Physical, Chemical, and Microbial Changes during Fermentation of Bungkil: A Traditional Snack Originated from Banyumas, Central Java

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Abstract: Bungkil is a traditional snack or side dish made from by-product of traditional process of coconut oil making process, originated from Banyumas and Kebumen regencies, Central Java. We interviewed a bungkil maker for bungkil making process, in the area of production,. The process includes washing mature coconut kernel, soaking in water for three days, draining, and first fermentation by wrapping in layers of banana leaf for three days, draining, grating, second fermentation by wrapping grated coconut in layers of banana leaf for two days, and sun-drying and oil separation. The by product is the cake, which is called 'bungkil'. The cake is mixed with spices, oval or round shaped, and then fried in coconut oil. It is then ready for consumption. We analysed pH, water activity, and microbial count during fermentation. Results showed that final pH, and water activity were 7.50, 0.88, respectively. Microbial concentration in fresh coconut was 9.84×10^7 cfu/mL, at the end of soaking was 4.42×10^9 cfu/mL, and at the end of sun-drying was 2.74×10^9 cfu/mL.

1 INTRODUCTION

There is a rising demand towards traditional food in international market, which has to be responded by food industry (Vanhonacker 2013, Kwon 2015). Recently, consumers highly valued traditional character in food, and in the same time also required safety, proper labelling, and availability and easy to access product in the market (Vanhonacker 2013). Apart from consumers' better appreciation to ethnic foods, traditional food is closely related to utilization of local produce, local knowledge and technology (Kwon 2015, Renna 2015), thus support food security. One of the ancient methods to preserve food is fermentation where growth of spoilage microorganisms is inhibited by other beneficial microorganisms (Kwon 2015). The role of fermented traditional food in balancing availability of food sources was also highlighted (Anal 2019). This process is now well-known as a method having health supporting effect. There are wide range of traditional fermented products reported previously (Anal 2019), however we did not encounter any of them made from coconut meat fermentation.

However, we found a traditional fermented coconut meat product in Indonesia. It is called 'bungkil' which is originated from Banyumas and Kebumen, two regencies in southern part of Central Java. Bungkil may be considered as by-product of traditional fermentation for coconut oil extraction. Fermentation is very cheap and easy method for coconut oil making process (Iskandar 2009), which can utilize wide range of microorganism including yeasts (Iskandar 2009), and lactobacilli (Agarwal and Bosco 2017). Although the process is more suitable for small enterprise (Iskandar 2009), it is time consuming and the quality of product was considered inferior due to poor colour and odor (Agarwal and Bosco 2017). Bungkil is consumed as a snack or a side dish to be eaten with rice. Recently, this product is rarely found in local market. Bungkil makers now made it based on individual request of consumer. Unlike a well-known forbidden fermented coconut product in the area called 'tempe bongkrek' (bongkrek tempeh) which can pose fatal poisoning (Anwar et al. 2017), there is no report on bungkil poisoning. Therefore, it is important to conduct preliminary study on fermentation process of bungkil. In this work, we collected information of bungkil making process, and subsequently studied some chemical and microbial profile during fermentation.

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2 METHODOLOGY

2.1 Stages of Process of Making Bungkil

We interviewed a 'bungkil' maker and previously a' bungkil' seller lived in Cilacap, called Ibu Sagem. After identifying stages of process, we carried out bungkil fermentation in the laboratory, and decided stages of process where samples would be collected. All samples were taken from two separate experiments, with two data readings in each parameter in every experiment.

2.2 pH

pH was determined using standard method where solid sample was grounded using pestle and mortar, and then diluted using distilled water. Solid was separated by filtration using Whatman paper no.40. Determination of pH of filtrate was carried out using pH-meter (PH 1120X, Mattler Toledo, China).

2.3 Water Activity

Water activity of sample was determined using an Aw-meter (Hygropalm, Rotronic, Bassersdorf). As much as 2 gram sample was put inside sample chamber which was then closed with the lid to start the reading.

2.4 Microbial Count, Macroscopical, and Microscopical Observation of Colonies

A serial dilution was performed for each sample taken from each stage of process. Then, one milliliter of suspension was aseptically transferred and spread evenly onto surface of a plate count agar (Oxoid CM0325).

3 RESULT AND DISCUSSION

The process of making 'bungkil' was described by Ibu Sagem, and it consisted of several stages. It started from fresh coconut meat which is washed, and then soaked in well water or mixed of water with coconut juice (approximately 1:1, v/v). The soaking stage took three days at room temperature. After that, the coconut chunks were drained, and put into a bamboo basket lined with two or three layers of banana leaves. The top of the coconut was covered with two layers of banana leaves. It was left for three days. This process was called 'emplep' or 'empep'. After that, coconut chunks were drained and grated. The grated coconut went into another three-days 'emplep' process in a bamboo basket lined with banana leaves. After that, for four days, grated coconut was sun-dried during day time, and put into bamboo basket for 'emplep' process during night. At the end of four days, grated coconut has been very soft and oily. The oil was separated by hand pressing of grated coconut wrapped in cheese cloth. The oil was collected, while the cake was then mixed with spices (shallot, garlic, chilli, salt, sugar, and galangal). The mixture was then shaped, and deep fried in coconut oil previously collected from the process.

