Chemically Modified Pomelo Pith for Oil Sorption

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Introduction

The 1967 Torrey Canyon oil spill spilled 117,000 tonnes of oil, with environmental damage lasting even till today

In February 2017, 10,000L of diesel was spilled at a Burton Latimer site.

Commercial sorbent:

Polypropylene

Made from non-renewable sources

Costly

Non-biodegradable

Our proposed sorbent:

Pomelo Pith

Obtained from waste materials

Low cost

Biodegradable

Objectives

1) To chemically modify pomelo pith with:
   - *methyltrimethoxysilane* (MTMS)
   - *oleic acid*
   - *mercerisation* (NaOH solution)
2) Evaluate the oil sorption capacity of the modified pomelo pith in pure oil & oil-seawater environment

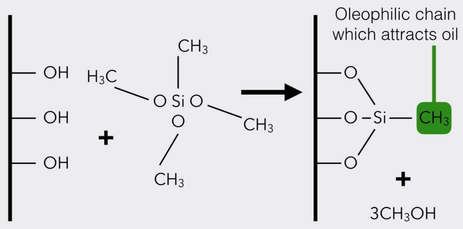
Overview of Methods

Preparation of sorbent

Pomelo pith was cut into cubes, washed and dried.

MTMS Treatment

Pomelo pith was coated with methyltrimethoxysilane (MTMS) via **chemical vapour deposition**.



Oleic Acid Treatment

Oleic acid was coated onto pomelo pith via **esterification** using a Dean-Stark apparatus.

$$R\text{-}OH + C_{17}H_{33}CO_2H \rightleftharpoons R\text{-}OCO\,C_{17}H_{33} + H_2O$$

Hydrophobic chain which repels water

Mercerisation

Pomelo pith was immersed in **sodium hydroxide** solution

Sorption Capacity

Pomelo pith was immersed in
- Pure water environment
- Pure oil environment
- Oil-seawater environment

$$Q_s = \frac{m_a - m_b}{m_b}$$

Where
Q_s is the sorption capacity in g/g
m_a is mass (in g) of sorbents after sorption
m_b is mass (in g) of sorbents before sorption

Results and Discussion

Water sorption capacity

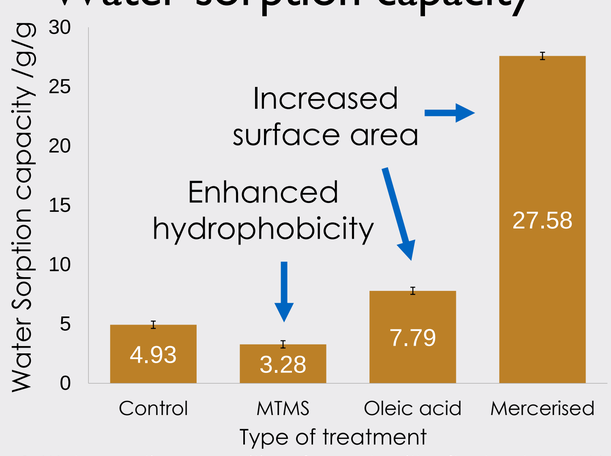
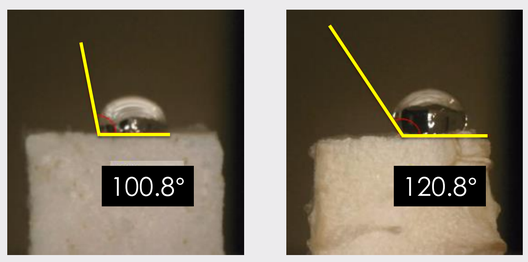


