Physical, mechanical, chemical and biological properties data of gellan gum incorporating titanium dioxide nanoparticles biofilm

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ABSTRACT

Gellan gum incorporating titanium dioxide nanoparticles biofilm was synthesized and characterized using UV, FTIR and XRD to study their physical and chemical properties. The mechanical properties were measured using universal mechanical testing. Meanwhile, the biological properties were investigated towards for antibacterial and cell proliferation. This comprehensive data are relevant with the research article entitled “Gellan gum incorporating titanium dioxide nanoparticles biofilm as wound dressing: Physicochemical, mechanical, antibacterial properties and wound healing studies” [1].

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Specifications table

| Subject                          | Chemistry, material science                         |
|---------------------------------|-----------------------------------------------------|
| Specific subject area           | Synthesis and characterization of materials         |
| Type of data                    | Table                                               |
|                                 | Image                                               |
|                                 | Graph                                               |
|                                 | Figure                                              |
| How data were acquired          | Data were acquired by UV–Vis, FTIR, XRD, universal  |
|                                 | testing machine, microscope                         |
|                                 | Raw                                                |
|                                 | Analyzed                                            |
| Data format                     | UV–Vis, FTIR and XRD were collected at room        |
|                                 | temperature. Universal testing machine was         |
|                                 | carried out according to the ASTM D882 [2].        |
|                                 | Antibacterial activity of biofilms against         |
|                                 | bacteria was carried using disk diffusion after 24 h|
| Parameters for data collection  | incubation. Meanwhile, cell viability and cell     |
|                                 | proliferation was measured after 24 h, 48 h, and    |
| Description of data             | 72 h incubation                                     |
| collection                      | UV–Vis spectroscopy and FTIR spectra was scanned   |
|                                 | from 200 to 800 nm and 400 to 4000 cm⁻¹, respectively. XRD |
|                                 | diffractogram was performed by using Rigaku        |
|                                 | Miniflex (II) X-ray diffractometer operating at a |
|                                 | scanning rate of 2.00° min⁻¹, from 10⁻⁰ to 80⁻¹ at |
|                                 | room temperature. Instron Universal Testing        |
|                                 | machine (model 3366) was used to study the         |
|                                 | mechanical properties of biofilms. The antibacterial|
|                                 | testing was carried against Staphylococcus Aureus  |
|                                 | and Escherichia Coli bacteria strains. The viability|
|                                 | of cells in contact with the biofilm samples       |
|                                 | for 24 h, 48 h, and 72 h incubation time was        |
|                                 | examined through a staining procedure of acridine  |
|                                 | orange/propidium iodide (AO/PI, Sigma Aldrich, USA) |
|                                 | and observed by light microscope (Olympus IX73-FL-CCD)|
|                                 | Meanwhile, the cells proliferations were quantified |
|                                 | using a MTT (3-(4,5-dimethylthiazol-2-yl)–2,5-     |
|                                 | diphenyltetrazolium bromide) (Thermo Fisher         |
|                                 | Scientific, USA).                                  |
| Data source location            | Universiti Malaysia Terengganu                     |
|                                 | Kuala Nerus/Terengganu                             |
|                                 | Malaysia                                           |
| Data accessibility              | The data were found only in this article            |
| Related research article        | Ismail, N.A., Amin, K.A.M., Majid, F.A.A. and Razali, |
|                                 | M.H., 2019. Gellan gum incorporating titanium      |
|                                 | dioxide nanoparticles biofilm as wound dressing:   |
|                                 | Physicochemical, mechanical, antibacterial         |
|                                 | properties and wound healing studies, Materials    |
|                                 | Science and Engineering: C, 103, p.109770.          |
|                                 | https://doi.org/10.1016/j.msec.2019.109770.        |

Value of the data

- Data obtained were important to know the physical, chemical, mechanical and biological properties of biofilm.
- Data may be useful for future research on the development of new nano-biocomposite film.
- These data were supported the good performance of fabricated biofilm for antibacterial and cell proliferation.

1. Data description

The dataset of this article provides information on physical, mechanical, chemical and biological properties of gellan gum incorporating titanium dioxide nanoparticles biofilms. Fig. 1 shows the photo images of pure gellan gum (GG) and gellan gum incorporating TiO₂ nanoparticles (GG+TiO₂-NPs) biofilms and their UV–Vis spectra were shown in Fig. 2. The mechanical properties of GG and GG+TiO₂-NPs biofilms are presented in Table 1. Fig. 3(a) and (b) displays the FTIR spectra and XRD patterns of GG, and GG+TiO₂-NPs biofilms as well as TiO₂ nanoparticles (TiO₂-NPs) powder. Photo images of antibacterial test against gram-positive (Staphylococcus Aureus)
Fig. 1. Photo images of GG and GG+TiO$_2$-NPs biofilms.

Fig. 2. UV–Vis spectra of GG and GG+TiO$_2$-NPs biofilms.

