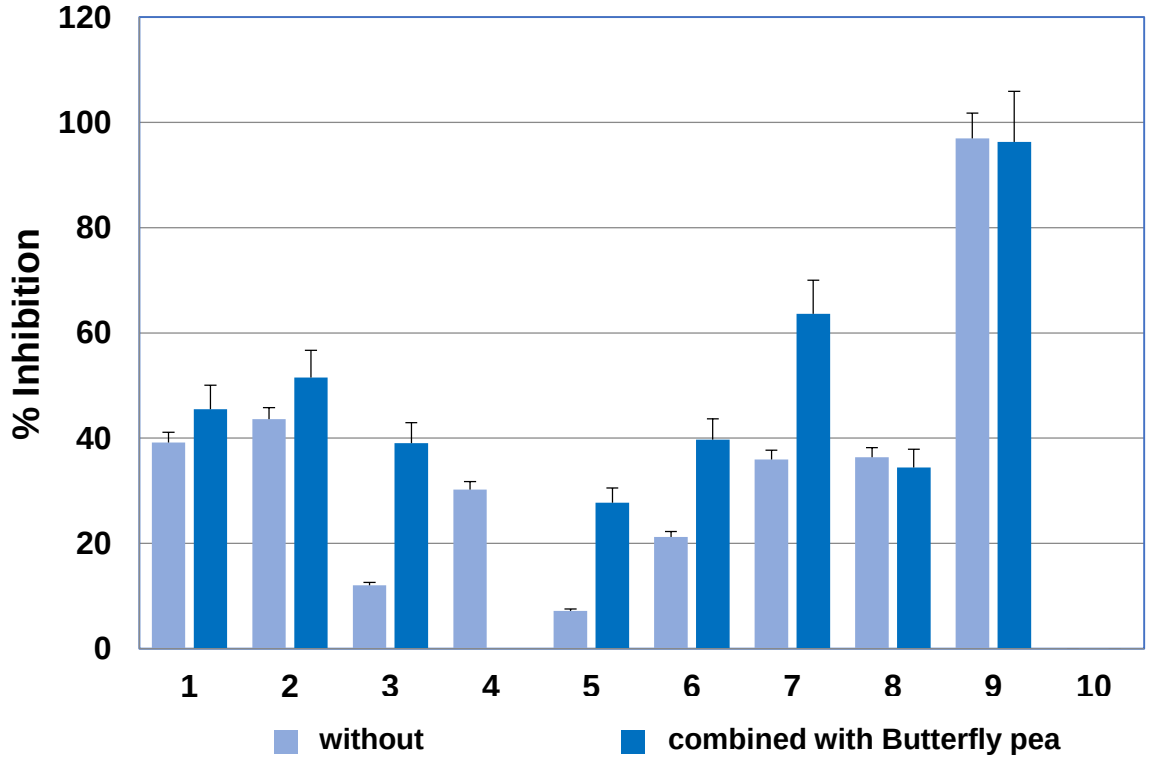


Figure 3.5.1 Graph of the combined effect on the percentage of inhibition of α-glucosidase activities in different flower tea.

Ch.4 Discussion

We have extracted the potential substance containing the inhibitory effect of *α*-glucosidase activity from eight different flower teas, and compared with their the inhibitory effect. According to our experimental results, we found that the extracts of *Chrysanthemum*, Roselle, Butterfly pea and *Osmanthus fragrans* contained the highest inhibitory effect of *α* -glucosidase activity, and the effect was the best among the others. The inhibition of *α* -glucosidase activity in *Osmanthus fragrans* tea extract is the highest

(around 88%), which is close to the inhibition level of the clinical drug Glucobay (acarbose). It suggested that it should have α-glucosidase inhibitor in the some of the flower tea extracts

. The water-soluble extract of *Osmanthus fragrans* may contain the most polyphenols, so the α-glucosidase activity inhibition is the highest. The literature points out that polyphenols have hypoglycemic effects. Through scientific research and clinical verification, tea polyphenols have a regulating effect on human glucose metabolism disorders, thus effectively preventing and treating diabetes and its complications, and it is the health care product of choice for diabetic patients [8-9].

Recent studies have indicated that plant-based edible natural plants or drinking natural teas contain high total polyphenolic compounds and high flavonoid yields that are closely related to in vitro intestinal α-glucosidase and pancreatic α-amylase inhibitory activity [6-7].

Ch.5 Conclusions and important findings

Our research project successfully confirmed that *Chrysanthemum*, Roselle, Butterfly pea and *Osmanthus fragrans* tea extracts have the highest inhibitory effect on α-glucosidase activity. Significantly, our experimental results show that the water soluble *Osmanthus fragrans* tea extract (0.25g/ml) has an inhibitory effect (up to 80%) on α-glucosidase activity, close to the inhibition level of clinical drug Glucobay (acarbose).

In addition, the α-glucosidase enzyme activity inhibitor in flower tea maintains its inhibition effect after heating at high temperature. Furthermore, the results of this study demonstrate that the combination of butterfly peas and *Osmanthus fragrans* flower tea extracts produces a synergistic inhibitory effect on α -glucosidase activity and exerted an additive inhibitory effect.

This study showed that extracts of natural flower tea contain α-glucosidase inhibitors, and it indicated that daily consumption of natural flower tea is a potential new method for preventing or treating diabetes through diet. In recent years, many efforts have been made to identify effective α-glucosidase inhibitors from natural sources in order to develop a physiologic functional super food for managing diabetes. **Natural flower tea is the best choice of healthy and functional food.**

Ch.6 Prospect

1. Investigate whether the α-glucosidase inhibitor in the natural flower tea extracts is a competitive inhibitor or non-competitive inhibitor by enzyme kinetic study.
2. Investigate and isolate the important bioactive components from the natural flower tea extract by chromatography (ion exchange chromatogram column and gel chromatogram column). Purification of α-glucosidase inhibitor can also be carried out in order to study its properties.

Ch.7 References

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亞軍

2019/20 — 2020/21
香港科學青苗獎

重金屬生物標誌物的比較

伊利沙伯中學舊生會中學

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陸采彥
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葉家成

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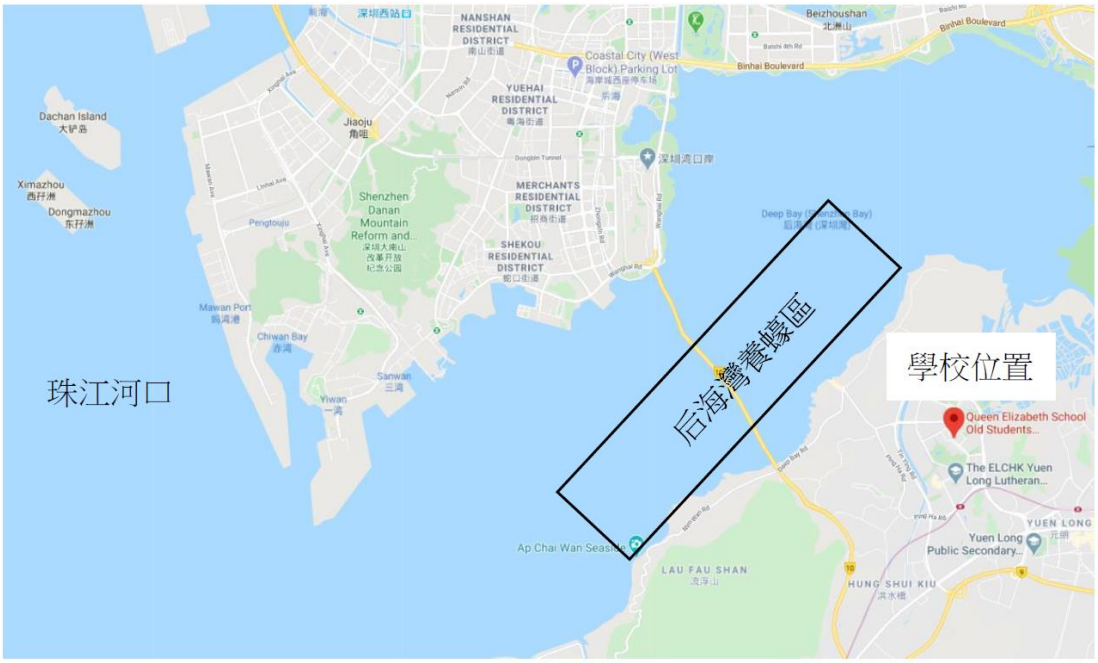
1. 簡介

1.1 后海灣水質

珠江河口一帶的養蠔業已有近千年歷史，而后海灣養蠔業仍是香港其中一個重要的海產養殖業(Morton and Wong, 1975)。據漁護署網頁顯示，在**2019 年，鮮蠔肉產量為 117 公噸，價值為 1 千 4 百萬元**。我校位於天水圍，與后海灣的養蠔區十分接近，因此我們亦十分關注后海灣的水污染問題。

后海灣位於珠江口側，部分珠江的污染物會流入后海灣；后海灣南岸(香港)和北岸(深圳)的污水亦會排放入后海灣，造成海水**污染**。重金屬是其中一種海水污染物，其離子通常依附(adsorb)於沈積物，甚至是微塑膠。流浮山的柱蠔或吊蠔在過濾海水的有機物作食物時，有機會會攝取到微塑膠及沉積物，因而攝取重金屬離子。Philips 等學者(1982) 和 Cheung & Wong (1992)在流浮山鮮蠔樣本中驗出較高水平的重金屬，而 2017 年蘋果日報曾化驗五個流浮山蠔產品，其中三個樣本的鎘或鉻超標。

這些研究提升了市民對食物安全的關注。進食過量重金屬，會使肝腎受損，增加細胞內自由基水平，亦會破壞中樞神經，導致智商降低，甚至增加患上癌症的風險(Jaishankar et al., 2014)。



圖一 后海灣一帶地圖(地圖來源：Google Maps)

圖二 后海灣(白泥)蠔排及蠔柱

1.2 水質的生物標誌物

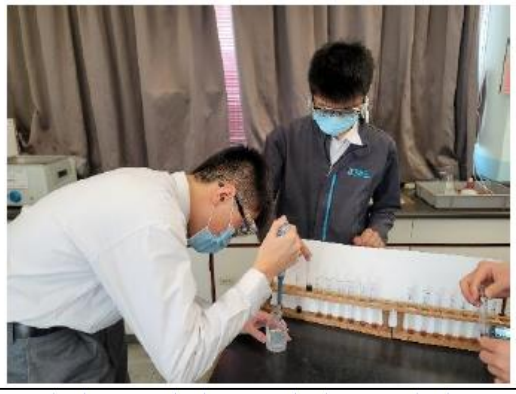
我們希望能夠**長期監測后海灣海水及沉積物的重金屬含量**，這有助蠔民了解水質變化，惟測試重金屬的濃度的原子吸收光譜和電感偶合等離子體發射光譜儀儀器價格高昂，非學校所能添置。

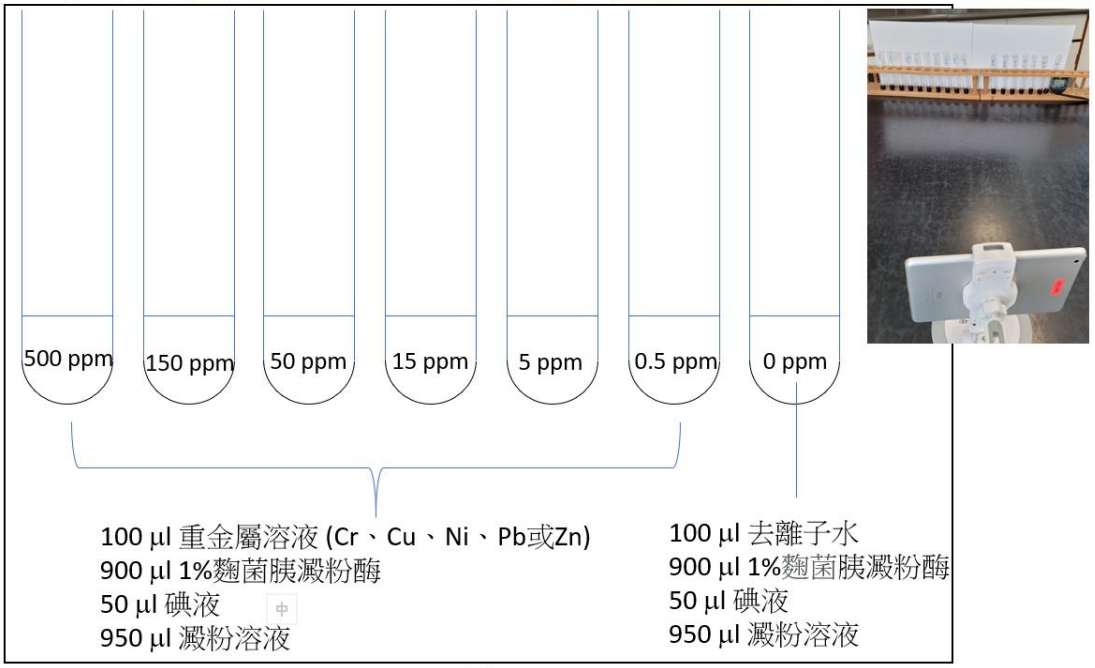
由於重金屬離子會在細胞內影響細胞內的生物化學作用，從而影響生物的生化作用、細胞的活性以致整個生物體，這些影響均可作為**重金屬的標誌物(Biomarker)**。Kaviraj et al (2014)指出量度這些影響，可估算這些**環境污染物對生物的早期風險**。在本研究，我們會測試能否以**麴菌澱粉酶、過氧化氫酶和豐年蝦**作為重金屬生物標誌物，並比較它們的敏感度。

為了比較不同重金屬對標誌物的影響，我們會將數據利用 AAT Bioquest 平台計算的半致效應濃度(Half maximal effective concentration, EC_{50})、半致死濃度(median lethal concentration，LC_{50})及半抑制濃度(Half maximal inhibitory concentration, IC_{50})。

