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Pusat Asasi

Preparation of Casein Protein-Based Bioplastics at Different Temperatures and Percentage of Acid Used

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ABSTRACT

The purpose of this study was to prepare casein protein-based bioplastics for biodegradable plastic materials application. Casein was extracted from spoiled cow milk heated at different temperatures (40 °C, 50 °C and 60 °C) and amount of acetic acid was varied (1 ml, 5 ml and 10 ml). By adjusting the extraction parameters of casein, two different types of protein-based bioplastics were produced: smooth and rough surface polymers. The preparation by using this technique can be beneficial as it is the most convenient and cost-effective process. These bioplastics have high potential for development of biodegradable plastic; the challenge of solid waste management can be wisely controlled if the plastics that are being used made up of waste material such as casein from the spoiled milk.

Keywords: Casein; plastic; biodegradable; spoiled milk; polymer

INTRODUCTION

Plastics are widely used to keep resources for human utilization. Due to the plastic's characteristics of being flexible, smooth surface, and lightweight, it can be moulded in various shapes. Almost 300 million tons of plastic each year worldwide [1], which is nearly equivalent to the amount of the whole human population. Besides reducing plastic use, making biodegradable plastics is the most effective ways to prevent this waste.

Casein is a significant component of a protein in milk. It is a family of related phosphoproteins which has variety of uses such as main component of cheese to being used as food additives. The regular form of casein is sodium caseinate, which can bind and organize a lattice like a polymer structure. Previous study reported that when milk is heated and an acid is added, the casein molecules unfold and restructure into a long chain [2]. The study aims to prepare casein protein-based bioplastics from spoiled milk for biodegradable plastic materials application.

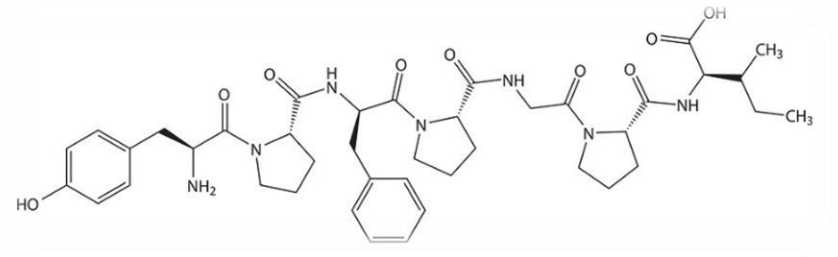

Figure 1: Casein structure

INNOVATION DEVELOPMENT

The study used an experimental research design where the casein was extracted from spoiled cow milk heated at different temperatures (40 ^{o}C, 50 ^{o}C and 60 ^{o}C) with 5 ml of 0.1 moldm^{-3} acetic acid. The highest production of the yield was at 60℃ which is 3.85 g. This temperature is slightly higher than the other temperatures that have been reported [3]. It can also be observed that the yield in both temperatures listed (40 ^{o}C and 50 ^{o}C) has lower yields. The coldest temperature at 40 ^{o}C yielded only 2.11 g of casein, while the temperature at 50 ^{o}C, has 3.05 g.

The amount of acetic acid used in coagulating the milk components is also determined. Given the desired temperature which is 60℃, a test on the amount of acetic acid is then being carried out. Another 3 sets of spoiled milk with different amounts (1 ml, 5 ml, and 10 ml) of acetic acid are subjected to casein extraction. Extraction of using 1 ml acetic acid shows no casein coagulation process occurred. The yield of casein by using 5 ml and 10 ml declined from 3.83 g to 3.35 g respectively. Smooth surface structure (Figure 4) of plastic produced using 5 ml acetic acid indicates the coagulation process took place slowly and organized a uniform layer structure. Meanwhile, the rough surface (Figure 5) of plastic produced when higher amount of acetic acid used; 10 ml.

The casein prepared from the best temperature set-up and best acetic acid amount were allowed to dry up. After a series of observation to the output, it was found that it is fully harden after 2 days.

Figure 2: Casein extraction process

Figure 3: Casein of spoiled milk

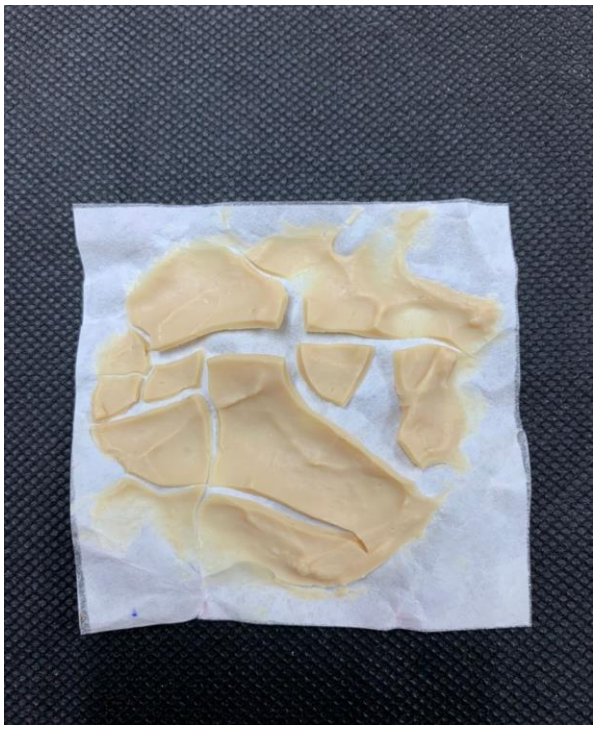

Figure 4: Plastic (dried casein) prepared at 60℃ using 5 ml of 0.1 moldm^{-3} acetic acid

Figure 5: Plastic (dried casein) prepared at 60℃ using 10 ml of 0.1 moldm^{-3} acetic acid

COMMERCIAL POTENTIAL

Plastics are widely used because they are durable and require low cost [4]. Unfortunately, these became a serious issue as they were not disposed properly and may harm and contribute to pollution. Food waste, such as spoiled milk is considered as a versatile substitution material against hydrocarbon to produce plastics [5,6]. The combination of acids and heat encourage to lift the protein casein from the milk [7]. This type of plastic is environmentally friendly because it is biodegradable which will naturally decomposed, unlike plastics that are made from petroleum products which requires very long time and high cost to decomposed.

Hence, the study utilized spoiled milk into biodegradable plastic since it is cost-efficient to produce a container to store dry goods and resources. The challenge of solid waste management can easily be done if the plastics that are being used in our daily lives are made up of simple materials [8] such as casein from milk.

CONCLUSION

It was found that to extract casein from milk, there are parameters needed to be observed such as temperature and amount of acetic acid required to be added to the milk. From the experiment conducted, the optimal temperature can be used is at 60℃ using 5 ml acetic acid tends to derive a higher yield of casein and smooth surface of plastic.

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