Table 1
Thickness and mechanical properties of GG and GG+TiO$_2$-NPs biofilms.

| Sample          | Thickness(μm) | TS(MPa)    | YM(MPa)    | T(J·g$^{-1}$) | EAB(%)   |
|-----------------|---------------|------------|------------|---------------|----------|
| GG              | 60 ± 0.003    | 3.29 ± 0.06| 58 ± 2.74  | 0.20 ± 0.008  | 13.21 ± 0.58 |
| GG+TiO$_2$-NPs  | 60 ± 0.004    | 3.76 ± 0.11| 67 ± 3.41  | 0.17 ± 0.004  | 11.51 ± 0.65 |

(mean ± SD) ($n=5$); TS (tensile strength), YM (Young’ Modulus), T (toughness), EAB (elongation-at-break).

and gram-negative (Escherichia Coli) bacteria strains using pure GG, GG+TiO$_2$-NPs biofilms and penicillin as a control sample were shown in Fig. 4(a) and (b), respectively. Their antibacterial activity was summarized in Table 2. Fig. 5(a) and (b) shows the fluorescence images of the cell viability and cell proliferation, respectively at different time interval.
Fig. 3. (a) FTIR spectra and (b) XRD diffractogram patterns of TiO$_2$-NPs, GG and GG+TiO$_2$-NPs biofilms.

Fig. 4. Photo images of antibacterial test result of penicillin (P), GG and GG+TiO$_2$-NPs biofilms against (a) Staphylococcus Aureus and (b) Escherichia Coli bacteria.

Table 2
Inhibition zone of biofilms against Staphylococcus Aureus and Escherichia Coli.

| Diameter of Inhibition (mm) | Staphylococcus Aureus | Escherichia Coli |
|----------------------------|-----------------------|-----------------|
| Sample                     |                       |                 |
| Penicillin (P)             | 12 ± 0.06             | 10 ± 0.12       |
| GG                         | –                     | –               |
| GG+TiO$_2$-NPs             | 9 ± 0.25              | 11 ± 0.06       |

2. Experimental design, materials, and methods

Gellan gum incorporating TiO$_2$ nanoparticles biofilm was fabricated using solvent casting method as used previously by other researchers [3,4]. Firstly, gellan gum solution was prepared by dissolving 1 g gellan gum in 100 mL deionized water under continuous stirring for
Glycerol (50 w/w%, percentage weight relative to GG) and calcium chloride (CaCl₂) (5 mM) was added into the solution. Then, 1 w/w% (percentage weight relative to GG) of TiO₂ nanoparticles was added and stirred for 2 h. The solution was transferred to a casting dish and was dried in oven for 24 h at 50 °C to produce spherical shape biofilm. All biofilms were preconditioned in a desiccator (27 °C, 50% relative humidity (RH)) for at least 2 days prior to testing. Pure GG biofilm was prepared using a similar procedure with the absence of TiO₂ nanoparticles. The obtained samples were characterized using UV–Vis, FTIR, XRD for physical and chemical characterization. The mechanical properties of biofilms were measured using an Instron universal testing machine (model 3366) according to ASTM D882 [2]. Five specimens with the size of 2.0 × 6.0 cm rectangular strips of biofilm samples were tested. The biological properties were studied for antibacterial and cell proliferation. Gram-positive (Staphylococcus aureus) and Gram-negative (Escherichia coli) microbes were used for an anti-bacterial assay. Meanwhile, the cells proliferations were quantified using a MTT (3-(4,5-dimethylthiazol-2-yl)–2,5-diphenyltetrazolium bromide) (Thermo Fisher Scientific, USA). The viability of cells in contact with the biofilm samples for 24 h, 48 h, and 72 h of incubation time was examined through a staining procedure of acridine orange/propidium iodide (AO/PI, Sigma Aldrich, USA) and observed by light microscope (Olympus IX73-FL-CCD). Control in this experiment is Dulbecco’s Modified Eagle Medium (DMEM) culture media without the presence of film samples.

Acknowledgments

The authors are grateful to Universiti Malaysia Terengganu (UMT) for providing the facilities to carry out this project and Malaysia Ministry of Education for financial support vote FRGS/1/2019/STG07/UMT/02/2.

Conflict of Interest

The authors as listed above have no conflicts of interest to declare.
Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi: 10.1016/j.dib.2020.105478.

References

[1] N.A. Ismail, K.A.M. Amin, F.A.A. Majid, M.H. Razali, Gellan gum incorporating titanium dioxide nanoparticles biofilm as wound dressing: physicochemical, mechanical, antibacterial properties and wound healing studies, Mater. Sci. Eng. C 103 (2019) 109770, doi: 10.1016/j.msec.2019.109770.

[2] ASTM, Designation D882-12, Standard Test Method For Tensile Properties of Thin Plastic Sheeting, Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA:, 2012.

[3] R. Balasubramanian, S.S. Kim, J. Lee, J. Lee, Effect of TiO₂ on highly elastic, stretchable UV protective nanocomposite film formed by using a combination of k-carrageenan, xanthan gum and gellan gum, Int. J. Biol. Macromol. 123 (2019) 1020–1027, doi: 10.1016/j.ijbiomac.2018.11.151.

[4] G. Joseba, G. Junkal, T. Agnieszka, Improvement of macroscale properties of TiO₂/cellulose acetate hybrid films by solvent vapour annealing, Carbohydr. Polym. 231 (2020) 115683, doi: 10.1016/j.carbpol.2019.115683.