2. 實驗方法

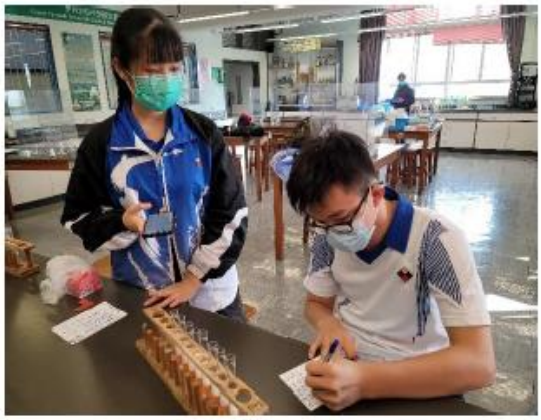
2.1 以麴菌澱粉酶作為重金屬生物標誌物

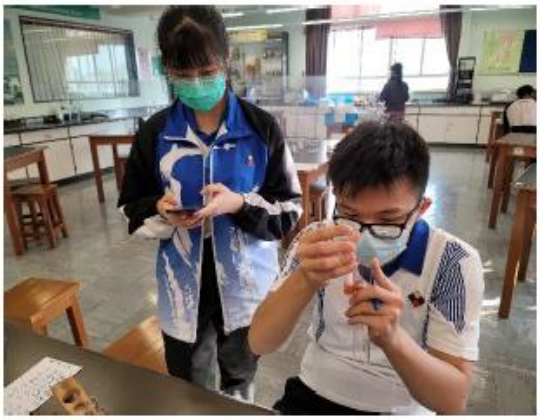


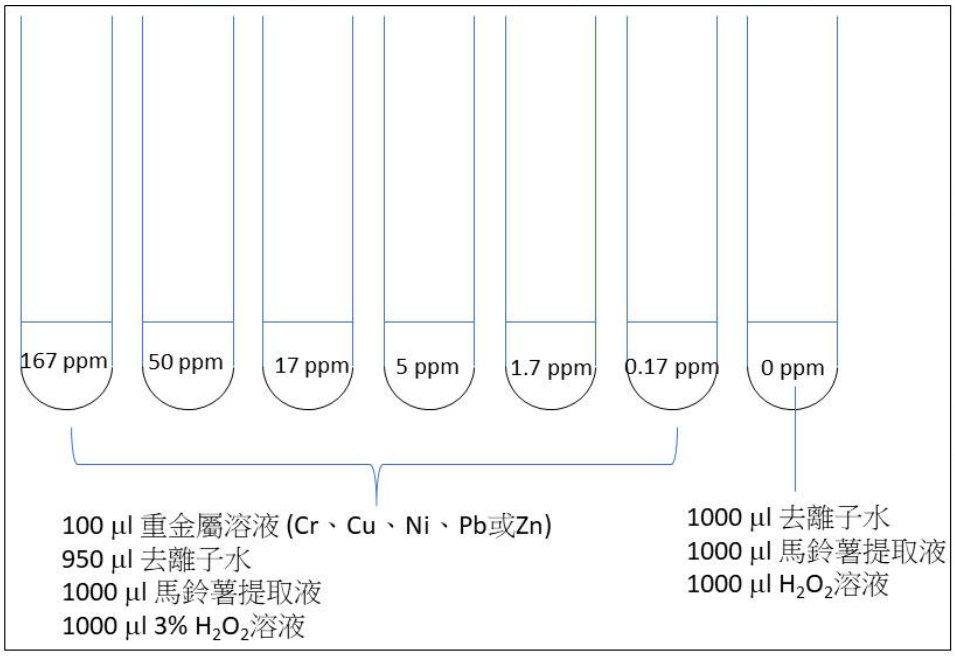


圖三　麴菌澱粉酶測試

2.2 馬鈴薯過氧化氫酶作為重金屬生物標誌物







圖四　過氧化氫酶測試

2.3 以豐年蝦作為重金屬生物標誌物

2.3.1 豐年蝦幼蟲測試

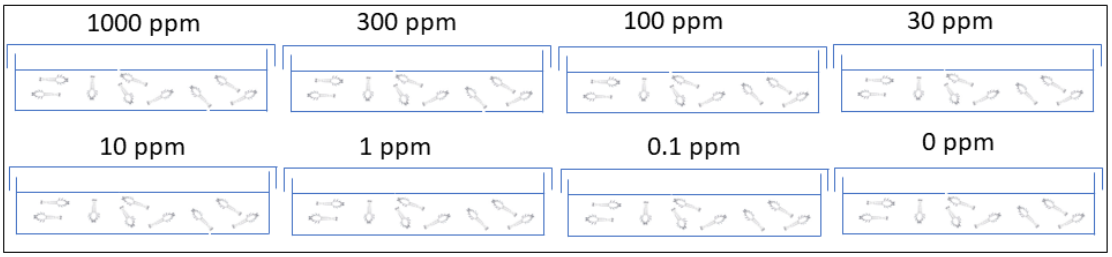
1. 將豐年蝦幼蟲放入含有不同濃度的重金屬溶液

小培養皿

2.7 mL豐年蝦幼蟲 + 0.3 mL重金屬 (Cr、Cu、Ni、Pb或Zn)溶液

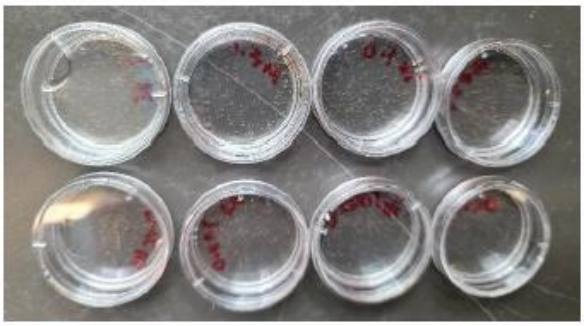
豐年蝦幼蟲

2. 等待兩小時



3. 利用解剖顯微鏡及手機進行拍攝，記錄活躍、不活躍及已死亡的豐年蝦幼蟲的數量，計算百分比

利用AAT Bioquest LC_{50}及EC_{50}計算機繪畫量效曲線圖和計算LC_{50}及EC_{50}

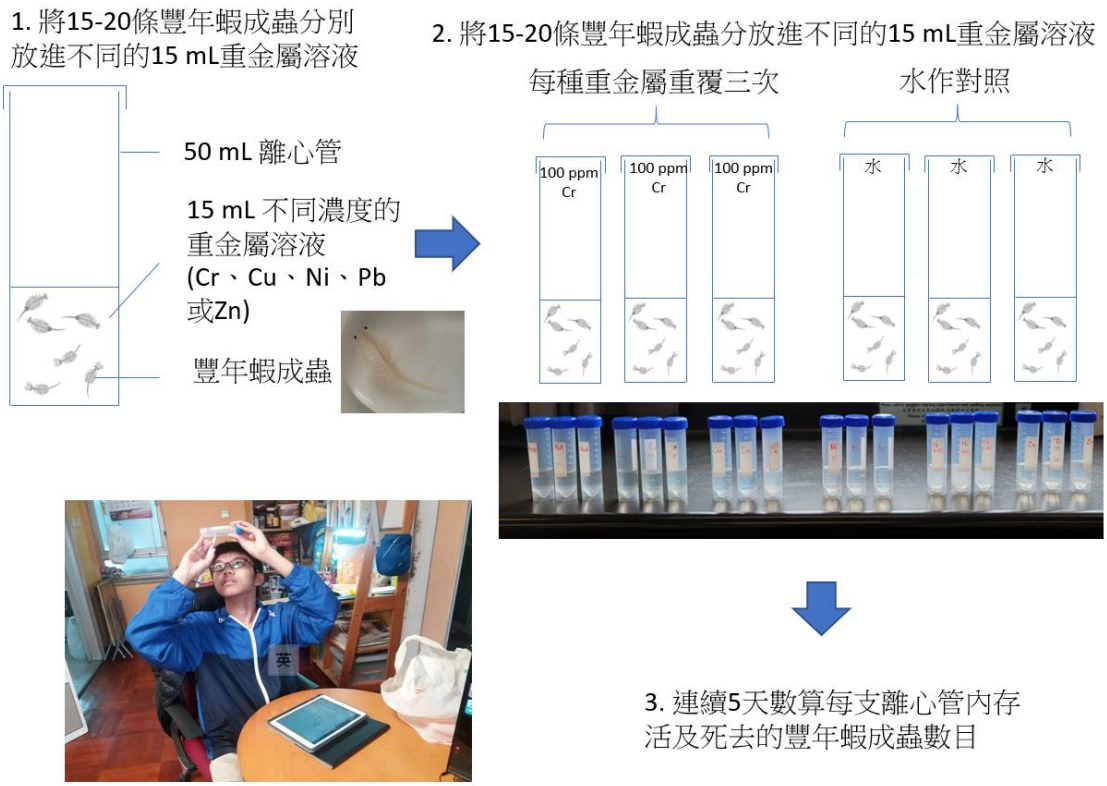


放置於小培養皿的豐年蝦幼蟲測試

豐年蝦幼蟲顯微照片

圖五　豐年蝦幼蟲測試

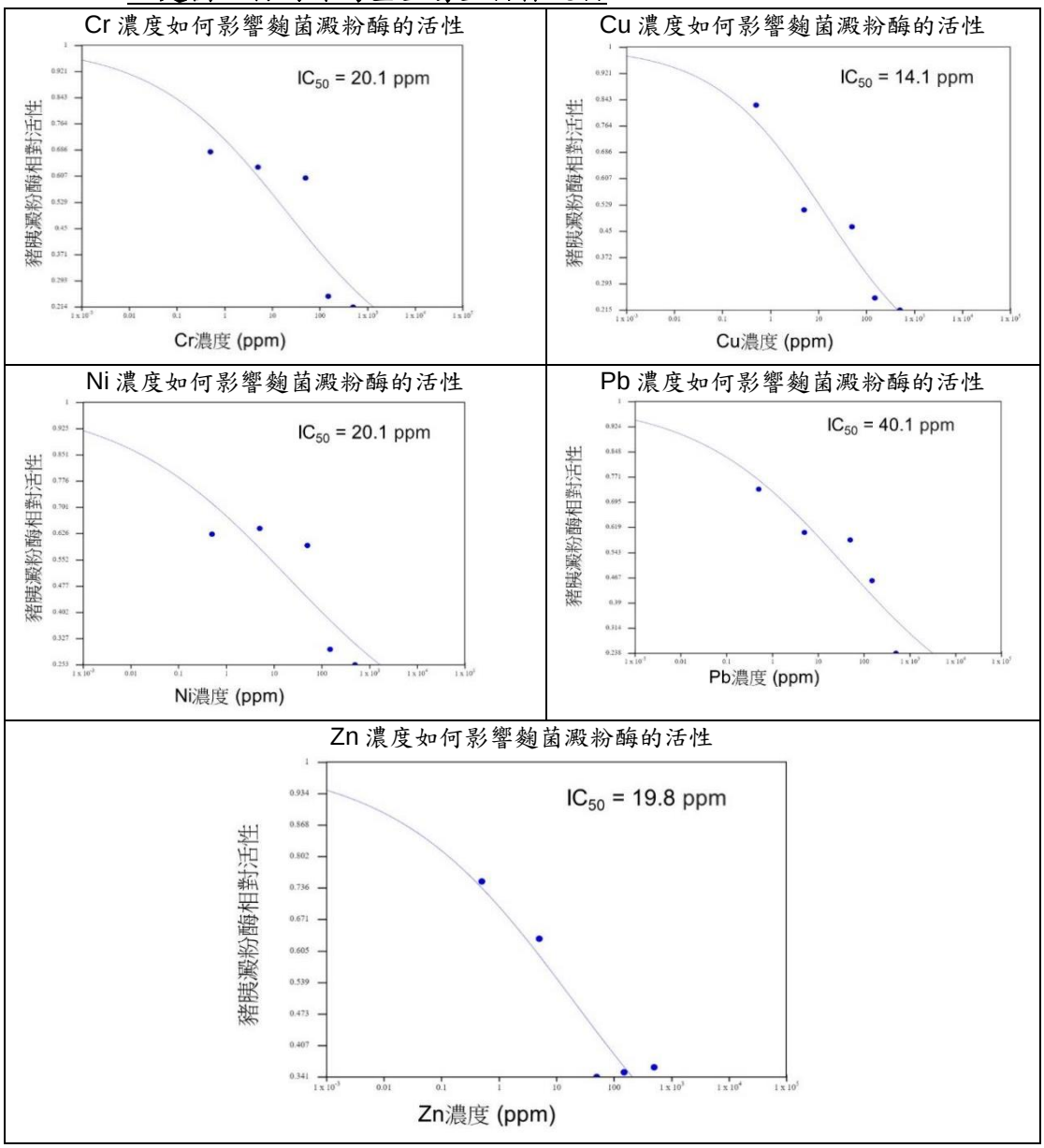
2.3.2 豐年蝦成蟲測試



圖六　豐年蝦幼蟲測試

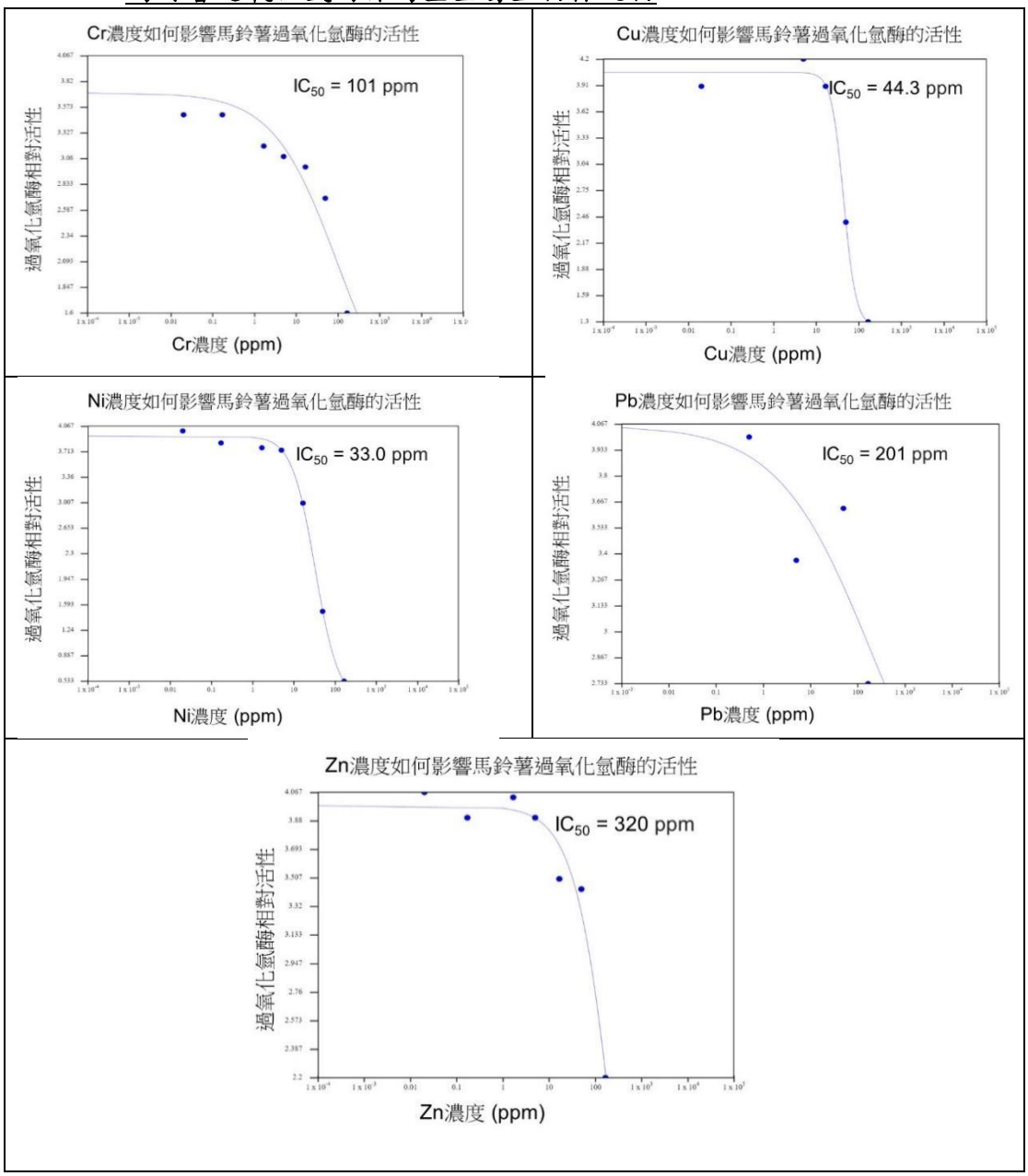
3. 實驗結果

3.1 以麴菌澱粉酶作為重金屬生物標誌物



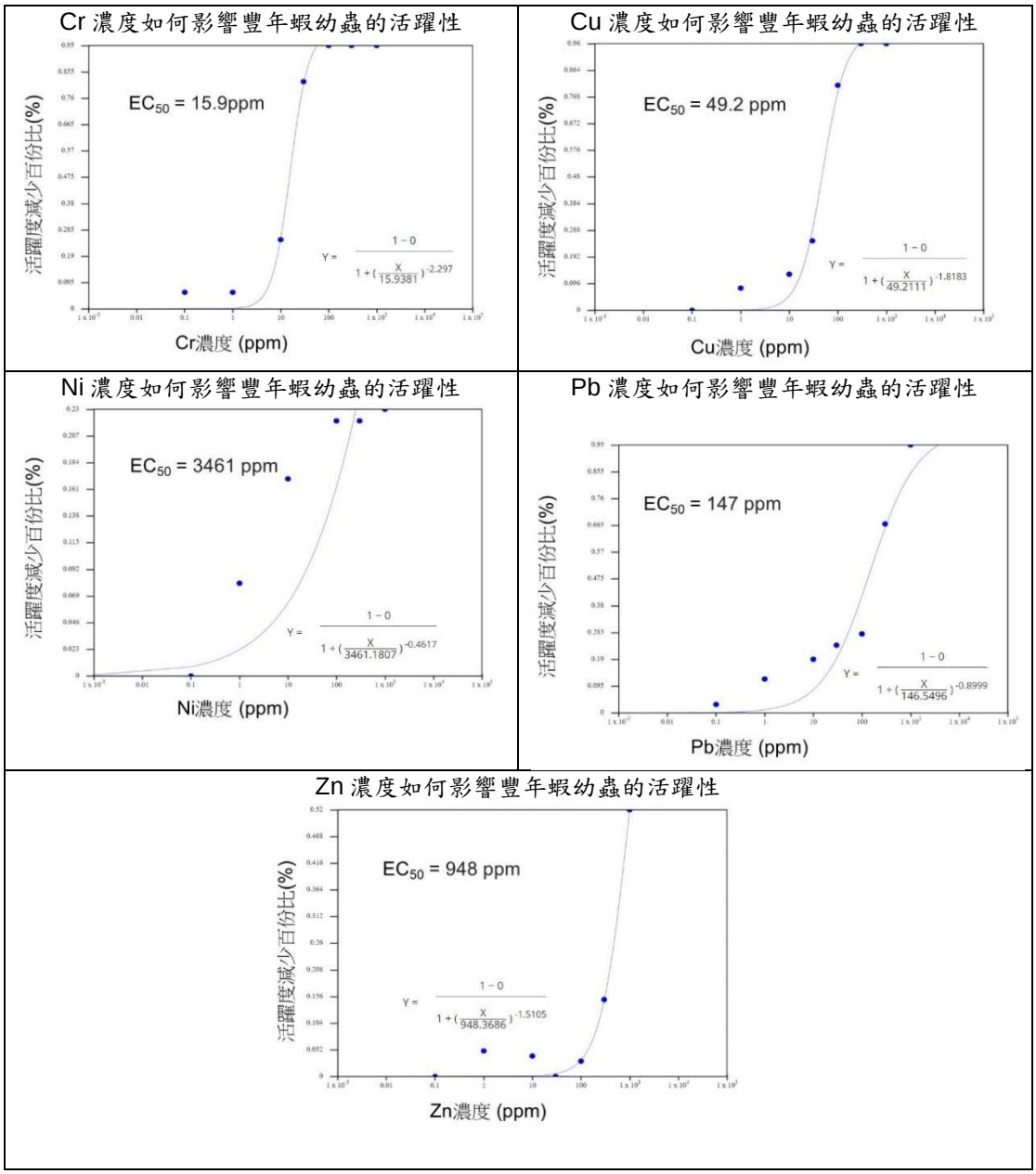
圖七　麴菌澱粉酶的 IC_{50} 結果

3.2 馬鈴薯過氧化氫酶作為重金屬生物標誌物

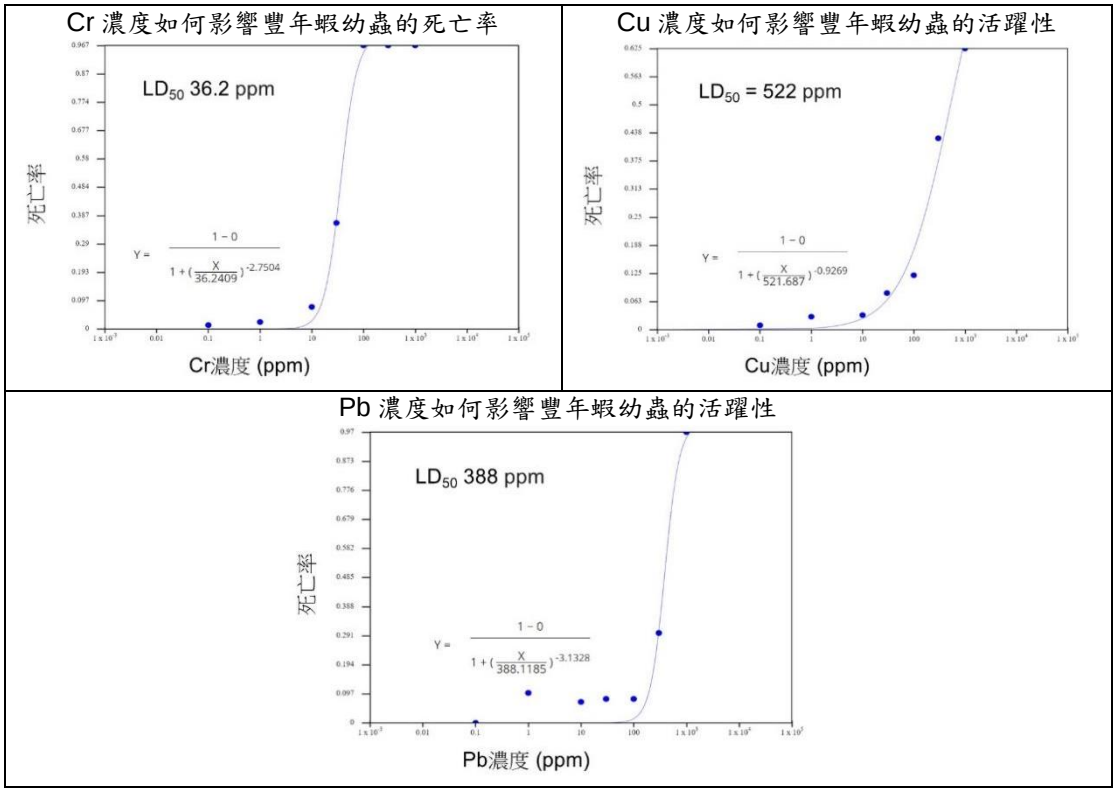


圖八　馬鈴薯過氧化氫酶的 IC_{50} 結果

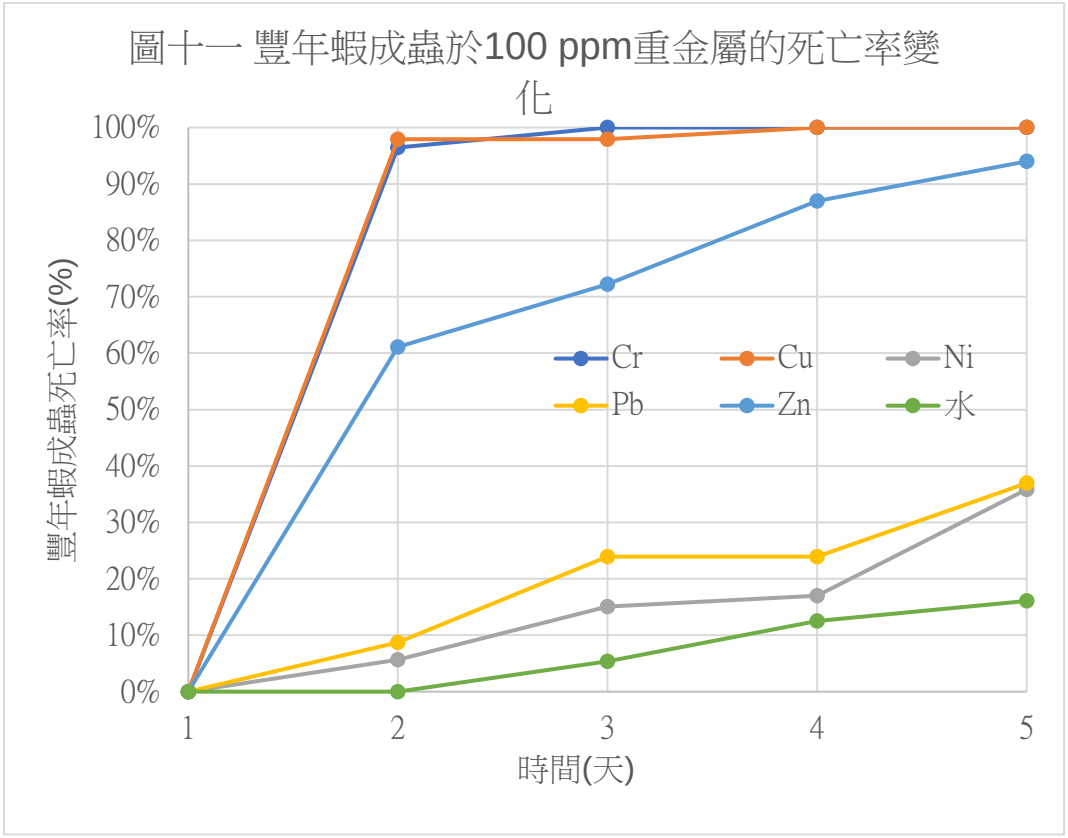
3.3 豐年蝦作為重金屬標誌物



圖九　豐年蝦幼蟲的 EC_{50}(兩小時內減低豐年蝦活躍性的 EC_{50}，包括活動減慢及死亡)



圖十　豐年蝦幼蟲的 LC_{50}(兩小時)



4. 討論

參考實驗結果，我們將各種重金屬的 IC_{50}、EC_{50}和 LC_{50}列出。

表一　各種重金屬的 IC_{50}、EC_{50}和 LC_{50}比較

重金屬	麴菌澱粉酶 IC_{50} (ppm)	*麴菌澱粉酶 IC_{50} (ppm)	馬鈴薯過氧化氫酶 IC_{50} (ppm)	#豐年蝦幼蟲 EC_{50} (ppm)	豐年蝦幼蟲 LC_{50} (ppm)
Cr^{3+}	20.1	2.25	168	15.9	36.2
Cu^{2+}	14.1	5.18	58.8	49.2	522
Ni^{2+}	20.1	15.8	27.3	3461	/
Pb^{2+}	40.1	6.34	206	101	388
Zn^{2+}	19.8	23.6	95.2	948	/

EC_{50}為導致豐年蝦幼蟲移動嚴重遲緩和死亡的半致效應濃度

* 結果來自另一組同學實驗結果

從表一，**麴菌澱粉酶的 IC_{50}一般都較過氧化氫酶及豐年蝦幼蟲低**，即表示麴菌澱粉酶對重金屬的敏感度較高，是**較好的生物標誌物**。我校另一組同學利用 37°C 溫水浴進行麴菌澱粉酶測試，更發現鉻的胰麴菌澱粉酶 IC_{50}為 2.25 ppm。不過這個測試要利用溫水浴及平板電腦進行記錄，每次進行測試的數目不能太多。而我們現時的方法，可在室溫下同時進行多組實驗。

利用豐年蝦幼蟲進行重金屬測試，兩小時的 EC_{50}及 LC_{50}方面，豐年蝦幼蟲的鉻 EC_{50}是 15.9 ppm，與麴菌澱粉酶的 IC_{50}水平相若，可見**豐年蝦幼蟲對鉻特別敏感，其次為銅及鉛**，但對鎳和鋅則不算敏感。這**趨勢跟成蟲的 LC_{50}相似**。由於在翌日大部份豐年蝦幼蟲都死去，我們相信若果進行四小時或六小時的觀察所得出的 LC_{50}、EC_{50}及 LC_{50}更能分辨這幾種重金屬的相對毒性。鋅有助生物進行 DNA 複製和有絲細胞分裂等過程(Beyersmann 及 Haase, 2001)，而由於豐年蝦的生長速度很快，對鋅的需求可能較大，這或可解釋為何豐年蝦的幼蟲對鋅不敏感。

由於**豐年蝦幼蟲**的價錢更為便宜，對重金屬的敏感度亦較成蟲高，**是較好的重金屬標誌物**。而且我們可在顯微鏡下觀察豐年蝦的行為及孵化情況，這些變化亦可作為生物標誌物，但有待我們跟進研究。

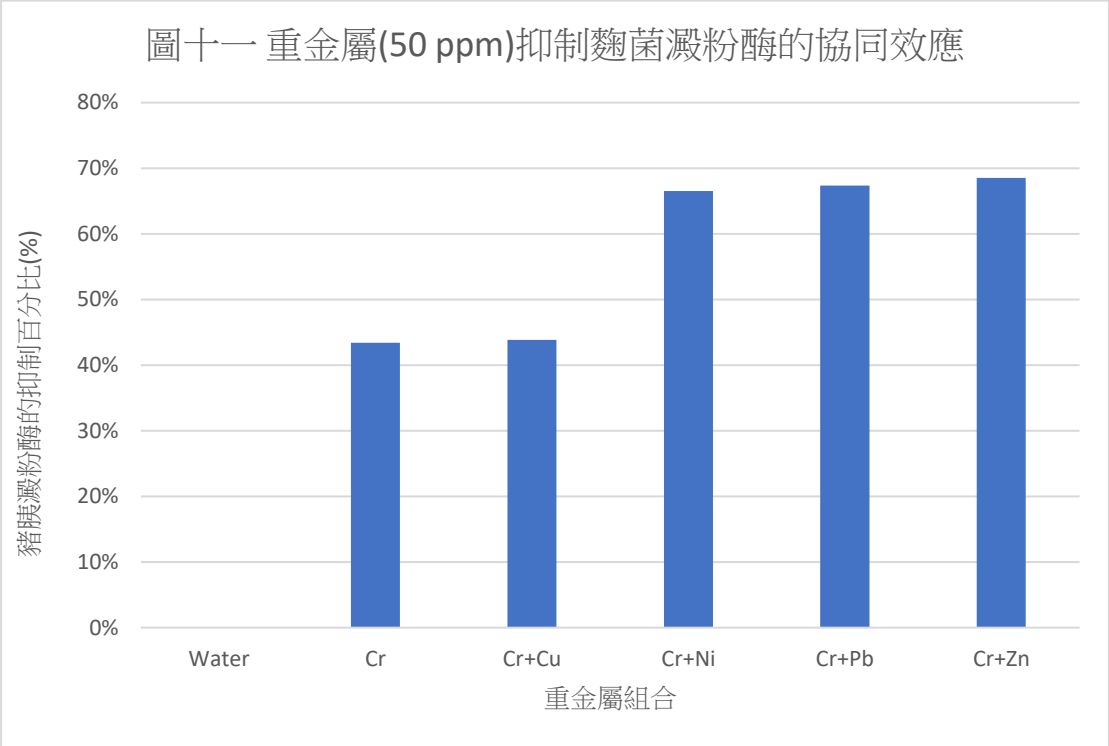