Chemical and microbial changes during stages of process was presented in Table 1. During 'emplep' or fermentation process, acidity as expressed in pH reduced from 7 to around 6. It was expected that lactic acid bacteria may utilize simple sugar of coconut meat to produce acid during the process. The final product, however, showed higher pH than that of fresh coconut. This may due to the formation of basic substances resulted from protein degradation, such as ammonia.

Water activity was high during the process, but reduced to 0.88 after drying. Even after drying, high water activity was expected, since coconut meat became very soft and moist during fermentation. The presence of oil in the product may hinder water evaporation. High water activity during 'emplep' facilitated growth of bacteria to increase from 9.84×10^7 cfu/mL to 4.42×10^9 during soaking and 2.74×10^9 after drying. We did not identify colonies to species level, however there was apparently change in types of microorganism during fermentation. Colonies isolated from fresh coconut meat was mostly white and cocci with around 3.3 μm diameter. During soaking there were orange colonies of streptobacilli cells, and white colonies of cocci. These colonies were also isolated from the final product.

As bungkil making process is basically a fermentation of coconut to produce coconut oil, it differs from other familiar process where fermentation was applied to coconut milk (Iskandar 2009) rather than coconut meat. Therefore, chemical and microbial changes in bungkil fermentation may not as fast as that in coconut milk fermentation. Final pH of coconut oil produced by coconut milk fermentation was 6 (Iskandar, 2009), while the solid part (locally called as "blondo") was 4.5 (Iskandar, 2009). The lowest pH in bungkil fermentation was 5.7, slightly lower than that of oil (Iskandar, 2009),

Table 1: Acidity, water activity, and microbial count of during processing of 'bungkil'.

Stages of process	**pH**	**Water activity**	**Microbial count (cell/mL)**	**Microbial characteristics**
Fresh coconut meat	7.32	0.93	9.84×10^7	White, shiny colonies; cocci, 3.3 µm diameter
Soaking	6.50	0.97	4.42×10^9	Orange colonies, streptobacilli 4-5 µm in length
				White colonies, cocci 4 µm in diameter
				White colonies, cocci, 11.3 µm in diameter
Coconut chunks fermentation	6.63	0.97	Not analysed	
Grated coconut fermentation	5.76	0.95	Not analysed	
Coconut cake after drying	7.50	0.88	2.74×10^9	White colonies, cocci, 2.1 µm
				Orange colonies, streptococci, 4.5 µm in length

but more basic than solid part of coconut milk (Iskandar 2009). There was an increase of pH during final of bungkil process after drying, to reach 7.5. Therefore, bungkil process may be categorized as alkaline fermentation (Anal 2019), where bacilli may be predominated (Anal 2019). Lypolitic and proteolytic activities during bungkil fermentation was likely to produce basic substances such as ammonia.

Micrococci, which is characterized by small diameter cell (0.5-3 µm), were isolated in several coconut-based product, such as dried grated coconut (Kinderlerer and Clark 1986), coconut milk (Suryani et al. 2014), fresh coconut (Su'i et al. 2015), coconut water (Salunkhe and Kadam 1995), and copra (Salunkhe and Kadam 1995). Coconut meat was a rich medium for growth of contaminating microorganism (Umesha and Nrayanaswamy 2016), as compared to coconut water (Umesha and Narayanaswamy 2016). Although micrococci maybe considered as spoilage bacteria which can be inhibited by lactic acid bacteria (Gollop et al. 2006), they showed growth stimulation effect to lactic acid bacteria (Nath and Wagner 1973b) by inhibition of hydrogen peroxide production (Nath and Wagner 1973a).

During bungkil fermentation, lactic acid bacteria growth is expected, as indicated by reduced pH. Lactic acid bacteria was reported to grow during coconut milk spontaneous fermentation (Suryani et al. 2014, Agarwal and Bosco 2017). Suitability of coconut meat for lactic acid bacteria growth is also shown by production coconut milk kefir employing *Lactobacillus* spp. (Lakshmi and Pramela 2018). Lactic acid bacteria are abundant in tropical environment, including some species of lactobacilli, *Leuconostoc sp*., *Weisella sp*. and *Lactococcus lactis* (Khota et al. 2016).

4 CONCLUSION

Bungkil making process involved acidic fermentation in early stage and basic fermentation in the later stage, by cocci and streptobaccilli.

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