# Glucosamine from hydrolysis of 3D printing chitosan for Osteoarthritis treatment


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## Abstract


This project aims to introduce a new way for osteoarthritis treatment which is expected to increase in the future. Glucosamine is the main subject for a treatment, which can be derived by hydrolyzing chitosan. This project also includes extraction of chitosan from shrimp waste to make a worthy use of food waste from industry. In this project, 3D printer is applied to print chitosan gel since 3D printing is adjustable to form various shapes of the gel.

The research process begins with the extraction of chitosan from shrimp shells. For the next step, the percent of deacetylation of chitosan was determined by titration technique and determined characteristics by FTIR and XRD analysis. Chitosan gel was prepared by dissolving chitosan with the mixed acetic acid, lactic acid, and citric acid. Finally, the 3D-printer for using in the gel printing was designed by the modification of the nozzle to match and fit for fabrication of chitosan gel. From the experiment, it indicates that chitosan gel formation could be readily prepared. The deacetylation percentage and FTIR analysis indicate that the synthesized chitosan is comparable to commercial chitosan. However, due to high crystallity of the chitosan, from XRD analysis, it made chitosan could not be efficiently dissolved into gel. Therefore, an adaptation of chitosan extraction was done. It was to heat in every steps of extraction. It resulted in better dissolving ability and gel formation and was printable my the modified 3D-printer.


## Objectives

1. To extract chitosan from the local waste by recycling natural materials which compose of chitin-chitosan such as shrimp shell.
2. To prepare chitosan gel to be printable by the modified 3D printer.
3. To design the 3D printer blueprint for fabricating chitosan gel into a designed shape as the alternative material for an osteoarthritis treatment.
4. To test the decomposition of chitosan by an enzyme to get the glucosamine for an osteoarthritis treatment.

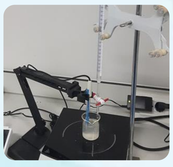
## Procedure

### Chitosan extraction from shrimp waste

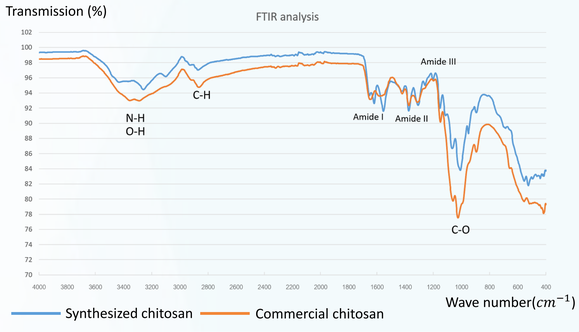
Deproteinization 1 liter of 3 M NaOH/ 100 g Shrimp waste
Demineralization 1 liter of 3 M HCl/ 100 g Shrimp waste
Deacetylation 1 liter of 50% w/v NaOH/ 100 g Shrimp waste


### Deacetylation Percentage Identification

It was determined by using titration technique. The calculated deacetylation percentage was 99.47%



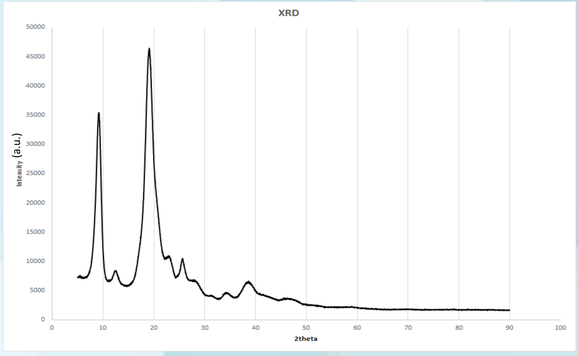
### Chemical analysis of synthesized chitosan using FTIR technique (Fourier Transform Infrared Spectroscopy)




The FTIR results can identify chemical bonding in the synthesized chitosan comparing with the commercial chitosan. The peaks of the graphs represented some specific bonds of N-H, O-H, C-H, and C-O in chitosan structure. These two types of chitosan had almost the same chemical components. It could be concluded that the synthesized chitosan was comparable to the commercial one.

### Crystallity analysis of synthesized chitosan using X-ray diffraction (XRD) measurement

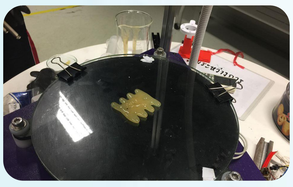
From the XRD pattern, it could be seen that there were many sharp peaks with very high intensity. These represented the high crystallity of the synthesized chitosan.

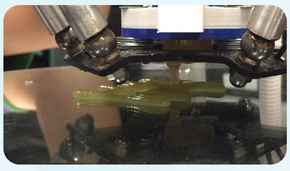


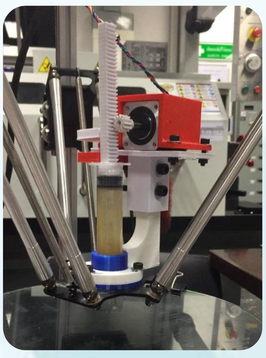

### Chitosan gel preparation

Gel was prepared with 20 grams of chitosan in acidic solution (acidic mixture: 40% v/v acetic acid, 10% v/v lactic acid, 3% w/v citric acid). Gel was stirred until dissolved. Later, it was filtered through a fabric to remove remaining chitosan precipitation.


### 3D printer construction and gel printing







A 3D-printer need to be modified to suitable for gel printing. It has been designed and modified at the first stage in the picture above to test its work. It will be modified and added up until completed to be able to do sol to gel printing method.

## Discussion

The synthesized chitosan, performed better as it all could dissolved homogenously.

Gel could be printed and formed in a shape using the 3D-printer. However, it was only a first step before introducing to the actual process which is sol to gel printing method. The 3D-printer's nozzle is supposed to be 0.1-0.2 mm diameter and able to heat to evaporate solvent out from chitosan.

## Conclusion

Chitosan from local waste was successfully synthesized. The synthesized chitosan was printable using 3D printer which could be designed to fit our aim. For next step, the glucosamine concentration from decomposition of chitosan is determined to be applicable to osteoarthritis treatment.

## References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