參考 Wyss & Yim (1981)及環保署的環評報告，香港沉積物的重金屬含量(ppm/乾質量)為 10-130 ppm 不等。由於重金屬會依附於沈積物和淤泥中，一般較難以離子形態於水中出現。要檢測海洋污染對生物的影響，通常會以可交換重金屬離子的含量作比較(Nowrouzi et al., 2014)。由於**香港水域內的重金屬含量與麴菌澱粉酶 IC_{50}和豐年蝦幼蟲的 EC_{50}水平相若，我們相信可以這兩種方去初步檢視沈積物的重金屬的毒性**。可惜因疫情關係，我們現時難以在香港水域，如流浮山養蠔區一帶取得沈積物進行分析。我們期待疫情過後，可作出跟進研究。

利用麴菌澱粉酶及豐年蝦幼蟲作標誌物有以下好處：

(a) **<u>價錢便宜</u>**。我們所用的物資，都是一般坊間容易購買的，估算每個測試的消耗品只需 0.1 至 0.5 元。

(b) **<u>測試過程簡單</u>**：我們所用的儀器亦是一般中學實驗室儀器，所佔空間不太多，方法簡單，一般可於半小時至數小時內完成。

(c) 可以測出**<u>污染物的協同效應</u>**。環境樣本中含有不同的環境污染物，生物標誌物可有助了解這些污染物會否存在協同效應。我們嘗試以麴菌澱粉酶作初探，結果可見於圖十一，結果顯示鉻跟鎳、鉛或鋅有較強的協同效應。這是原子吸收光譜儀不能做到的，同時有機會讓我們知道在多種污染物同時出現時，對生物體的潛在風險或毒性。



5. <u>結論</u>

三種重金屬測試中，以麴菌澱粉酶敏感度最佳，而豐年蝦幼蟲亦較成蟲高。以麴菌澱粉酶及豐年蝦作重金屬毒性測試，價格便宜、容易操作。

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季軍

2019/20 — 2020/21
Hong Kong Budding Scientists Award

Investigation on the feasibility of "Bio-Textile Material" - SCOBY

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Introduction

Environmental Problems caused by the Textile Industry

According to ***The 2015 United Nations Climate Change Conference***, the textile industry is the second-largest source of pollution in the world. Different stages of textile production produce tones of harmful pollutants. According to the World Wildlife Fund, to produce a single cotton t-shirt, 2,700 liters of water is necessary. Nowadays, cotton is the world's largest pesticide-consuming crop and harms both soil and water.

Polyester fiber is the most common material and uses up 70 million barrels of oil each year. It requires more than 200 years to be completely decomposed which leads to more rubbish.

Leather also causes pollution by using harmful chemicals in the tanning process, which harms workers' health.

What can we do to relieve environmental damages made by the textile industry? Are there any eco-friendly materials we can use instead? Recently, QUT fashion academic Dean Brough and other designers proposed using kombucha SCOBY as a textile material.

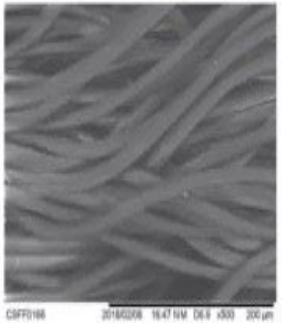
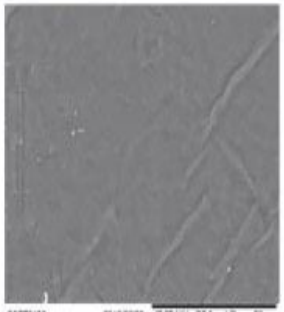
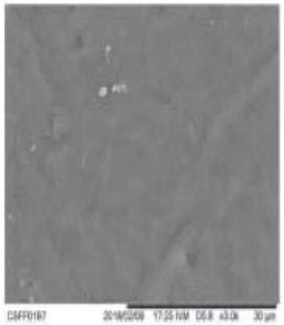
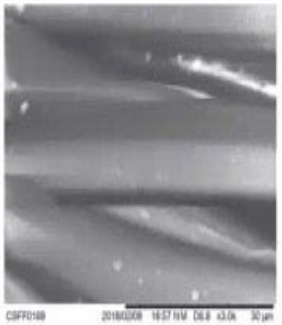
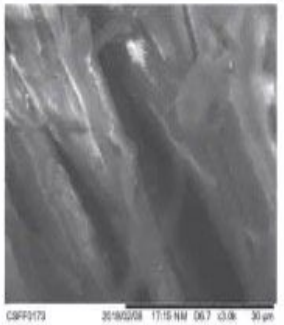
What is Kombucha SCOBY?

