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Ester Bond in Casein Plastic

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Abstract

From the perspective of contributing to solving the problems of plastic waste and food loss, we focused on casein plastic, a biodegradable material whose main component is casein, a protein found in milk. In previous research, it has been found caseins form cross-links via ester bonds. We speculated that the ester bond may be related to the strength of this casein, and that by increasing these bonds, it might be possible to increase the strength of plastic.

1　Introduction

With the aim of finding the conditions under which ester bonds are most likely to form, we change the conditions under which casein in milk aggregates and examine the relationship. Our goal was to find a biodegradable yet still strong material.

2　Theory and Experiment

1. 1200 ml of milk was placed in a 500 ml beaker and heated in hot water.
2. 10 ml of 0.825 mol/L (approximately 5%) acetic acid was added to the heated milk and stirred well with a glass rod.
3. The casein aggregated in step 2 was placed in a draining net and rinsed three times with cold water. The casein was then removed and wiped dry with kitchen paper, and then its mass was measured.
4. The casein was dried, placed in a 2cm x 2cm x 1cm mold, and molded by pressing at 1.25 x 10^5Pa for 60 seconds, and was left in a dryer (50℃) for 7 days.
5. IR spectrum measurement was then performed on the molded casein plastic. (Requested at Kobe Laboratory Co., Ltd.)

3　Results

There were white and yellow areas on the surface, and an oily substance was also attached to it. This material was not strong enough to break or crack spontaneously during IR measurements. IR spectra of the white areas yellow areas, and the cross-section, confirmed the presence of ester bonds. At the same time, the presence of a large amount of C-H bonds were also confirmed.

4　Discussion

The casein plastic we produced showed the presence of ester bonds. However, its strength was low, so whether the ester bonds between the caseins had increased could not be determined. The detection of others substances within the casein, may indicate the existence of other types of ester or compounds with CH bonds. These substances may also reduce the strength of casein plastic.

5　Conclusion

In conclusion, it was not possible to compare differences in strength due to the high amount of ester bonds. The reason why casein could not be extracted at lower flocculation temperatures may be that the thermal motion of the casein micelles was low, and they were likely to stick to the free hydrogen ions.

6　References

・Research on casein plastics derived from milk (Tatsuno High School, class of 2022 graduate)
・Research on improving casein plastics (Tatsuno High School, class of 2023 graduate)
・Infrared absorption spectroscopy materials (Kobe Industrial Research Institute)
・"Esters and fats" chemistry textbook (Suken Publishing)