Innovative Usage of Waste and Applications of Theoretical Science

Selin Öz[1], Ali Maga[2]

Abstract

Improving technology and increasing demands in its application has became the biggest challenge for the waste utilizing sector. Most technological benefits result with waste and in order to overcome the increasing waste production seafood processing technologies has become a huge aid. The experiment aimed to minimize the 326000 metric tons of gelatin waste resulting from nutrition packing, cosmetics, pharmaceuticals and fertilizers by using horse mackerel flakes to obtain recyclable gelatins. Gelatin can be obtained from the partial hydrolysis of collagen, which is a type of protein which can be derived from the skin or bones of animals. By using hydrolysis techniques and thermal treatment, these collagen proteins converted to gelatin. As the produced gelatin was compared with the gelling temperature, viscosity and gel strength of other commercial calf or pork skin gelatins in order to find out whether the produced gelatin was as functionable as the unrecyclable ones. As AP Chemistry students and future engineers, we have been learning about acids and bases, molarity, and techniques for experimental procedures, such as hydrolysis and denaturation. Though a basic knowledge for experimental procedures had been obtained, a scientific experiment as such has given a chance for hands-on experience and has enabled to apply the knowledge in different platforms and concepts -other than exams. We are aware of the consequences of developing technology, more and more waste. With this project, we take active role in preserving our environment and in order to do that we want to minimize waste production and find ways for the re-usage of "what seems to be non recyclable or recyclable".

Keywords: *waste utilizing, seafood processing, collagen, gelatin, recycling, horse mackerel flakes;*

Introduction

Gelatin is the water-soluble product of the dissolution, disorganization or degradation of water insoluble collagen fibers. It acts as a barrier for water loss and can be obtained from the partial hydrolysis of collagen, which is a type of protein which can be derived from the skin or bones of animals. By using hydrolysis techniques and thermal treatment, these collagen proteins can be converted to gelatin. In Turkey, fishery is common since Turkey is surrounded by 3 seas and seafoods and especially fish is essential for human health. In a year, according to Hurriyet newspaper, a person in Turkey consumes 6 kilograms of fish. With a population of 80 million people, when 6 kilograms of fish is consumed per person in a year, tons of fish scale is thrown to trash and never used again. Though fish scale might be an organic waste, instead of its usage for gelatin production and the benefit of the environment, non recyclable gelatin is favored by manufacturers. In our experiment we aimed to demonstrate how fish scale should be beneficial for the environment and gelatin production could be made by recycling fish scale instead of damaging the environment. Throughout the experiment, various chemicals such as NaOH, isobutyl alcohol, EDTA and acetic acid are used in order to modify fish scales and at the end result with a fish scale that was not harmful to the environment. Therefore, our experiment highlighted that fish scales are a potential source for gelatin production and could be used as an innovative way to reuse waste since it provides a chance to reuse fish scales as well as the gelatin produced by them through recycling.

Procedure

Materials:

- Horse mackerel - Avg. weight 500 - 800g
- 5% NaCl solution
- 4% NaOH solution
- Isobutyl alcohol
- 5% EDTA

[1] Hisar School, Turkey
[2] Hisar School, Turkey

- Acetic Acid

Obtaining Gelatin From Horse Mackerel Scales:

Step 1
The scales of *Horse mackerel* are removed by hand. Then scales are washed and placed in room temperature until samples are completely dry.

Step 2*
Separation of non-collagen proteins: 1200g of dried scales are mixed with 5% NaCl (1/10, w/v) solution at room temperature for 30 minutes. Then repeat this process one more time, total of 60 minutes. Then wash the samples and place them in 4% NaOH (1/10, w/v) solution to remove the non-collagen proteins, mix sample for 60 minutes.

Step 3*
Removing lipids from the scales: The scales are then placed in Isobutyl alcohol (1/4, w/v) in order to remove lipids. This step is repeated for a total of 3 times, in 30 minute intervals. A digital shaker is used to mix the mixture.

Step 4*
De-mineralization process: As the final treatment, the scales are placed in 5% EDTA solution four times, intervals of 12h, 2h, 2h, and 1h respectively. The mixture must be stirred throughout the treatment via digital shaker. Then collected scales are soaked in 0.05 M acetic acid solution for 3 hours.

Step 5
Then the scales are placed in a tray containing (1/3, w/v) water and heated at 60^{o}C for overnight in an oven. Then the filtered sample is dried by placing under air condition for overnight. (set on 18 °C, flow temperature was determined 10 ± 2 °C)

Step 6
Finally, in order to obtain gelatin powder, dried films are crushed via a coffee grinder.

Expected Results and Discussion

Due to insufficient digital shaker appliances and small sample size accurate measurements were not able to be made. However expected results were as;

Bloom Value (Gel Strength): Gel strength is the most important quality for gelatins. Since our experiment aimed to come up with an alternative way for the gelatin producing sector, in order for the sector to favor fish flakes as a source for gelatin production, the sector's needs were needed to be met. Our expected results were to have high bloom values as well as high viscosity [1] values compared to already manufactured gelatin in order to obtain a gelatin that would be favorable.

Gelling Temperature: At gelling point the solution of scales undergo gelation and lose fluidity by forming 2 or 3 dimensional networks and making polymerization. Therefore, as a result we would expect the gelling temperature of the scales to be close to the gelling temperature of the manufactured ones which would mean that they would have similar chemical properties to result in their formation of gelatin and that would assist the gelatin formed from scales to be efficient.

Conclusion

To conclude, considering our expected results, fish scales are a possible source for gelatin production since they show high bloom values as well as high viscosity that show similarity with already manufactured gelatin and support possibility for usage.

References

[1] Viscosity of Gelatin Solutions. Clarke E. Davis, Earle T. Oakes, and Harold H. Browne Journal of the American Chemical Society 1921 43 (7), 1526-1538 DOI: 10.1021/ja01440a013

**Note that after each step scales are filtered and then washed with distilled water to prevent any residual matter remaining.*