Kombucha is a drink made by adding acetic acid bacteria and yeast to sweetened tea which assists in digestive health. Yeasts and bacteria are involved in metabolic activities. They hydrolyze sucrose into glucose and fructose by invertase and produce ethanol in the process, with fructose as a substrate. Acetic acid bacteria produces gluconic acid and ethanol to produce acetic acid. It will form a pellicle on the surface of the tea made of cellulose which we call SCOBY.

Red Tea SCOBY

In the previous experiment, we had come to a conclusion that Red Tea SCOBY performs the best among Red Tea SCOBY, Green Tea SCOBY and Oolong Tea SCOBY and other commercially available textile materials (polyester, nylon and cotton) based on surface morphology, tensile strength and heat retention. From the SEM scanning, we can see that there are a numerous number of “porous” fibers between cotton and polyester while for Red Tea SCOBY, the fibers are closely packed with very little to no space between them. The scanning is shown below:

Comparing the Surface Morphology of Different Tea SCOBYs with commercial textile materials

Magnification	Red Tea SCOBY	Oolong Tea SCOBY	Polyester	Cotton
500X				
1500X				
3000X				

The fine fibers in Red Tea SCOBY perform excellently in tensile strength and heat retention tests. In the tensile strength test, results showed that polyester is the stiffest substance, followed by nylon, cotton, Red Tea SCOBY and Oolong Tea SCOBY. In the study of the thickness effect of tensile strength, the tensile strength of SCOBY increased with thickness. Hence, we made an assumption that tensile strength is directly proportional to its thickness and estimated the tensile strength thickness. It is found that with the same thickness, the tensile strength of Red Tea SCOBY is nearly double that of the polyester and 3.7 times stronger than the cotton.

In the heat retention test, Red Tea SCOBY showed the best performance among all the other materials. The fibers of Red Tea SCOBY are closely packed so it conserves heat energy better than cotton and polyester.

Therefore,we are going to use Red Tea SCOBY for further investigation. To increase the production yield, we found the optimum conditions for finer SCOBY growth is temperature, sugar concentration and exposed area. This enables us to study the feasibility of using SCOBY as an alternative to textile materials.

Aim and Objective

Aim: to investigate the feasibility of using SCOBY as alternative to textile materials

The objectives of this research are:

1. To have a deeper insight into pollution caused by the textile industry.

2. To increase the production yield of Red Tea SCOBY by growing it in different conditions

3. To find out the features of Red Tea SCOBY by studying its other properties by experiments

Methodology

We plan to find out the problems arising from the textile industry and study the feasibility of SCOBY by using microbes to grow "textile". To study it, we searched for secondary information from websites, books , and carried out experiments.

First, we will increase the production yield of Red Tea SCOBY by optimizing its growth conditions (temperature, sugar concentration, exposed area and days of growth). Next, we will study the textile properties of the SCOBY and compare them with various textile materials (e.g Cotton, Nylon and Polyester) to study the feasibility of using SCOBY as textile material.

In the experimental investigation, two sections are involved:

Section 1: Growing SCOBY at different conditions

Section 2: Comparing "textile" properties of SCOBY with various textiles.

Experimental details

Section 1

Growing SCOBY at different conditions

1. Objective

- To grow the SCOBY at different conditions (such as temperatures, sugar concentrations and exposed areas)
- To find out the optimum conditions for SCOBY growth.

2. Safety Precaution

1. Wear safety goggles and gloves

3. Procedure to grow SCOBY

1. Weigh 20 g sugar using electronic balance.
2. Mix 20 g sugar, 600 mL water and 2 tea bags of Red Tea, and boil the mixture using an electric kettle.
3. Pour it into a 1L beaker and cool it.
4. Measure 200 mL Kombucha using a measuring cylinder and mix it in with the mixture.
5. Pour the mixture into three 250 mL beakers evenly.
6. Cover the mixture and grow “SCOBY”.
7. After a few days, the SCOBY will be air-dried overnight.

Part A Growing SCOBY using different temperatures

1. Prepare two different bottles with SCOBY in it.
2. Put one of the bottles at room temperature.
3. Put the other in an incubator with the temperature set to 35ºC.
4. Check on the SCOBY for 7 days, 15 days and 30 days respectively.
5. Measure the thickness of the SCOBY.
6. Compare both of them and find out the more optimum temperature that assists SCOBY growth.

Part B Growing SCOBY at 35°C using different sugar concentrations

1. Prepare 5 bottles with the different levels of sugar concentrations (6.67g/200mL, 20g/200mL, 33.33g/200mL and 133.3g/200mL).
2. Once cooled, pour the SCOBY culture into each bottle.
3. Put them into the incubator and set it to 35 ºC.
4. Measure the thickness of the SCOBY in both containers.

Part C Growing SCOBY using different exposed surfaces

1. Prepare containers of different exposed surfaces.
2. Pour the SCOBY mixture into the containers.
3. Measure the size of SCOBY grown in each container.

Part D Growing SCOBY with seawater

Same as the Procedure to grow scoby, except the tap water is replaced by the seawater

Section 2

Compare “textile” properties of SCOBYs with commercially available textile materials.

Objective

To study the features of SCOBY by comparing the textile properties of Red Tea SCOBY with Cotton and Polyester

Safety Precaution

1. Wear safety goggles and gloves

Part A Air Permeability Test

1. Cover the plastic tube with Red Tea SCOBY and secure it with a rubber band.
2. Place a table tennis ball inside of the tube, and cover it .
3. Put the setup on a flat surface so that gravity will not affect the experiment.
4. Put the hairdryer in front of the side of the tube covered with SCOBY.
5. Switch on the hair dryer for 2s.
6. Observe the movement of the ball.
7. Repeat Steps 1-6 using cotton.

Part B Dyeing Test

1. Add and dissolve one spoon of fabric dyeing powder into 150 mL hot water
2. Immerse SCOBY into the solution.
3. Wait for the color to become fully absorbed into SCOBY.

4.Take the SCOBY out and wash it under running water for 1 minute.

5.Dry it for one day

Part C Chemical Test

1. Prepare beakers containing 20 mL of the following solutions respectively:

- Dilute Sodium Hydroxide solution
- Baking Soda solution
- Dilute Sulphuric Acid
- Coconut oil
- Cellulase solution
- Distilled water (control)
- Boiled water

2. Immerse one SCOBY into each solution for 2 hours.

Part D Chemical Test with SCOBY in acid and alkaline environments

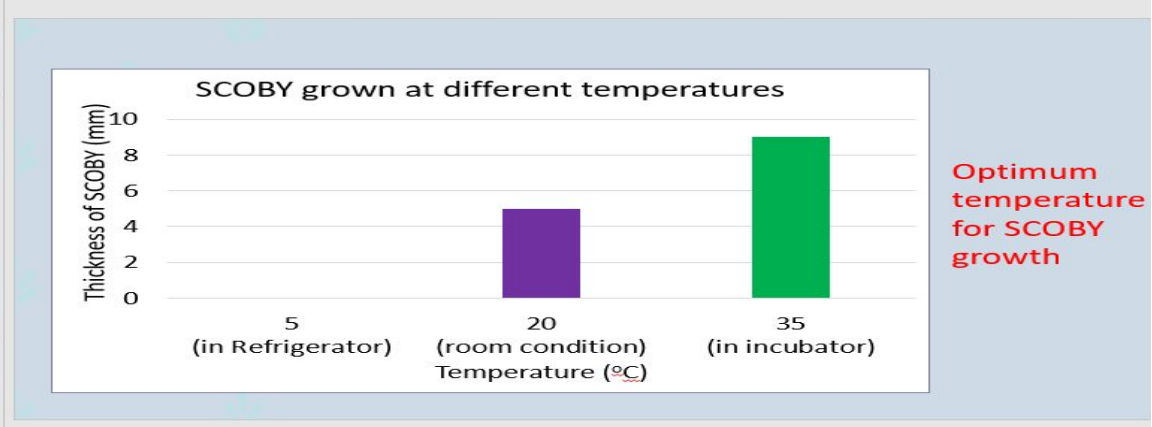
Experiment :

1. Prepare 2 samples of SCOBY, dilute hydrochloric acid and dilute sodium hydroxide solution.
2. Add 20mL dilute hydrochloric acid to a SCOBY sample.
3. Add 20mL sodium hydroxide solution to another SCOBY sample.
4. After 3 hours, compare the samples
5. Observe the texture of the samples.

Results and Analysis

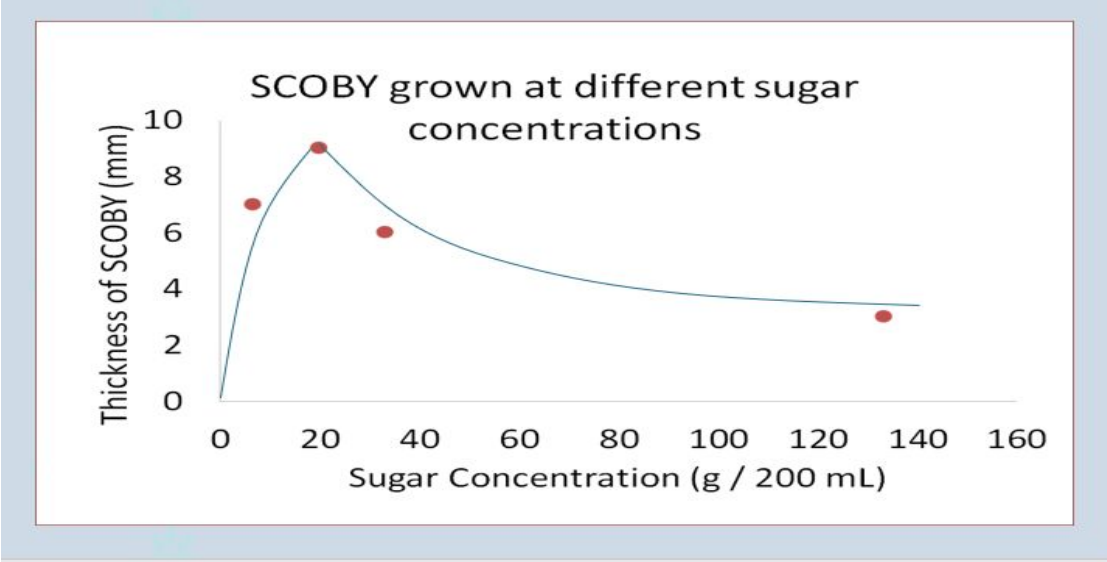
Section 1

Part A Growing SCOBY using different temperatures (room condition and 35oC)

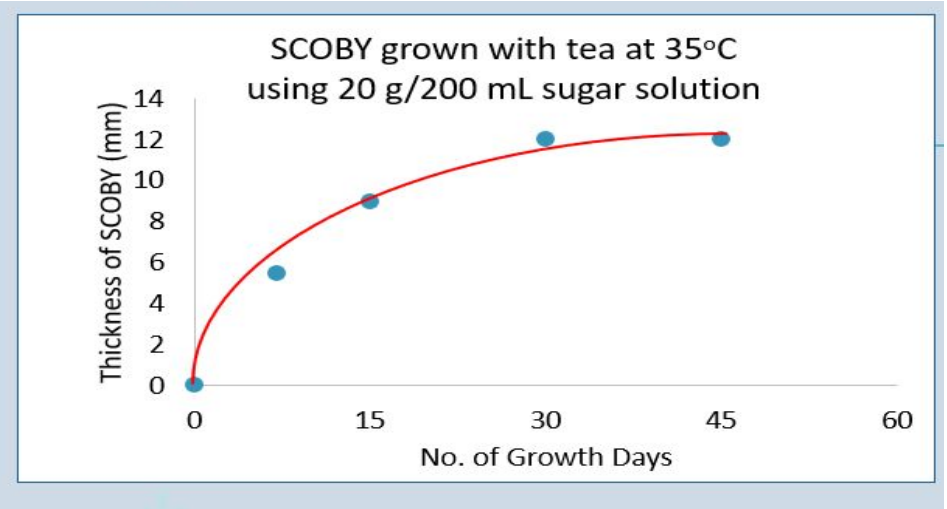


We carried out an experiment on growing SCOBY at refrigerator temperature (5ºC), room temperature (20ºC) and incubator temperature (35ºC). 15 days later, its thickness went up to 9mm in the environment of 35ºC). SCOBY grew in room condition and in the refrigerator performed poorly, with 5mm thickness at 20ºC and 0mm at 5ºC. As a result, 35ºC is used as our default SCOBY growth temperature.

Part B Growing SCOBY at 35oC using different sugar concentrations

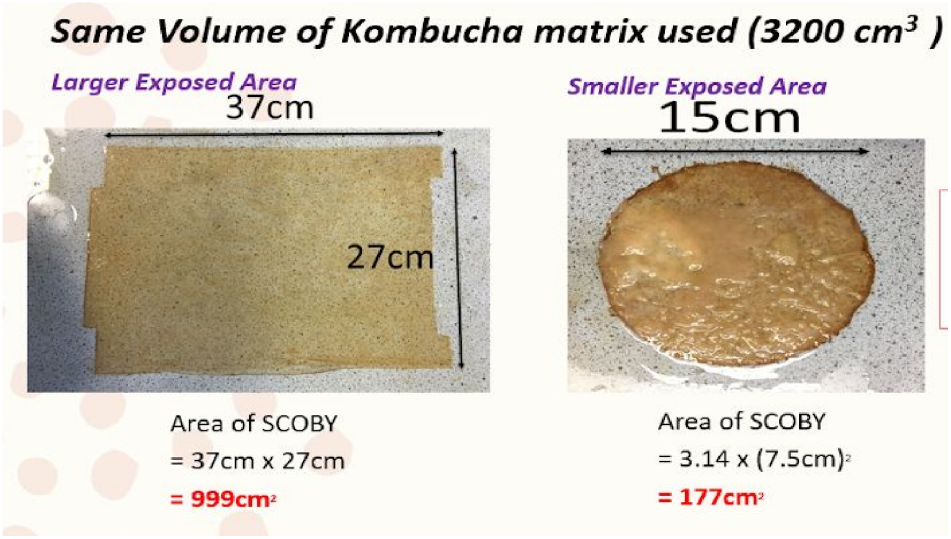


On the 15th day, the SCOBY using sugar concentration of 20g/200mL grew to 9mm and reached the peak in the curve, while its thickness using sugar concentrations 6.67, 33.33, 133.3 g/200mL only grew 7mm, 6mm, 3mm respectively.This might be caused by insufficient nutrients for microbe growth in 6.67g/200mL sugar concentration,while 33.33g and 133.3 g of sugar provided excess nutrient for SCOBY, causing extra microbe growth and increase the toxic chemicals during fermentation, which disfavour the microbes' growth. Therefore, SCOBY thickness decreases when the sugar concentration exceeds its need. Based on our results, it grows the best in the 20g/200mL sugar concentration.



The chart shows that SCOBY thickness increases with the number of days and is saturated at ~45th days. Although SCOBY grew to 9mm on the 15th day, by the 30th day, the thickness of SCOBY only increased marginally (by 33.3%).Therefore, it is suggested to increase the yield by growing them for ~15 days with a more batches.

Part C Growing SCOBY using different exposed surfaces



The area of the SCOBY increases with increasing exposed area .

Part D Growing SCOBY with seawater

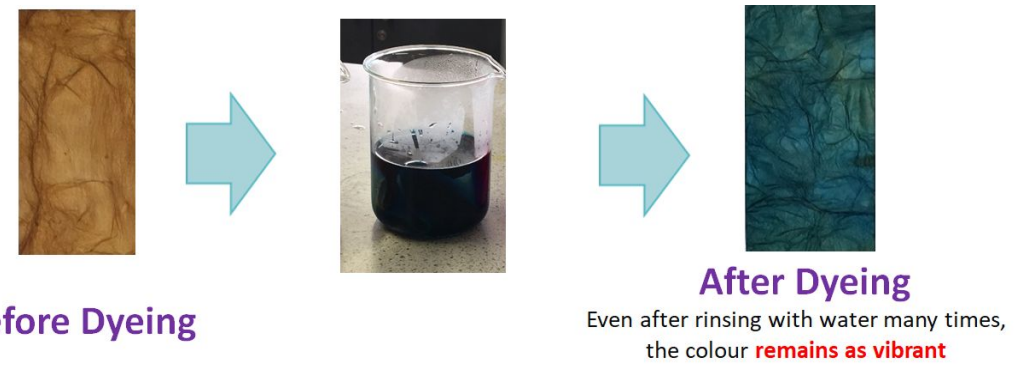
The result shows that the SCOBY grew with seawater is the same as that grew with tap water. Therefore, seawater is suitable for growing SCOBY.

