Surface Morphological Studies of the Fermented Rice Grains during Bedak Sejuk Production

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Abstract

Bedak sejuk is a traditional fermented rice based cosmetic used by women in Malaysia. The production of bedak sejuk is simple but takes time to produce as repeated soaking are needed to get fine rice flour at the end of the production. During the soaking of rice grains, natural fermentation will occur. Here, we monitored the surface morphological studies of the rice grains during the natural fermentation for bedak sejuk production. Basmati rice grains variety (Indica) was used in this study. These rice grains were soaked in a tap water (w/v) in a closed jar for 84 days (6 times soaking interval; 14 days for each soaking interval). When subjected to natural fermentation, the whole figure and surface of the rice grains were extremely changed at the end of the sixth soaking. The presence of indigenous microbial during the fermentation led to more irregular surface due to external corrosion with granule pitting. Fermented rice grains exhibited uneven surfaces having a number of shallow pits with large diameters in accordance with scanning electron microscope (SEM) observations for the fourth until sixth soaking interval. Furthermore, the granular size was deceased and fragments were formed started at the second soaking. Overall, enzymatic hydrolysis could form porous granules and keep granular morphology, whereas the hydrolysis exhibited morphology with many small porous fragments.

Keywords: Rice Starch, Rice Grains Surface, Morphology, SEM

INTRODUCTION

Structures of rice starch are described as semi-crystalline biopolymer of D-glucose. The starch molecule is composed of linear amylose and branched amylopectin fraction which show amorphous and crystalline regions [1]. Starch granule shows wide variation in size and shape depending on their botanical source; e.g. rice 2-7 μm with polygonal and irregular shape [2]. Bedak sejuk is a traditional cosmetic that still being fond by women in Malaysia. Bedak sejuk is fermented rice flour that has been shaped into water-droplet or cone shape pastille. The production of bedak sejuk is still using the traditional process and usually it is produced as a homemade product. The soaking process is a repeated process because the soaking water need to be changed intermediately because of the pungent smell. The overall soaking will take long time to get the rice flour at the end of the soaking process. As the production of bedak sejuk is quite time consuming, sometimes the fermented rice grains will be ground to get the rice flour.

By the previous study [3,4], the rice grains should be soaked for few times interval to get rice flour at the end of soaking process. This soaking process suggested that a natural fermentation occurred by the high amount of titratable acidity (which is expressed as lactic acid) produced [5] and high number of anaerobic bacteria which is believed as lactic acid bacteria population growth [6]. The high amount of the titratable acidity shows that the amount of organic acids that produced during the fermentation is high. Moreover the pH of the soaking water is acidic which indicates that the high concentration of organic acids turned the soaking water into an acidic environment [5]. Besides α-amylase was detected on the previous study too [7]. α-amylase will contribute to the saccharification and liquefaction of the rice grains too. So the first idea on degradation of rice grains into fragments and finally become rice flour at the end of the soaking is the degradation happened because of the acid and enzyme that produced during the natural fermentation.

Natural fermentation is a complicated biochemical system. Enzymes, organic acids, low molecular weight sugars as well as other metabolites will be produce consequentially and affect the physicochemical properties of final [7]. Enzyme and organic acids are the most important likely contributes to starch modification or degradation. Acid modification causes degradation of starch without damaging the basic granular size and structure [8] although some change in the surface morphology is observed. While enzymatic modification can change the physicochemical nature of starch including its morphological and crystalline properties [9,10].

In this study, the fermented rice grains (bedak sejuk) surface morphology were investigated by scanning electron microscope (SEM). The objective of this study was to evaluate the fermented rice grains surface morphology. This study should be very helpful to obtain better understanding on how the fermentation affect the rice grains and the final structure of bedak sejuk obtained.

PREPARATION OF BEDAK SEJUK

Basmati rice grains variety (Indica) were purchased from the local market. The soaking process is followed the traditional methods of bedak sejuk production. In order to stimulate household conditions, the container used was not sterilized and tap water was used. 250 g of rice grains were soaked in tap water (w/v) and allowed to ferment undisturbed naturally at ambient temperature for 14 days. After 14 days, the rice grains were filtered and then soaked again (w/v). The overall soaking process was 84 days or 6 times of soaking. Sample of bedak sejuk (fermented rice grains) were collected at the end of each soaking interval.
SCANNING ELECTRON MICROSCOPY (SEM)

Scanning electron microscopy (High Resolution Fesem Supra 55VP) was used to see the surface morphology of fermented rice grains at each soaking interval. Six samples were placed on scanning electron microscope stubs using double sided adhesive tape. It observed at 10 kV accelerating voltage.