Figure 1. Water sorption capacities of pomelo pith after treatment. N=5

Water contact angle

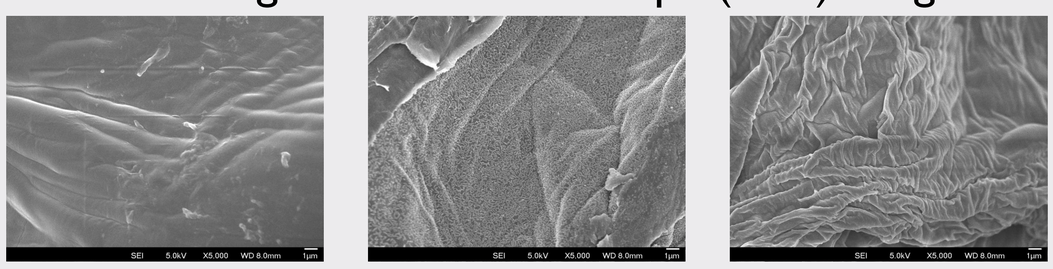
Larger contact angle → More hydrophobic



Control ***MTMS treated pith***

Figure 4. Water contact angle of pomelo pith before and after MTMS treatment

Scanning Electron Microscope (SEM) images



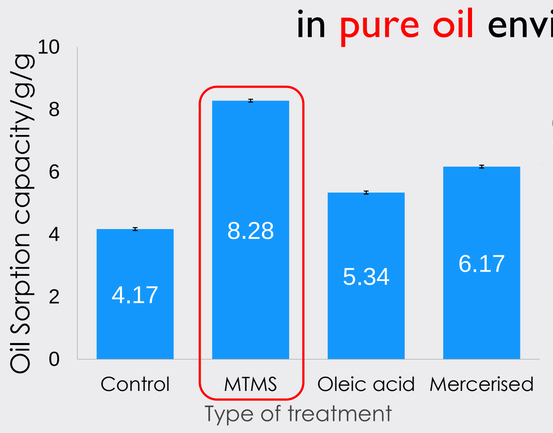
Control (Unmodified) **Oleic acid treated pith** **Mercerised pith**

Figure 5. SEM images of control, oleic acid treated pith and mercerized pith

Oleic acid treatment: Concentrated sulfuric acid catalyst dehydrates cellulose, breaking it up into fragments and increasing its surface area.

Mercerisation: NaOH removes cellulose and hemicellulose, resulting in more folds and increasing its surface area.

Effect of treatment on oil sorption capacity of pomelo pith in pure oil environment

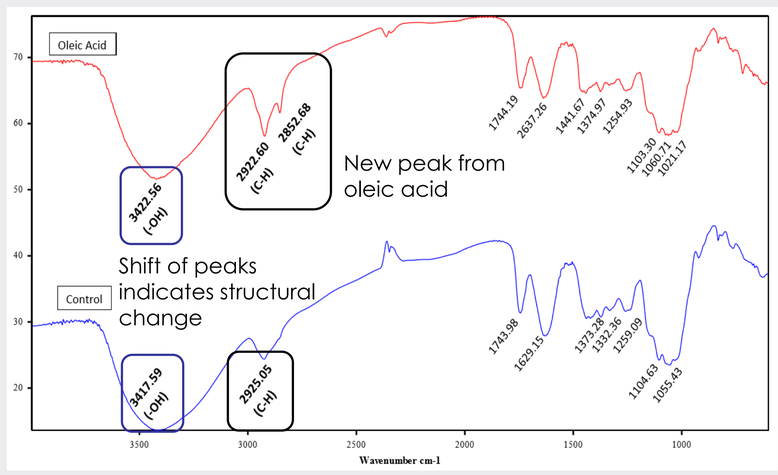


Oleophilic methyl groups attract oil

Dehydration of cellulose increases surface area

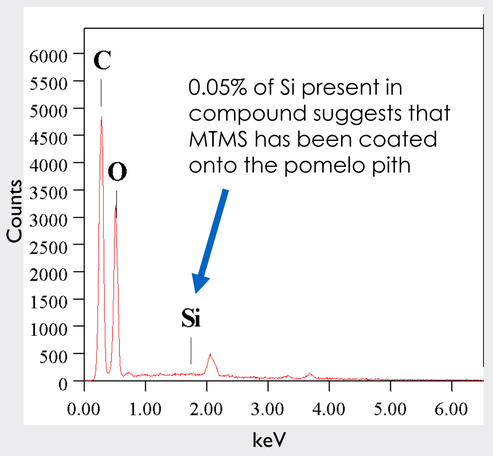
Removal of lignin & hemicellulose increases surface area