Section 2

Part A Air Permeability Test

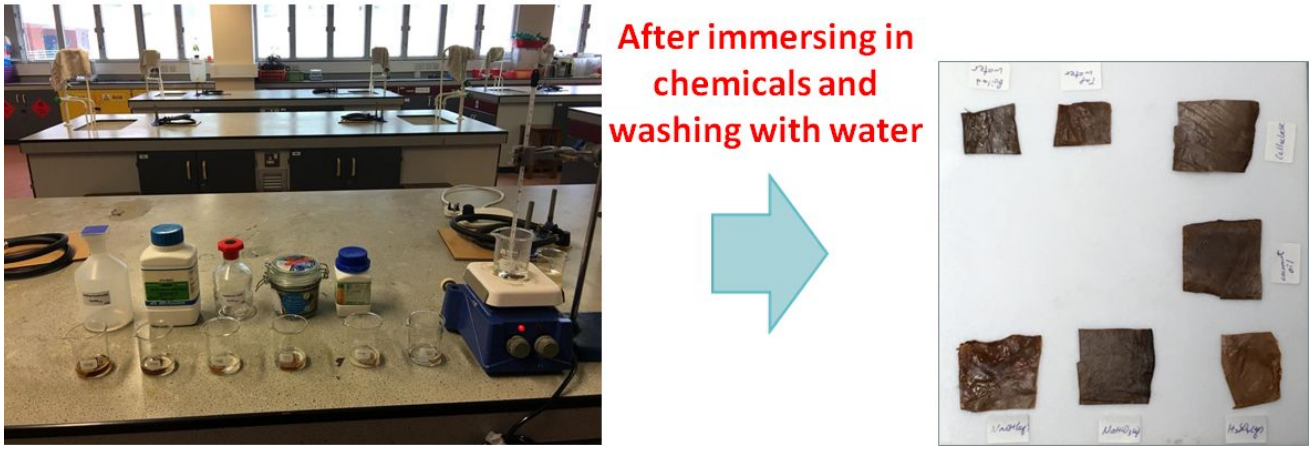
The ball in the plastic tube wrapped with SCOBY remained stationary after switching on the hairdryer whereas the one in the plastic tube wrapped with cotton did .This indicates SCOBY is not permeable to air while cotton is.

Part B Dyeing Test



After being dyed, we rinsed SCOBY with water numerous times and found that it still remained vibrant. Therefore,we conclude that dye sticks to SCOBY firmly.

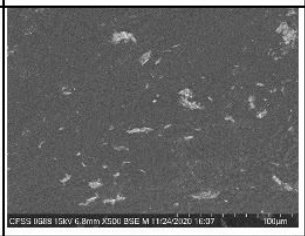
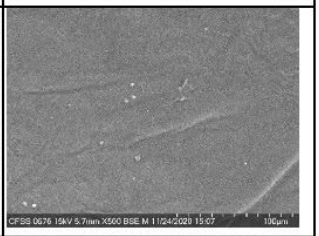
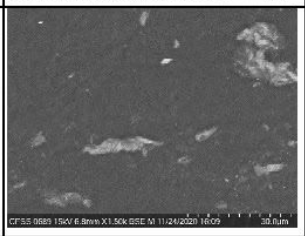
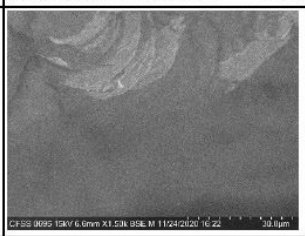
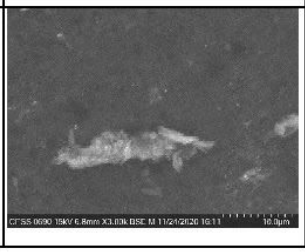
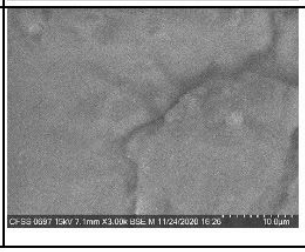
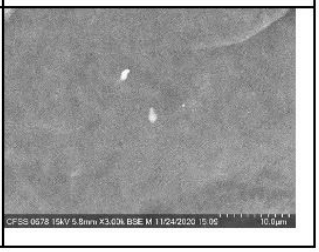
Part C Chemical Test



SCOBY was chemical resistant as it was not destroyed nor decomposed during the experiment. The alkalis were also found to reduce the stickiness of SCOBY by removing the organic acid.

Part D Chemical Test with SCOBY grew in seawater

SCOBY grew with seawater and was also proven to be chemical resistant as it was not decomposed.

magnification	SCOBY+NaOH	SCOBY+HCl	SCOBY
500X			
1500X			
3000X			

Summary and Conclusion

As stated by COP21, the textile industry is the second-largest polluter. Besides, the shrinking supply of cotton results in the rise of production cost. In this study, we investigated the feasibility of using Red Tea SCOBY as an alternative to textile materials. Firstly, we inspected the growth conditions to increase production yield. We conducted an air permeability test, dyeing test and chemical test and compared it with cotton.

In experiments, it was found that SCOBY grows the best at 35 ^{o}C, with the sugar concentration of 20g/200mL. To increase the yield, it will only be grown for 15 days in each batch.The increase in the exposed area for SCOBY growth will increase its size. To reduce the growth cost , we grew SCOBY using seawater, which was a success.

In the air permeability test, we found that SCOBY is impermeable to air while cotton is . In the dyeing test, we used fabric dye that is commonly used for dyeing cotton. After it was dyed, we rinsed it with water and it remained in a vibrant state. This indicates dye can stick firmly on SCOBY. In the chemical test, the SCOBY was not destroyed or decomposed, which proves its chemical resistance. We found that alkaline substances reduce the stickiness of the SCOBY by removing the organic acid produced during its growth. In the chemical test performed with SCOBY grown with seawater, the SCOBY was still chemical resistant. Therefore, seawater is suitable for growing SCOBY.

To conclude, growing SCOBY at 35 ^{o}C in seawater and a sugar concentration of 20g per 200mL, then putting it in a larger exposed area for 15 days increases its production yield. For the application of materials in the textile industry, Red Tea SCOBY is impermeable to air,

chemical-resistant, and can be dyed easily, which shows a great potential in being a heat insulative material.

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Note:
This report was featured in other competitions such as Budding Scientists Award, STIC and SSPC competitions. Thank you.

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2019/20 — 2020/21
Hong Kong Budding Scientists Award

Topic 1

Scientific Investigation Related to Clothing

Presented by:

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Content

1.Background

In recent years, the average mean temperature of the Earth has been increasing rapidly and it is projected to rise in the near future as well.

In order to deal with this global issue, we decided to conduct an investigation regarding our daily clothing to cope with the situation. In our research, we hope to use various materials to create clothing which can help people escape from the sufferings brought by the extreme heat.

Normally people would like to take off their clothes when they are on a very hot day to lose heat more quickly and make themselves not sweat as much, for example when people go to the beach.

Fig.1: People on a beach on a hot summer day

But in areas with high outdoor temperature such as Egypt, people wear a lot of clothes on their body to prevent the heat from surrounding their body which is a lot different from what people would normally do in a situation like this.

Fig.2: People in the desert

The areas we would consider in this research includes how the material, color and the thickness of the clothing would affect the effectiveness of keeping the body cooler.

2.Introduction

On a sunny day, when the air temperature is higher than the human body, heat can be transferred to the human body through three methods: radiation, conduction and convection. Light from the sun gives off radiation, which can be absorbed by the human body. It also heats up the surrounding air. The heated air rises and transfers heat to the human body through convection. Heat is also transferred into the human body through conduction from the hot clothes and air. When the surrounding temperature is higher than the human body, the material of clothing should block the outside heat from overheating the human body by conduction, convection and radiation.

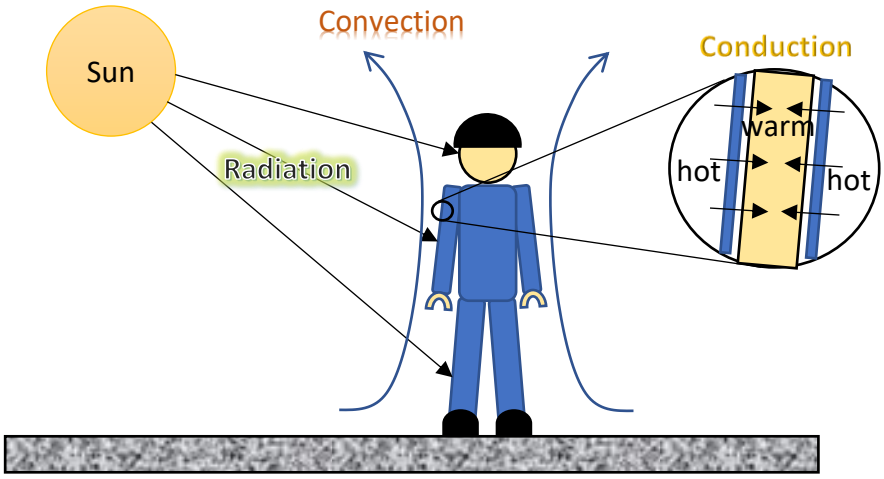


Fig.3: Heat transfer process

Since it is expected that the outdoor temperature on a hot summer day will be often higher than 36°C, the human body overheats very easily. Therefore, we would like to conduct an investigation to find the most suitable clothing under hot weather.

To investigate what kind of clothing is most suitable under hot weather, we have conducted different groups of experiments on several variables, including color, thickness and material of the clothing. Each effects a different heat transfer method, thus we would like to create a composite material which can reduce heat gained by the human body from all three heat transfer methods.

3.Hypothesis

In common situations, cotton and linen are expected to be the most suitable material for clothing under hot weather conditions as they provide higher convection rates. However, in extreme weather conditions, it would be best for the material to be able to block out heat outside from entering the body through convection. Therefore, wool and polyurethane laminate cloth are tested to see whether they can provide better insulation to the human body.

Other than that, the color of the cloth would affect the body temperature as well. It is known that materials that are silver in color are a bad absorber of radiation, while materials that are black in color are a good absorber of radiation. Therefore, having the clothes in silver color would be the best in reducing heat gained through radiation. However, the different combinations of color may also give different results, and thus will be tested to see which combination would keep the heat gained through radiation to the lowest, thus keeping the body cool.

The thickness of the cloth would also affect the result of the experiments. As air is a good insulator of heat, clothing with considerable thickness would be able to reduce heat gained by the human body through conduction.

4.Preparation
4.1 Experimental Setup

The following systems will be used in all three tests.

4.1 DIY data logging system:

Several temperature and humidity sensors are used to record the air temperature surrounding the body as well the change in humidity from the evaporation of sweat. Arduino UNO is used as a microcontroller and it is connected to a submersible temperature sensor (DS18B20) and a temperature and humidity sensor (DHT11). Data collected is transferred to the computer through USB cable and is recorded in a spreadsheet.

4.2 Artificial sunlight:

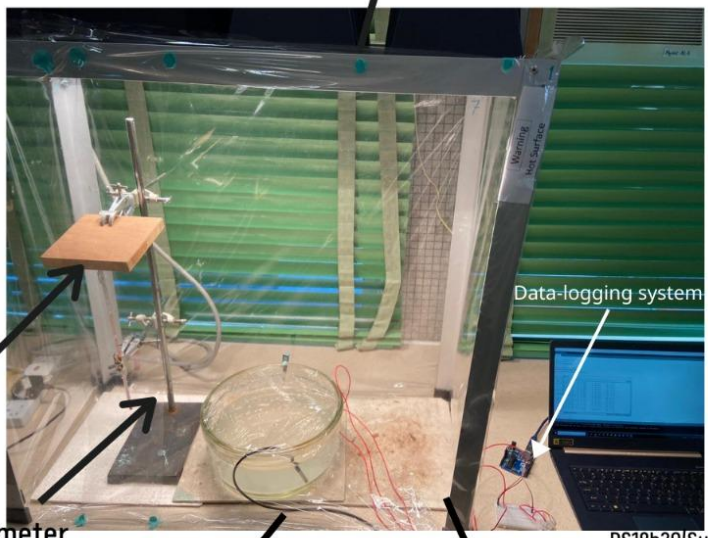
Four sunlamps, a metal frame and plastic book wrap are used to create an artificial sunlight setup. Four sunlamps were placed on top of the metal frame, then the frame is wrapped with plastic book wrap to reduce heat loss to the surroundings for our experiments. A thermometer is placed using a stand and clamp inside the setup to monitor the temperature inside. To reduce direct radiation from the artificial sunlight so as to measure air temperature, a wooden block is hung over the thermometer.

4.3 Human sweat:

Human sweat contains 0.9g/L of Na+ ions, 0.2g/L of K+ ions, 2.9g/L of lactic acid and 1.8g/L of urea. This means that there are 0.9g/L23=0.0391 mol/L Na+ ions and 0.2g/L39.1=0.00512 mol/L K+ ions. To mimic sweat, NaCl, KCl, lactic acid and urea are used to create an artificial sweat solution. 0.0391mol/L 58.4 g/mol =2.28g/L NaCl and 0.00512 mol/L and 74.6 g/mol = 0.382 g/L KCl are used to create our artificial sweat solution.

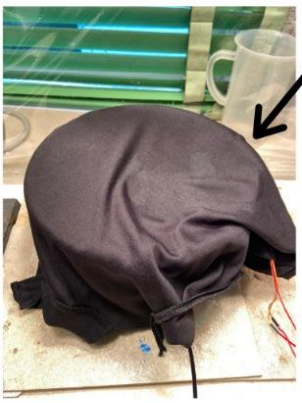
Experimental Setup

Artificial sunlight: With about 2000kW, Covering about 1 m^2



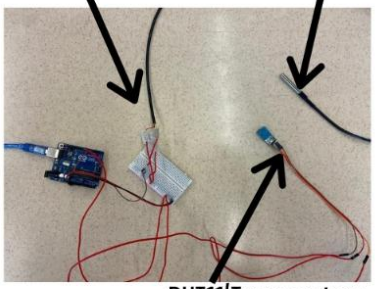
Wooden block: Prevent the thermometer from direct heating by radiation

Thermometer



Artificial sweat: Mixed with different metal ions to mimic human sweat.

DS18b20(Submersible Temperature Sensor)



DHT11(Temperature Sensor)

4.2 Preparation of all tests

1. 2.5L of the artificial sweat solution is poured into the glass bowl.
2. The water temperature sensor is submerged in the solution while the temperature sensor is sticked to the side of the glass bowl
3. The artificial sunlight setup is turned on and waits for the temperature to reach 40°C.
4. The setup is prepared and different testers can be placed above the glass bowl.

5.Experiments
5.1 Test between different materials

5.1.1 Aim

To test the rate of heat gained through convection by the human body.

5.1.2 Material to be tested:

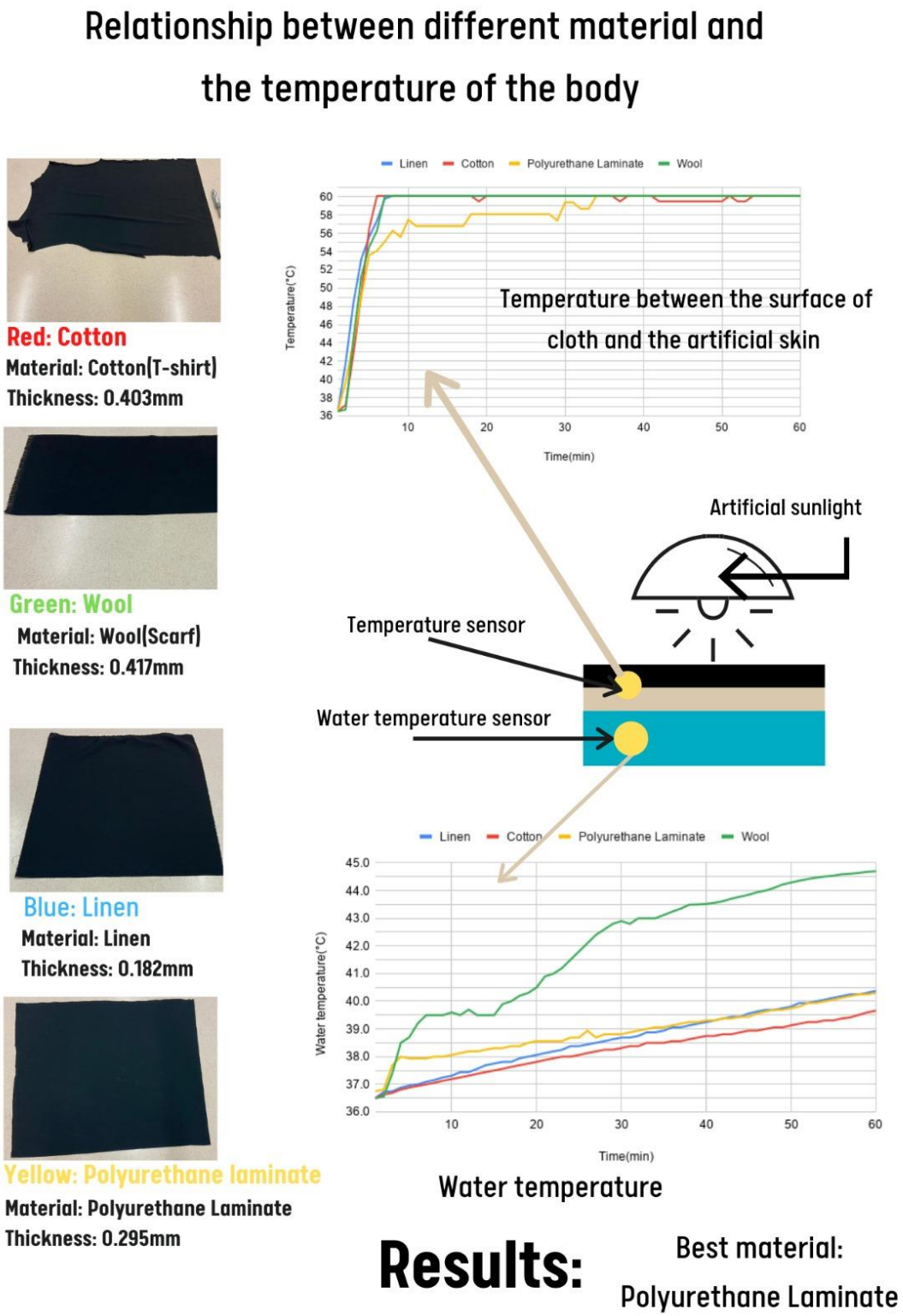
- Cotton
- Wool
- Linen
- Polyurethane laminate cloth

***Assume they are in same color and same thickness**

5.1.3Procedures:

1. Step1 - 6 of 5.1.3 is repeated in this experiment.
2. Procedures are repeated with four different materials.

5.1.4 Results:



5.1.5 Conclusion

Among all experimental results, it is found out that the rise in both air temperature and water temperature was the lowest when polyurethane laminate cloth was applied. Therefore, polyurethane laminate cloth is the most ideal material.