SURFACE MORPHOLOGY OF BEDAK SEJUK

Scanning electron micrographs of the Basmati rice grains are presented in Figure 1. Based on the SEM pictures, we can see that the length of the rice grains became short. After the rice grains from the sixth soaking were filtered, the fermented rice flour was a mixture of coarse and fine powder.

Fig. 1(B-C) show a cracked mark on the rice grains (arrows show cracked marks) while Fig.1D shows that hollow formed on the rice grains (circle show hollow formed). While Fig. 1(E-F) show that the rice grains has more clear cracked mark and also more deep hallow. Furthermore, at the sixth soaking, the rice grains absolutely changed its shape and lost its surface smoothness. All of this indicates that the soaking process has degrade the rice starch. Plus, more soaking interval need to be done for achieving more fine powder.

![Figure 1](image1.jpg)

Figure 1. Scanning electron micrographs of unfermented rice grains (A) and first until sixth soaking of fermented rice starch (B-G) for few selected grains.

Scanning electron micrographs of surface of the unfermented rice grains and fermented rice grains are presented in Figure 2. Little variation in the morphology of the rice endosperms (unfermented rice starch) can be found when viewed under the scanning electron microscope. The endosperm region is composed of cell wall materials and starch granules that cluster into compound starch granules [11]. A closer observation of the starch granules revealed that the starch is mainly composed of large polyhedral and irregular shaped granules, which is typical of many rice starches.

But as we can see at Fig. 2(A), there is impurity on the grains (circles show impurities). We cannot see clear the polyhedral and irregular shaped granules of this Basmati rice grain’s. This is because the impurities are actually the damaged starch that produced during the polishing process of the rice grains.
As described in the preparation of the *bedak sejuk*, the rice grains were not washed first. So the damaged starch was still stick on the surface of the rice grains.

At the end of first soaking (Fig. 2B), the fermented rice grains showed polygonal shape. The surfaces of the granules were rough and flat. As for the second soaking (Fig. 2C), the fermented rice grains showed a clear polygonal shape with sharp angles and edges. While the surfaces of the granules were smooth and flat or slightly concave. The differences of the fermented rice grains for the first and second soaking might be due to the presence of damaged starch. The damaged starch that produced from the polishing process of the rice grains were attached on the rice grains. It can be seen that during the first soaking, there were few small granules which is believed to be the damaged (circles show damaged starches) (Fig. 2B). These damaged starch were attacked by the indigenous microorganism as they provided the carbon source to the indigenous microorganism during the soaking process [12]. From Fig. 2B, we can say that the damaged starch was still not fully utilized during the first soaking as we can see there were still some impurities (circled).

While for the second soaking, there were no presence of damaged starch anymore (Fig. 2C). It can be suggested that the damaged starch has been fully degraded during the second soaking. The fermented rice starch at the end of the third soaking revealed some small pits and pores on the surfaces of the starch granules (Fig. 2D, arrows show the pits and pores). These pits and pores occurred for the fourth, fifth and sixth soaking too (Fig. 2D-G, arrows show the pits and pores). The sizes and numbers of pores and pits increased through those three soaking process. At the sixth soaking, it can be seen that some pits penetrated deep into the granule (Fig. 2G).

Numerous pits were appeared on the rice starch granules (Fig. 2D-G), which are openings to channels for providing access to the granule interior [13]. With fermentation time being longer, the holes became larger, and more extensive extent of hydrolysis occurred (Fig. 2D-G). Furthermore, the granular size was deceased and fragments were formed (Fig. 2G) at the end of the overall soaking.

Figure 2. Scanning electron micrographs of unfermented rice grains (A) and first until sixth soaking of fermented rice starch (B-G) showing he surface of the rice grains.
During the soaking process, the enzyme release during the fermentation and enzyme indigenously from the rice starch itself and also the organic acid produced that turned the soaking water into acidic environment making the enzymatic and acid hydrolysis happened. Obviously, amylase and acid exhibited into acidic environment making the enzymatic and acid hydrolysis happened. Therefore, enzymatic hydrolysis could form porous granules and keep granular morphology, whereas the hydrolysis exhibited morphology with many small porous fragments.

CONCLUSION
This work showed that the natural fermentation which combined acid and enzyme modification yielded many porous fragments and made native starch be readily digested. Research is underway to obtain a more precise understanding of the relationship between the starch digestibility and structure.

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