Figure 2. Oil sorption capacities chemically modified pomelo pith in pure oil environment. N=5



FTIR Analysis

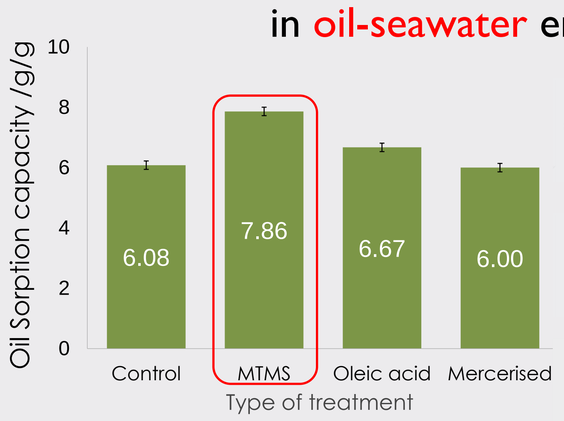
Figure 6. FTIR Graph of control & oleic acid sorbents



EDS Analysis

Figure 8. EDS Graph of MTMS sorbents

Effect of treatment on oil sorption capacity of pomelo pith in oil-seawater environment



Oleophilic & hydrophobic methyl groups attract oil and repel water

Hydrophobic methyl groups and increased surface area

Increased surface area causes absorption of both oil and water

Figure 3. Oil sorption capacities chemically modified pomelo pith in pure oil environment. N=5

Elemental Analysis

Type of pith	% of C	% of H
Control (Unmodified)	36.7	6.09
Oleic acid treated sorbents	39.4	6.24

Figure 7. EA of control & oleic acid sorbents

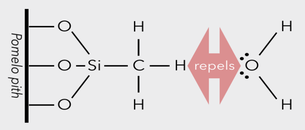
Increased percentage of C & H → Grafting of **methyl group** from oleic acid

Conclusion

MTMS treated pomelo pith had the largest increase in oil sorption capacity in both pure oil and oil-water environment → **Most promising** to be developed as an oil sorbent

Derived from renewable sources

Biodegradable



High oil sorption capacity

Future Work

1. Synergy of treatments (Mercerisation followed by MTMS coating)
   Increasing surface area + enhancing hydrophobicity
2. Making a boom
   Prototype can be tested for its practical usage

3. Testing for leeching of chemicals
   Sorbents can be tested for leeching when used in seawater

References

Page, C.A., Bonner, J.S., McDonald, T.J., & Autenrieth, R.L. (2002). Behavior of a chemically dispersed oil in a wetland environment. *Water Research*, *36*, 3821-3833. doi:10.1016/S0043-1354(02)00079-9

Bayat, A., Aghamiri, S.F., Moheb, A., & Vakili-Nezhaad, G.R. (2005). Oil Spill Cleanup from Sea Water by Sorbent Materials. *Chemical Engineering and Technology*, *28*.

Images/ graphs/ photos in this poster were self-drawn or taken unless otherwise stated.

Icons from The Noun Project (www.thenounproject.com): "Dead Fish" by Gemma Evans, "Tanker Oil Spill" by Gan Khoon Lay. Pomelo image from http://fruiticons.com/img/large-vector-fruit-icon-line-art/fil/66-fruit-icons-pomelo-line-art.svg, Vapour image from http://moziru.com/explore/Water%20Blister%20clipart%20water%20vapour/#go_post_10385_idea-clipart-bubble-6.png, Container image from http://weclipart.com/oil+container+clipart, Flask image from https://www.shareicon.net/chemicals-flasks-chemistry-education-flask-chemical-science-70208. Biodegradable logo from http://www.norwexmovement.com/recycled-vs-biodegradable-vs-compostable/.