5.2 Test between different colors

From the results in 5.1, we knew that polyurethane laminate cloth is the most ideal material. The second experiment would be investigating effect of different color combinations on temperature

5.2.1 Aim

To test out the rate of heat gain by radiation by the human body.

5.2.2 Color combinations to be tested the rate of heat gain by radiation:

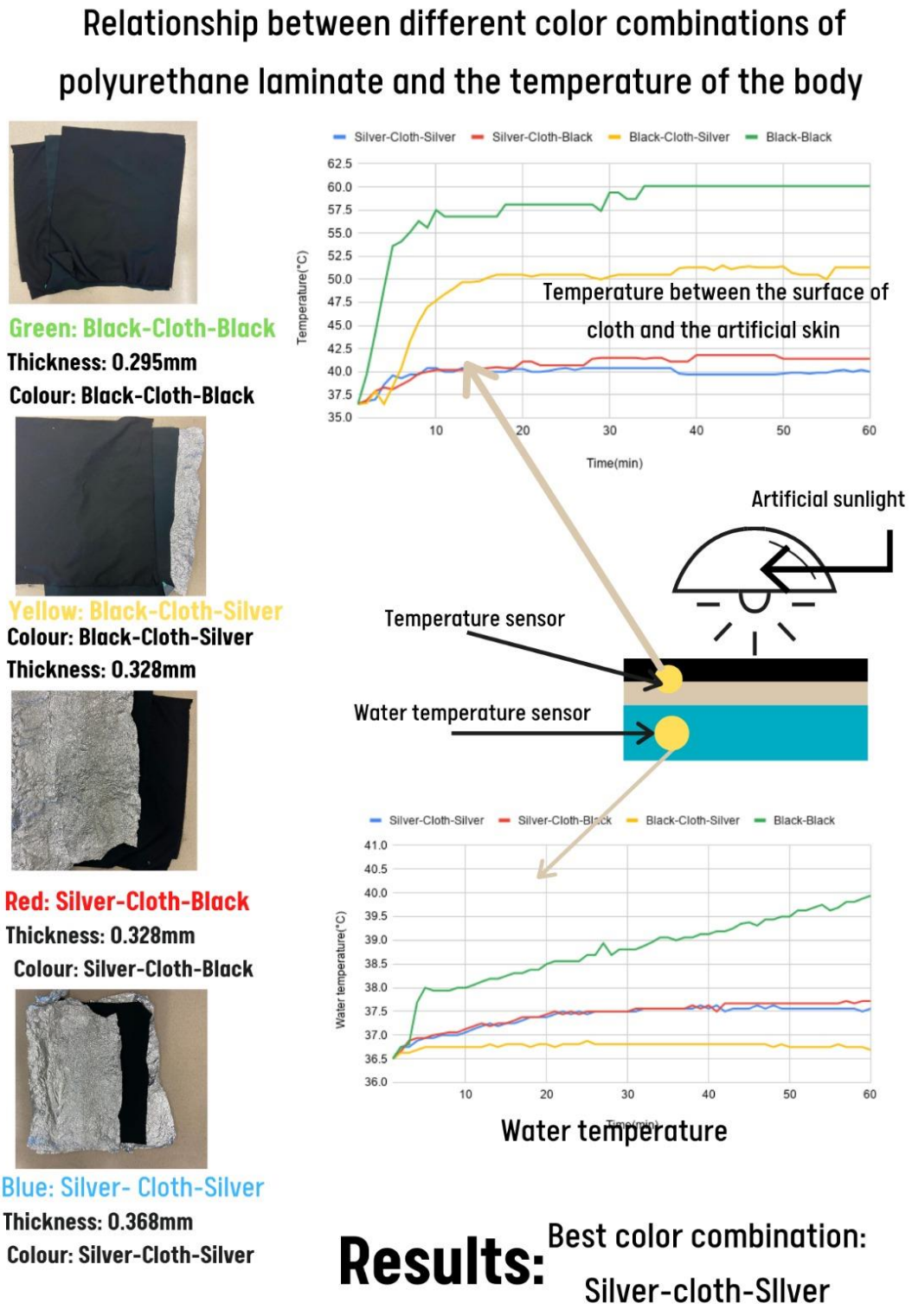
In order to provide a silvery surface for the polyurethane laminate cloth, aluminium foil is used to cover the black surface of polyurethane laminate cloth. The following are the combinations that we are going to test:

- Black-Black (Polyurethane laminate cloth)
- Black-Silver (Aluminium foil-Polyurethane laminate cloth)
- Silver-Black (Polyurethane laminate cloth-Aluminium foil)
- Silver-Silver (Aluminium foil- Polyurethane laminate cloth-Aluminium foil)

5.2.3 Procedures

1. Step1 - 6 of 5.1.3 is repeated in this experiment.
2. Procedures are repeated with four different color.

5.2.4 Results



5.2.5 Conclusion

Among all the tested combinations, Silver-Silver (Aluminium foil-Aluminium foil) showed the lowest rise in temperature. Therefore, having both sides colored silver is the best color combination.

5.3 Test between different thickness

From the results in 5.1and 5.2, we knew that polyurethane laminate cloth with a silvery top and bottom layer is the most ideal material. The third experiment would be investigating effect of different thickness on temperature

5.3.1 Aim

To test the different temperatures and humidity around the human body when different thickness of the same type, same color of cloth are applied to the body.

5.3.2 Thickness to be tested

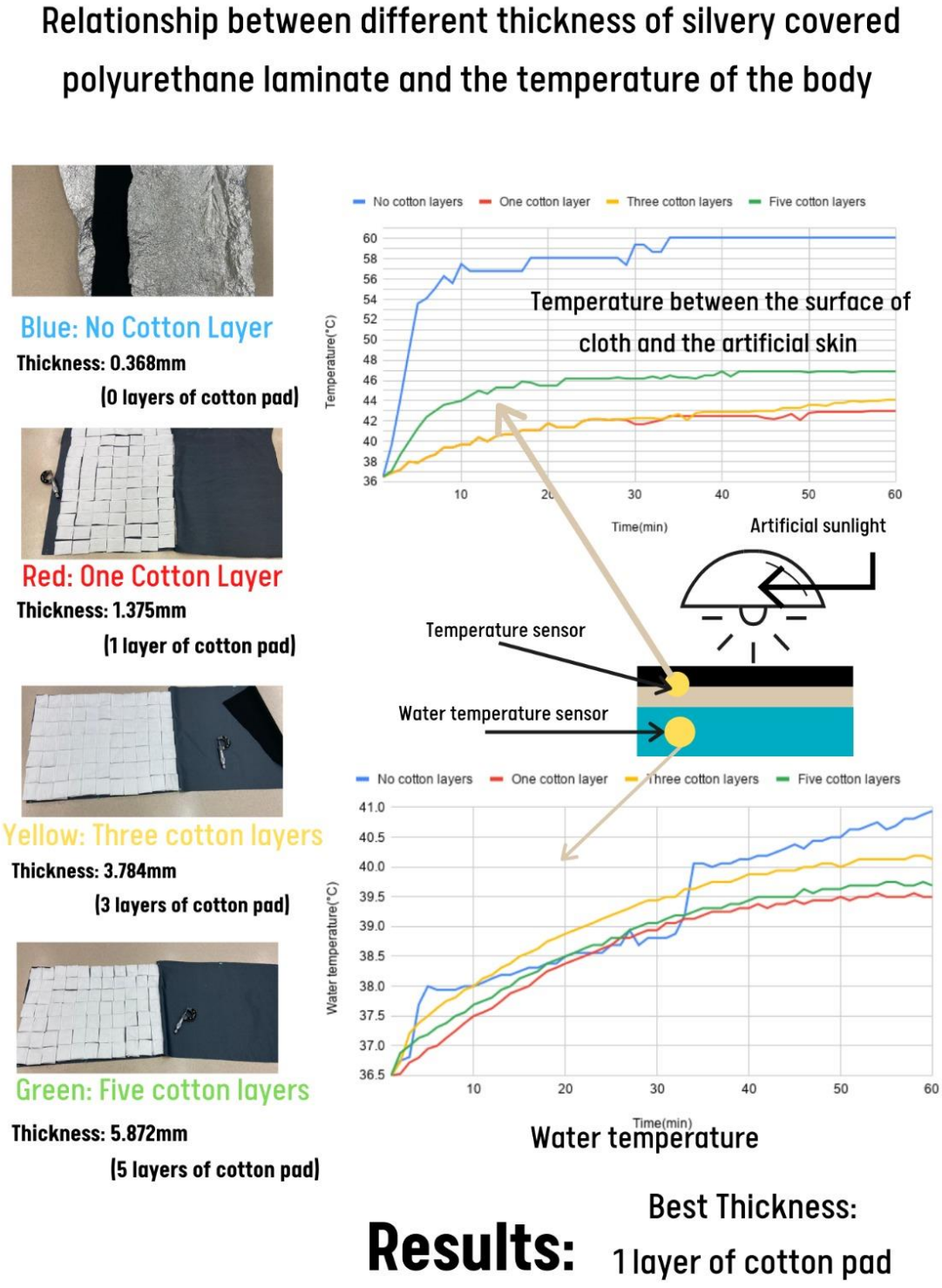
In order to increase the thickness, cotton pads are used. The following are the combinations that we are going to test:

- 0 layer of cotton pad
- 1 layer of cotton pad
- 3 layer of cotton pads
- 5 layer of cotton pads

5.3.3Procedures

1. Step1 - 6 of 5.1.3 is repeated in this experiment.
2. Procedures are repeated with four different thicknesses.

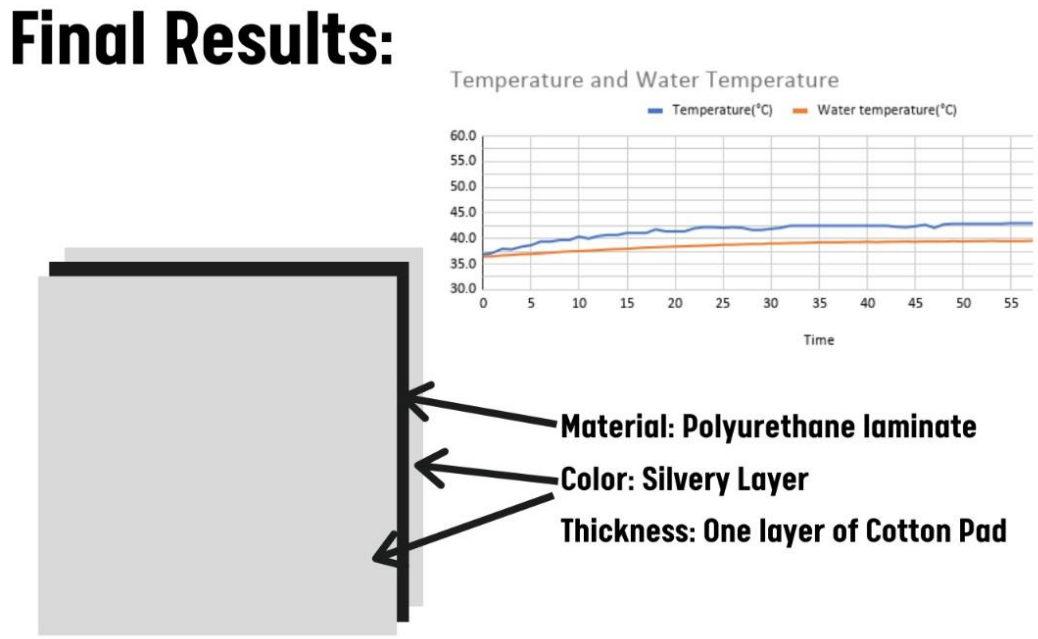
5.3.4 Results



5.3.5 Conclusion

Among all the tested combinations, the setup with no layers of cotton showed the lowest rise in temperature. Therefore, a thinner cloth is better than a thicker one.

5.4 Final Conclusion



To conclude, the best composite material should be one made of polyurethane laminate that has a layer of cotton, and has a silvery color.

6. Limitations and Errors

Unable to mimic the human body perfectly.

Whether it is the human skin, the sweating process, or even the self-heating process of the human body, we are unable to create an artificial replica of the human body. Therefore, the results can only represent a fraction of the effects of clothing on the human body, as well as providing an overview of what might happen to the temperature surrounding the human body.

Variations on colour and thickness

The initial color and thickness of the cloth varies from one type to the other. It is unsure to what degree the slight difference in colour and thickness would affect the final results of the experiment. However, it is still a possible error and should be taken into account.

Fig.14 Inconsistent color of different cloth

Unable to provide a realistic replica of hot weather

Whilst we are able to create a consistent supply of artificial sunlight, the heat inside the setup heats up gradually to around 43-45°C. Moreover, in a real environment, there will be other factors affecting the temperature, such as wind and cloud cover. Therefore, the results cannot completely represent the situation in the real world.

7. Further Improvements

Increase number of trials for each experiment

There might be slight errors or extreme data recorded in individual trials, making the experimental results inaccurate. Doing more trials for each setup could decrease these potential errors. However, the time limit does not allow us to do multiple trials since each experiment requires about 2-3 hours to prepare for the setup and record the data.

Improve the DIY data logger system

Our current data logger system still has some issues such as extreme data recorded, or may be not accurate enough. Therefore, we would like to improve the accuracy and consistency of the data logger system to acquire more accurate data in the future.

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9. Appendix

1. DIY data logger system (program)

Budding §

```
#include <DHT.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#define ONE_WIRE_BUS 4
#define dhtPin 8
#define dhtType DHT11
DHT dht(dhtPin, dhtType);
OneWire onewire(ONE_WIRE_BUS);
DallasTemperature ds18b20 (&onewire);
void setup() {
  Serial.begin(9600);
  Serial.println("Label,Time,Temperature,Humidity,Water Temperature");
  dht.begin();
  ds18b20.begin();
}

void loop() {
  ds18b20.requestTemperatures();
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float wt = ds18b20.getTempCByIndex(0);
  Serial.print("DATA,TIME,");
  Serial.print(t);
  Serial.print(",");
  Serial.print(h);
  Serial.print(",");
  Serial.println(wt);
  delay(60000);
}
```

INTERVIEW WITH PROFESSOR YUEN, MAN FUNG

Ho Nga Ki / Hon Yan Ming / Lai Yuk Wai / Lai Yik Tao / Leung Kwan Yi

Introduction

With great honour, we have conducted an interview with Professor YUEN, Man Fung on 08.12.2020 via Zoom. Prof. Yuen has shared with us his experiences of being a medical doctor who also conducts scientific research in the field of medicine, as well as his journey of hard work, dealing with difficulties and sometimes, results. He also has given us advice in the pathway of research. We are very glad to have such a precious opportunity to talk to Prof. Yuen and we are much inspired and encouraged by his story.

Content Page

Biography

Professor YUEN, Man Fung is a world-class clinician scientist who has obtained 3 doctoral degrees including Doctor of Medicine with Sir Patrick Manson Gold Medal in 2001, Doctor of Philosophy in 2005 and Doctor of Science in 2017. His research interests include prevention, natural history, serology, virology and treatment of chronic hepatitis B and C, and hepatocellular carcinoma. He is one of the top internationally renowned researchers in the field of hepatitis B disease. He has now published more than 450 papers in world renowned medical journals including New England Journal of Medicine, Lancet, Lancet Infectious Diseases, Lancet Oncology.

With his international academic and professional achievements, Professor Yuen is an invited member serving as key opinion leader for several international coalition committees on hepatitis B disease. Professor Yuen is also honourably invited by The Novel Assembly at Karolinska Institutet to nominate candidates for the Nobel Prize in Physiology or Medicine for both 2020 and 2021. Recently, he was awarded the Croucher Senior Medical Research Fellowships.

After graduating in 1992, professor Yuen started his research with analysing the medical history of the disease. As time went on, he shifted his focus to the testing cures of the diseases. In recent years, he performed further medicine analytics, aiming to lower the risk of liver disease to the minimum.

The Road to Research - “Why have you chosen to be a researcher?”

After graduation, professor Yuen embarked on his adventure of being a researching doctor in pursuit of his interests. During his internship, he has witnessed many suffering patients and various kinds of diseases, but the one that caught his eye was hepatitis. Patients suffering from this liver disease were often seen during the internship but there was no cure, as a result many patients passed away in front of his eyes, this inspired Professor Yuen to research hepatitis.

The encouragement from processor Lai Ching Lung also inspired him to devote himself to liver research. When he was still an intern, who hadn't even completed his medical training, professor Lai, authority in liver research, invited him to participate in the investigation of the liver. This made him feel honored and he was persuaded by professor Lai, who told him there would be a large development space for liver investigation and he could help lots of patients by choosing this area as hepatitis is very common in Asia and the treatment system is not yet mature.

Combined three factors: self-interest, environment and other’s encouragement, Professor Yuen has chosen to be a hepatitis researcher.

Remarkable Achievements - Formulation of “GAG-HCC score”

Professor Yuen has done many remarkable monumental works in hepatitis research. One of the most well-known triumphs is the invention of the formula GAG-HCC score, which can be used to evaluate a patient's potential risk of developing hepatitis. The risk of developing liver cancer in the next 5 to 10 years was assessed by substituting some risk factors like gender, age and so on,the risk increases by 6% for each point in the total score. Formula accuracy is up to 88%, if the risk is high, these patients can take in medicine for control in advance. Moreover, it can be used to find potential carriers so that they can have follow up consultations regularly. This score is also an international index to decide whether the patient needs treatments or not. The formula helps find potential cancer patients effectively and lowers the death rate of people suffering from hepatitis.

Before achieving this remarkable result, much effort was put into the study and the process of formulation was very tough and gruelling. At that time, there were no advanced technologies such as big data analytics, thus it was very difficult to collect and analyse huge amounts of data. Professor Yuen and his team found 3000 hepatitis carriers and analyzed their cases one by one. By doing regular checking, they recorded the carriers’ habits, physical conditions and so on. Mr Yuen penned the data and records on paper and checked them one at a time. It involved loads of paperwork and needed great efforts and patience. At last, the hard work finally paid off, and Professor Yuen’s team has worked out the GAG-HCC score successfully.

Dealing with Failures - Every effort matters

Professor Yuen has shared with us his frustrations during his path of research. Obtaining unimportant negative results, suggesting false hypotheses is always an inevitable part of research. As an experienced researcher, Professor Yuen believes that every effort matters and the more experience you gain, the better thoughts you have, and the more accurate predictions you can make.

False hypothesis

Most researches in the medical field start with hypotheses. After making the hypothesis, data are then collected to test for it. The data collection and analysis take effort and time in every research. However, the effort does not always pay off. Sometimes, the research he and his team has put loads of hard work in would give negative results. By that time, professor Yuen may feel disappointed. But after that, when he looked back, he would believe numbers of negative results were actually important. They have shown some ways of curing just don't work, and other scientists' time would be saved from investigating those methods.

Negative AND unimportant results

Professor Yuen said, surely not all negative results are important. Sometimes, they could be neither positive nor important. In such cases, it is highly possible that no journals would like to accept the manuscripts. Without the recognition from other scholars, it was easy to think the hard work was meaningless and was a total waste. Yet, professor Yuen viewed it in another perspective. Even obtaining negative and unimportant findings, people can learn from the gruelling experience. Professor Yuen believes that the efforts made are never wasted as gaining more experience helps build the foundation of accurate findings in the future. For instance, he said, "at the beginning, I may only obtain 3 positive results from 10 researches. For now, I think I am obtaining 9 out of 10, as I am now much more experienced to make accurate predictions."

Rejection in journal submission

Other than obtaining negative results, the greatest disappointment may come with the short of expectations. Professor Yuen shared with us his experience of sending research papers to medical journalists with high expectations but no affirmative feedback from reviewers. This may represent failures to others but Professor Yuen has a different point of view. When receiving negative comments, he has learned about emotion control for a better start and improvements. Professor Yuen admitted, “it is hard not to feel bad. But the point is, you gotta move on.”

Epilogue - Advice to young researchers-wanna-be

Professor Yuen shared some essential attributes for being a researcher.

Develop interest in research work

Professor Yuen said having interest in the field is a necessary factor. Research work is not always fun and interesting, it might even seem tedious and repetitive to some people. More importantly, one may never know when satisfactory results will be obtained. Therefore, it may not be easy to keep the momentum. Interest or passion is crucial for us to keep on researching, especially when we don't know how long the way left to go.

Being persistent and diligent

Research work involves the sorting of thousands of data and information. With such heavy workload, being studious plays an important role. Also, profound knowledge is needed to carry out the research, therefore long time study and learning is required. Professor Yuen reminded us, "only if you put in enough efforts will you be qualified to start research." Besides, when facing countless difficulties during research, persistence and enthusiasm can help researchers to continue and reach their next milestone.

Stick to the trends

Besides, it is also important for us to be flexible and acclimatize ourselves into the environment and the trend. It is rather hard to study a topic that is not popular at all. Taking medical research as an example, it will be very hard, if not possible, to study a disease which has no cases in Hong Kong. It is also a reason why Professor Yuen has focused on hepatitis, which is widespread in the local community, so that more references and cases can be investigated and more people can be benefited from it.

Time Management

Being a researcher requires a lot of effort and time. It is very important to strike a balance between work and life. Professor Yuen shared some tips for managing time with us. He usually goes to school or working place earlier so that he has more time to do his work in his working place. He has a 'rule' that he would do the work at his working place within

working hours and won't bring work back home so as to have quality time with his family. Though he has much work to do, he will try his best to hold this principle. He said that it is lucky that he is not an outreach person and doesn't like to socialize with people, so relatively he can spend more time on work and family.

Don't value the reward

Sometimes, we may be dejected as it seems that the payoff is inequivalent with the effort we make. Instead of value the reward in terms of money and frames, professor Yuen suggests us to consider the satisfaction of treating the patient as reward. When we understand that rewards are not guaranteed, we can avoid having over-expectation and can focus on the study itself.

Self-improvement and character building

Professor Yuen thinks that we can start equipping ourselves for future studies in science. First of all, as plenty of information can be found on the internet, we should make good use of this database. Read through more research and retrieve information from the published sources in order to sharpen our logical thinking. Once we figure out our interested fields, we can follow up relative references on the Internet as a basis.

Moreover,we should develop good habits such as time-management ,having a well-planned schedule can lead to efficient work. Have the ability to draw logical inferences from the observational and experiment data which is helpful in making predictions and hypotheses.

On the other hand, hard-work is required as piling experiments are carried out and many published papers are needed to be studied. There are no shortcuts, such persistence is needed to overcome the repeated work before the final conclusion can be made.

Reflection and Inspiration

From Professor Yuen's sharing, we learn that no matter how insurmountable obstacles might seem, we should try our best to overcome them. If we give up, no results will be observed and discovered. Doing research is simply "no pain, no gain."

And even if we get no good results, we shall not be discouraged. As we learnt from professor Yuen, though there is no guarantee in researching, we are now sure the "seeming" failures are precious meaningful learning experiences for future better findings. While it can be hard, we would try hard to make every failure in our lives a lesson to enrich our experience.

Professor Yuen's attitude in doing scientific research is respectable. No matter whether we are going to work in the field of research or not, we can really think about following the footsteps of Professor Yuen.

Acknowledgements

We deeply appreciate Professor Yuen's positive mindset towards life and research, and we sincerely thank Professor Yuen for talking to us, and more importantly, being such a great role model.

2019/20 — 2020/21
Hong Kong Budding Scientists Award

Interview with a Scientist – Professor Joseph Jao-Yiu SUNG

SBS, MB BS, PhD, MD, FRCP (London), FRCP (Edinburgh), FRCP (Glasgow), FRACP, FAGA, FACG, FHKCP, FHKAM (Medicine)

SKH Bishop Baker Secondary School

From left to right: HOU Chin Pang, YAU Josh, Professor Joseph JY SUNG, WONG Yat Ching, WU Sau Ying Zoe

Introduction

On the 16th October 2020, we conducted an interview with Professor Joseph JY Sung in a conference room at the Prince of Wales Hospital, Shatin. During the interview, he told us his wonderful story of being a successful scientist and shared his memorable working experiences with us. We were deeply inspired by him and have learnt the qualities that a scientist should possess form his precious words.

A. Biography

Professor Joseph JY SUNG
(med.cuhk.edu.hk)

Professor Joseph JY Sung served as the seventh Vice-Chancellor and President of The Chinese University of Hong Kong (CUHK). Professor Sung is a world-renowned scientist in gastroenterology. He joined the Prince of Wales Hospital, CUHK's teaching hospital, in 1985 as Medical Officer. He later joined the Department of Medicine of CUHK as Lecturer, and was promoted to Professor of Medicine and Therapeutics in 1998. He had been the chairman of the Department of Medicine and Therapeutics, and the associate dean of the Faculty of Medicine with clinical and general affairs portfolios. Professor Sung was appointed Mok Hing Yiu Professor of Medicine in recognition of his significant contributions to the prevention and early diagnosis of gastrointestinal cancers. He became the Head of Shaw College in 2008. Professor Sung serves as Director of two key CUHK research entities, the Institute of Digestive Disease and the Stanley Ho Big Data Decision Analytics Research Centre. He is a prolific author of scholarly academic research papers, his international distinctions include awards for his contributions in the fight against the SARS outbreak and being named an "Asian Hero" by *TIME* Magazine in 2003.

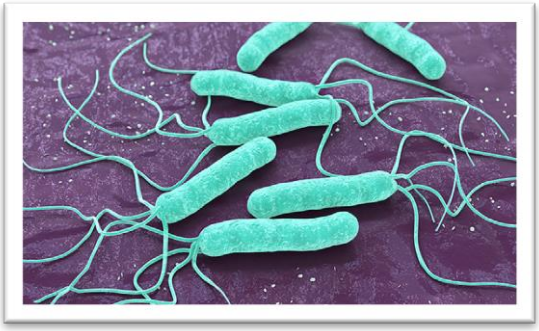
Throughout his career, Professor Sung has received high recognition for his research in gastroenterology, teaching and leadership, as well as substantial grants for his varied research work spanning a variety of healthcare concerns from the prevention and early diagnosis of gastric disorders and cancers to SARS and infectious diseases. He pioneered the treatment of gastric ulcers caused by *Helicobacter pylori* with antibiotics and was the first to treat bleeding ulcers with endoscopy, making him a place in the forefront on medical research [1-2].

Professor Sung will join Nanyang Technological University (NTU) Singapore as the new Dean of its Lee Kong Chian School of Medicine and will be concurrently appointed NTU's Senior Vice President (Health and Life Sciences) [5].

B. Research Interests

Professor Sung's research interests are focusing on intestinal bleeding, *Helicobacter Pylori*, peptic ulcer, Hepatitis B, colorectal cancer and other cancers related to the digestive system. Professor Sung and his team proved the relationship between *H. Pylori* and peptic ulcer diseases. They were first in demonstrating that a

course of antibiotics lasting a week can cure *H. Pylori* infection and successfully treat peptic ulcers and minimize their relapse. This research results has a major impact on and have changed the practice of gastroenterology worldwide. Professor Sung is a renowned scientist in gastroenterology and hepatology. He led a group of experts from 15 Asia-Pacific countries to launch colorectal cancer screening research in 2004, and has laid down clear guidelines and promoted colorectal screenings in the region [1-4].



Helicobacter Pylori bacterium (badgut.org)

Recently, Professor Sung as the director of the "CUHK Jockey Club Multi-Cancer Prevention" research program started a five-year multi-cancer screening project. This was initiated by the university's faculty of medicine and funded by the Jockey Club, aimed to look into the correlation between obesity and various cancers in 10,000 participants [6].

C. Significant achievement and contribution to society

1. Academic achievement

Professor Sung is a world leader in gastroenterological research. He has published over 1,000 full scientific articles in leading medical and scientific journals including *The New England Journal of Medicine* and the *Lancet*. He has edited and authored around 30 books, as well as many chapters in major textbooks including the Oxford Textbook of Medicine (5th Ed.) He also refereed for more than 15 prestigious journals. Professor Sung is a renowned scientist whose tremendous contributions to healthcare service and medical research have won him an array of honours and awards in Hong Kong and abroad. His unswerving dedication to scientific research continued after he assumed the vice-chancellorship of CUHK. The remarkable research findings made by him and his teammates won numerous Higher Education Outstanding Scientific Research Output Awards by the Ministry of Education, People's Republic of China.

In 2009, he was awarded the Marshall and Warren Lecture Award, the highest award in Gastroenterology in the Asia-Pacific region, for his excellent research on the treatment of gastric ulcer bleeding. In the same year, he also won the Endoscopy Award of the German Society of Gastroenterology. In 2011, he also won the Ho

Leung Ho Lee Advancement Prize (The Ho Leung Ho Lee Foundation, 2011). In 2013, he was awarded The Master of the World Gastroenterology Organization (WGO) Award by the World Gastroenterology Organization and Foundation [4].

Recently, Professor Sung is one of the six CU Medicine professors are named "Highly Cited Researchers 2020", meaning that he is the CU Medicine Scholars among the world's top researchers who has published a high number of papers that rank in the top 1% by citations in his respective fields of study and year of publication. It is also the third consecutive year for Professor Sung to receive this honour [7].

2. Devotion to education

Professor Sung had been the President of CUHK for 10 years. He is a teacher who is willing to listen to student's needs and demands. By the communication, mutual respect, building trust between he and students, he believes these are the first step to cultivate and discover elites who process humanistic values, integrity and independent thinking ability. Besides, talents should also need to be honest and upright, cultivate one-self and govern other, serve the society, and protect the environment as one's own responsibility. Professor Sung shared about during his headship of Shaw College, he led students and colleagues to offer help to victims in the affected areas after the Sichuan earthquake and to learn about the progress of rebuilding from local government officials and relief workers. These showed us that the teaching style of Professor Sung practiced with students and learned with them together. He also mentioned that it is face-to-face interaction which he finds most stimulating. He has been making acquaintances with new students and colleagues every day since he assumed the vice-chancellorship and has even taken opportunities to participate in campus events. Various nouns have been used to describe Professor Sung: doctor, scholar, hero, leader; but the most fitting one is simply that of "communicator", someone who is not only willing to speak openly his opinions and ideas but also listen to those of others. During his vice-chancellorship, he liked to talk informally with staff and students as part of his desire for the University to move forward with a unified heart and mind [2-3].

Prof. Sung passes on his experience to future doctors at the laboratory (cuhk.edu.hk/cpr/pressrelease)

D. Path to become a scientist

1. Interested in science

Curiosity and exploratory mind are basic requirements for one to look into the world of science. During the interview, Professor Sung shared with us when he was young, he always inquired about many things around the world, and asking many different simple questions, such as 'Why the colour of sky and sea is blue and green?'. He was eager to know and tried to find out the solutions from the books in the library. He believes that life is a miracle. There are still lots of things about life we don't understand. Professor Sung's curiosity about life eventually leaded him to become a great scientist.

The inspiration of mentor is another reason that made Professor Sung to become a scientist. Sir David Todd, who was the Professor of Medicine in the University of Hong Kong, was described as an enlightening teacher by Professor Sung during the interview. Professor Todd was a haematologist and his research interests were focused on thalassemia and blood cancer. Professor Todd prescribed and practiced ways of modernizing medicine by bringing new training programmes to Hong Kong and adopting recently developed molecular biology to investigate disease. Professor Sung shared when he studied medicine under Professor Sir David Todd in university, Professor Todd carried out some microscopic observations of bone marrow cell specimens with his student. Professor Sung remembered that the beautiful picture formed by different colour of bone marrow cells was very impressive. More importantly, it also aroused his interests in studying different cells. Apart from the scientific knowledge learnt from Professor Todd, Professor Sung also admired his teacher's attitude towards making a lifetime contribution to science and medicine. Nevertheless, he also shared that "Professor Todd exemplified what a good physician and the way he made clinical judgments. He reminded us we were to be there as long as the patient needed us".

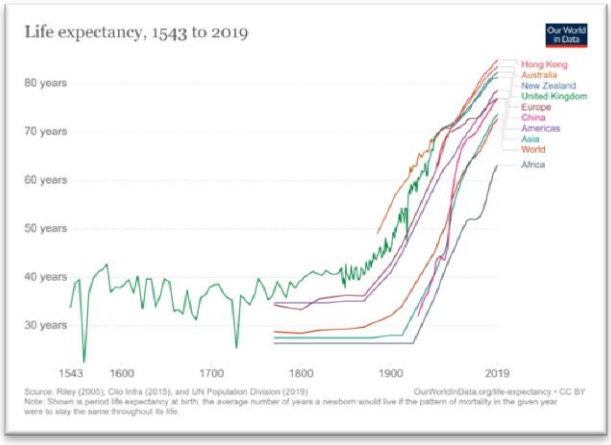
Professor Joseph Sung (medicalinspire.com)

2. Marvelous research experiences

Professor Sung shared his own unforgettable experiences with us. During his medical doctor study, he conducted a course of treatment with antibacterial agent to treat patients with *H. pylori* infection and gastric ulcers unrelated to the use of nonsteroidal anti-inflammatory drugs. That was no expensive medication to suppress gastric acid of the patients. He finally observed that this one week antibacterial therapy was more effective and successfully to heal the patients with *H. pylori* infection and gastric ulcers without acid suppression and reduce the rate of their recurrence. He then wrote an article and published their findings on *The New England Journal of Medicine*. At that time, it was the second article paper from Hong Kong that could be published on this top-notch journal in the field of clinical medicine [8]. The most surprising fact was that the release of this journal paper leaded to the sudden drop of the stock market from most of the pharmaceutical company producing anti-inflammatory drugs. In summary, Professor Sung shared that there is no need to fear about proving others people's mistakes. That should be the role of doing science! Science is the discovery of the true!

3. Future prospects on medical research

Professor Sung is very confident about the future prospects of medical research and developments. It should absolutely benefit our human life. For recent decades, the development in medical research is actually very rapid. Anti-diabetic medication, antacid, antibiotic are both developed within the recent century. The most effective scientific and medical investigation is the invention of vaccine. It was because it leaded to the extinction of many viral infection diseases such as, smallpox. Professor Sung believes that the ultimate goal for all those development of biomedical researches is to prolong human life which should increase the average lifetime of humans. It is as similarly shown in the Figure (*on the left*).



Life expectancy has improved globally. (ourworldindata.org)

In addition, development of artificial intelligence (AI) technologies tremendously increased nowadays. This AI technology is affected by more in-depth human brain observation, massive

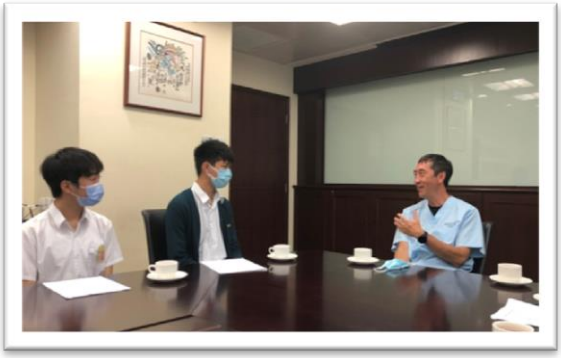
big data analysis and technological progress. AI can imitate human cognition through machine learning. Professor Sung shared and explained that AI could help improving and advancing the medical treatment on patients in the future. It is because super computer with AI can quickly analyzing the big data of the complexity of human genome DNA sequences. It can also help physician to prescribe medication to patients accurately. Professor Sung foresees that the development of AI with robotic system, the complex medical surgery on patients can greatly be improved. He shared that as a scientist, you should always be moving forwards with dreams.

"No great discovery was ever made without a bold guess."

~ Sir Isaac Newton

4. Encouragement and advice

Compared with scientists and physicians, Professor Sung shares two different views. Professor Sung listed the main qualities which he thinks scientists should possess. He shared with four of us that scientists should be hardworking and willing to try. Since doing research experiments is all about try and error, he can't guarantee full success. Since failures are inevitable, he has to change our minds to accept failures and more importantly, don't give up and learn from them. As he believes that success isn't always come by chance. In fact, the more effort you make is equal to the reward you will get. Professor Sung suggests that every teenage should keep trying despite of failures. Interestingly, until now, he is always facing many failures in his research. But he shared with us and told us to remember that don't give up and keep moving forwards. Therefore, Professor Sung believes that having perseverance is one of the qualities scientists required.



Interview with Professor Joseph Sung

Apart from being scientists, Professor Sung also shared some advice to us and the student who want to become physician in future. "Be careful and understand the needs of patients," is the main idea he told four of us.

"Life is like riding a bicycle. To keep your balance you must keep moving."

~ Albert Einstein

E. Epilogue

Professor Sung is renowned by his enormous contribution in society during the SARS outbreak. Besides an outstanding physician and scientist he is, it is very clear to identify that he is also an excellent teacher. We found out that being an influential scientist, a remarkable research is generally not enough. Furthermore, make a good use on your own ability to the society is more important. Just like Professor Sung give most of his life to the education and to cultivate the next generation of talents.

During the interview, Professor Sung was willing to share his experience with us in a relaxing way without any esoteric vocabulary. We all fully immersed in his stories. At the same time, the massages that Professor Sung wanted to bring us would never be ignored, “Be hardworking, and Try! “ Those of them have deeply inspired us and give us a confidence to believe dreams will come true with our persistence.

Last but not least, we deeply appreciate Professor Sung’s positive attitude and passion on science. We would like to express our sincere gratitude to Professor Sung for spending his valuable time to have an unforgettable interview with us.

F. Reflection

Before the interview, I was on pins and needles because I’m an introvert. Professor Joseph Sung shared a lot of eye-opening experiences to us. The most unforgettable one is that he worked on a research project about cure the patients with gastric ulcers without traditional medication but using antibiotic only. Then, he published their findings in a renowned peer-reviewed journal and it caused the stock of a pharmaceutical company to plummet. It is really interesting. Coincidently, Albert Einstein is both his and my favorite and mostly appreciative scientist.

(From Hou Chin Pang)

Professor Sung shared a lot of his precious experiences. He told us, “Don’t be fear to prove that others are wrong. It is science,” “All of the success is based on hardworking and many tries over a period of long time. Keep on failure, but ultimately it will lead to the road of success.” Those words inspired me a lot. To be concluded, I have learnt so much about a scientist’s life, thank you very much to this valuable chance to meet Professor Sung.

(From Wong Yat Ching)

During the interview, Professor Sung shared that he has gone through the road of failure most of the time due to the lack of self-confidence. However, by his enthusiasm and curiosity of science, he successfully defended the challenge and even has done accomplishment outside the circle (become a Professor). That's why he had inspired me to never forget the very beginning mind. It is the most accomplished mind of true enlightenment.

(From Wu Sau Ying Zoe)

We are honored to have the chance to interview Professor Sung. It is because he is a busy physician, his working hours is exhausting long, but he still spent lots of time in studying new theory and working on research projects. It really inspired me of being a scientist. After the interview, I learnt about curiosity is the start of being a scientist, and one of the important elements of being a good scientist. Professor Sung always studies science when he wants to satisfy his curiosity. For me, I have numerous questions in daily life. However, I don't satisfy my curiosity in the past. Recently, I try to search for my daily questions now through surfing in the internet and try to fulfill my curiosity. It is really an interesting experience for me.

(From Yau Josh)

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科學家專訪獎

2019/20 — 2020/21
Hong Kong Budding Scientists Award

An Interview with a Local Scientist

Professor Dennis LO Yuk Ming

Marymount Secondary School

Katrina Fong
Natalie Mak
Danielle Zee
Marie Sham
Lamm Liu

Foreword

The unforeseeable pandemic of 2020 disrupted our schedule and added difficulty to our task. However, it did not put off our curiosity and eagerness to find out how the scientists of Hong Kong are doing during this period. We were very lucky and honored to have Professor Dennis Lo available and willing to share with us his valuable experiences through an online video conference.

Introduction

Professor Dennis Lo is currently the Director of the Li Ka Shing Institute of Health Sciences, the Li Ka Shing Professor of Medicine and Professor of Chemical Pathology of The Chinese University of Hong Kong (CUHK), and the Associate Dean (Research) of the Faculty of Medicine of CUHK. Fascinated by the complexity of biological structures and the nature of biological science subjects since his youth, Professor Lo had been passionate to become a scientist. He studied hard and received his Bachelor of Arts degree from the University of Cambridge and the Doctor of Medicine and Doctor of Philosophy degrees from the University of Oxford. Later on, he returned to Hong Kong in 1997, and discovered the presence of fetal DNA in maternal plasma. With his devotion to his career and massive amounts of dedication and hard work, his research team remained at the forefront of this field. Throughout his career, Professor Lo has maintained his enthusiasm, and is always excited to discover new theories.

Research Interest

Professor Lo's most influential and game-changing scientific finding is the discovery of the presence of foetal DNA and fetal epigenetic markers in maternal plasma. With his discovery, he and his team succeeded in deciphering a genome-wide genetic map of the fetus through analysing small amounts of fragmented DNA floating in the blood of pregnant women, which allowed abnormalities such as Down Syndrome and many other diseases transferred via chromosomes in the foetus to be detected early on. Such a method of prenatal testing, as compared to previously existing technologies, is much less invasive and gives infinitely more reliable results. This achievement laid the foundation for developing non-invasive prenatal diagnostic tests for multiple genetic diseases. Currently, Professor Lo and his team are working on new approaches to detect cancer through cancer liquid biopsy, striving to utilize the previously developed prenatal detection technology. His method of testing can help detect cancer in early stages, and it is believed that this would be able to halve the mortality rate from a cancer virus in China.

Significant Achievements

Professor Lo has received numerous awards, honours and titles for his outstanding achievements and contributions in the field of biological science over the years. He was awarded the State Natural Science Award from the State Council of China in 2005, followed by the US National Academy of Clinical Biochemistry Distinguished Scientist Award the next year. He was elected as a Fellow of the Royal Society in 2011, as a Foreign Associate of the US National Academy of Sciences in 2013 and as a Founding Member of the Academy of Sciences of Hong Kong in 2015. He was awarded the King Faisal International Prize in Medicine in 2014 and the Future Science Prize - Life Science Prize in 2016. In recognition of the high number of citations that rank Professor Lo in the top 0.1% of his field worldwide, he was entitled the Thomson Reuters Citation Laureate (Chemistry) in 2017.

Fundamental Attributes of an Outstanding Scientist

1. Spotting "connections" for directions

"Find the connections between seemingly unrelated fields."

When a scientist has no direction in mind for investigation, it is extremely hard to achieve a breakthrough. Therefore, Professor Lo suggested that one of the many principles of working in the field of scientific investigations is to always spot connections between seemingly unrelated events and fields.

He illustrated this principle with an example of his own experience. After making a discovery that mother DNA contains foetus DNA (e.g., if the foetus is male sex, Y chromosome will be present in the mother's blood), he questioned if there are chances that a female's blood would also contain the Y chromosome. In wondering how his research would possibly impact organ transplants, he found out that through monitoring and testing the DNA in blood plasma, the possibility of rejection during an organ donation from a donor of the opposite sex would be more easily ascertained. This contributes to the opening up of another project to work on. By spotting the linkage in parallel situations or similar phenomenon, new ideas are more likely to come up.

2. Initiative in question asking

"Inventions originate from asking valid questions."

One of the characteristics of a successful scientist is to be observative and think critically, and Professor Dennis Lo is no exception. In order to spot different connections between different fields, he has spent his whole life observing his surroundings. He even shared the story of how watching a Harry Potter movie with his wife inspired him to think from a new angle about his research on DNA, leading to his discovery in prenatal testing. Going back to his previous point, he mentioned how this is an example that science is everywhere in our lives.

In particular, during his research in the prenatal testing and cancer testing field, he has drawn conclusions that nobody would have dared think of. For instance, during later stages, he proposed a question: Since a foetus releases DNA into his mother's blood, would their DNA also be present in other fluids, e.g., urine? He then tried to connect the dots between prenatal testing and cancer- testing, hoping to apply his research to a wider extent. By proposing questions, a scientist is able to explore the endless possibilities of a topic, and breakthroughs would soon be in sight.

3. Value your time

"Treat every day as if it's your last."
"That way, you will be able to produce better work."

To a scientist, time is of the essence when publishing their work. Yet, everyone has had that time in their lives when they are constantly procrastinating or simply too unmotivated to do any work. To tackle this problem. Professor Lo used this quote as his motto to success. As a scientist, a serious attitude must be adopted towards all their work. If you treat every day as your last, you will be inclined to cherish your time more, and be more productive.

Professor Lo then explained that this quote not only applies to his career, but also his whole life. His inspiring quote called for us to reflect on ourselves with a brand-new perspective. In this process, he proposed 3 questions for us to think about. "Are the things we are doing now really meaningful?", "Do they satisfy us?" and "Are they really what we want to do?". By answering these questions, we will be able to figure out our actual goals, and achieve self-actualization, which means to live life to one's fullest potential (Maslow's Theory). Professor Lo hopes that during the process of achieving self-actualization, we can better utilize our resources and produce more significant and serious work.

4. Just the right amount of creativity and concreteness

"Always start from a simple first step."

Professor Lo believes that in order to disestablish existing beliefs and theories, a scientist must be able to think creatively as well as logically. Science is a mixture of creativity and evidence. Without concrete ideas, there is no room for creativity. As the old Chinese proverb says, "Learning without thought is labor lost; thought without learning is perilous" （學而不思則罔 思而不學則殆）; Similarly, while thinking creatively and innovatively allows us to look at the matter in a different perspective, without just the right amount of accuracy, we will only wander in the wrong direction endlessly. A delicate balance must be struck in order to disprove long-established theories.

Professor Lo shared with us that when working in the scientific field, he typically first starts with a simple theory, then branches out his ideas as he goes and develops his ideas step by step. For instance, he quoted the development of the current model of the Apple iPhone. Without the primitive model of the first iPhone, they would never have been able to develop such a sophisticated model of the current iPhone X. In science, research and development are often based on previous work. With just the right amount of evidence and creativity, we can easily complete and target things while thinking outside the box.

Reflection

In the field of science, there will always be countless obstacles. To achieve our destination in the pursuit of knowledge, patience is needed. When Professor Lo first started asking for funding to investigate the connection between mother's blood and foetus DNA, criticism arose. Many doubted whether this research will be able to have any sort of progress, while some simply discredited his abilities. His funding was rejected. Nevertheless, he persisted with his research, and only after 8 years and countless impediments did it result in anything substantial, and this research made him one of the most well-known scientists in Hong Kong now.

During this pandemic, we were faced with countless uncertainties and obstacles. Fortunately, healthcare professionals and scientists are still keeping their nose to the grindstone to help Hong Kong. Yet, how often have we taken scientists' and doctors work for granted? Success is never something that can be easily achieved in a short period of time. Especially for scientists, breakthroughs are always the product of years' worth of research and experimenting. In Professor Lo's case, it took him 8 whole years to achieve a breakthrough. Patience is the key in a scientist' work, and Professor Lo's work, which has taught us the importance of it, is no exception.

Concurrent with patience is determination. When working in a field where it may take years to come to a result, it is important to keep your goal in sight and continue to work towards it, regardless of any obstacles or hardships. This is the only way you can eventually arrive at your moment of "eureka!" This goes hand-in-hand with passion, which Professor Lo reminded us never to lose, for it is the motivator of all scientific research.

Through interviewing Professor Lo, we also learned about the necessary attributes of a scientist. Though we did not get a chance to ask him about it, Professor Lo was a great communicator, guiding us through questions and gave us many examples to help us understand the nature of scientific investigation and the points he raised. He littered the conversation with small snippets and stories to keep his audience engaged, and had a clear step-by-step structure that was easy to follow. Though it is often overlooked, good communication is required when presenting scientific findings, such that you can prove your point and explain your thought processes to other people. We have no doubt this trait greatly assisted him in his journey of being a scientist.

Even in such challenging times, we had the honour of interviewing Professor Lo. The recent novel coronavirus has highlighted for us the role and importance of science in modern civilisation. In our interview, he shared many of his insights from his career in the field of science, along with imparting many lessons that will accompany us for life. Even through the screen of a computer, we were able to feel his enthusiasm and passion towards science, and his hope for a better future for the scientific community. This has inspired us to put more effort in our studies, such that we may be able to follow our dreams and passions in the future. We are very grateful for this experience, and hope to have more opportunities like this.

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