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Yogurt Making as a Tool To Understand the Food Fermentation Process for Nonscience Participants †

Widya Agustinah[1]*, Renna Eliana Warjoto[2], and Meda Canti[1]
[1]*Program of Food Technology, Faculty of Biotechnology, Atma Jaya Catholic University of Indonesia, Jakarta 12930, Indonesia,* [2]*Program of Biology, Faculty of Biotechnology, Atma Jaya Catholic University of Indonesia, Jakarta 12930, Indonesia*

Designing an outreach program concerning food fermentation for nonscience participants offers an opportunity to introduce the basic principles of microbiology and their application in food preservation. This program can be adapted to microbiology courses at the undergraduate level to help students understand the concept of food fermentation and its process control. Yogurt is a type of fermented milk that is commercially available in Indonesia. While yogurt fermentation is usually performed in a closed fermenter in an aseptically controlled room, yogurt can also be made at home using lactic acid bacteria culture starters, such as *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*, and applying proper hygiene and sanitation procedures. Yogurt making requires not only appropriate ingredients but also an understanding of the microbiological concepts of yogurt fermentation in order to enable control and modification of the fermentation process so that the end product is safe to consume. Through this activity, we provided training to residents from a nonscience background in Bogor, Indonesia, for simple and feasible homemade yogurt production using a variety of milk substrates and sources of starter culture. All participants prepared the ingredients and sanitized kitchen equipment, performed the yogurt fermentation process, and evaluated the product's sensory properties. Participants were challenged to explore the differences among various yogurt batches. This activity can be completed in two days, and the recipe could be modified once the participants have understood the concept of yogurt fermentation.

Pelaksanaan program pengabdian masyarakat tentang fermentasi pangan bagi peserta awam yang tidak berlatar belakang sains dapat memberikan peluang untuk mengenalkan prinsip dasar mikrobiologi dan aplikasinya dalam pengawetan pangan. Kegiatan ini dapat diadaptasikan dalam mata kuliah mikrobiologi pada program S1 agar dapat membantu mahasiswa memahami prinsip dasar mikrobiologi dan pengendalian proses yang melibatkan mikrobiologi dalam bidang pangan. Yogurt adalah salah satu jenis susu fermentasi yang tersedia secara komersial di Indonesia. Produksi yogurt umumnya dilakukan dalam fermentor tertutup yang dikontrol secara aseptis. Selain itu, yogurt juga dapat dibuat di rumah dengan menerapkan prosedur higienis dan sanitasi yang tepat serta menggunakan kultur *starter* bakteri asam laktat, seperti *Lactobacillus delbrueckii* ssp. *bulgaricus* dan *Streptococcus thermophilus.* Pembuatan yogurt tidak hanya memerlukan bahan-bahan yang sesuai, namun juga pengertian tentang konsep mikrobiologi fermentasi yogurt agar pembuat dapat mengendalikan sekaligus melakukan modifikasi terhadap proses fermentasi untuk menghasilkan produk akhir yang aman untuk dikonsumsi. Melalui program ini, kami menyediakan pelatihan bagi warga awam yang tidak memiliki latar belakang sains dan tinggal di wilayah Bogor, Indonesia tentang pembuatan yogurt skala rumah tangga secara sederhana dengan memanfaatkan berbagai jenis substrat susu dan sumber kultur *starter*. Seluruh peserta menyiapkan bahan dan perlengkapan dapur yang telah disanitasi, mengerjakan proses fermentasi yogurt, dan mengevaluasi sifat sensori produk akhir. Peserta juga diminta untuk membahas perbedaan antara berbagai jenis yogurt yang telah dibuat. Kegiatan ini dapat diselesaikan dalam waktu dua hari dan bermanfaat memberikan pemahaman tentang konsep fermentasi yogurt sehingga peserta mampu melakukan modifikasi terhadap formulasi yogurt.

*Corresponding author. Mailing address: Program of Food Technology, Faculty of Biotechnology, Atma Jaya Catholic University of Indonesia, Jalan Jenderal Sudirman No. 51, Jakarta 12930, Indonesia. Phone: +62 21 5703306. Fax: +62 21 5719060.
E-mail: widya.agustinah@atmajaya.ac.id.
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INTRODUCTION

Designing an outreach program concerning food fermentation for nonscience participants offers an opportunity to introduce the basic principles of microbiology and their application in food preservation. Yogurt fermentation can be used as an active learning tool in which participants learn the principles of aseptic technique, hygiene and sanitation of kitchen equipment, preparation of a substrate and bacterial

cultures, and control of the fermentation process in order to create a safe product. This program can be adapted to microbiology courses at the undergraduate level to help students understand the concept of food fermentation and its process control.

Yogurt is well known as a type of fermented milk that contains lactic acid–producing bacteria (LAB) and provides nutritional benefits for human health in improving gastrointestinal function and increasing longevity (1, 2). Certain LAB are typically used in yogurt fermentation, such as *Lactobacillus delbrueckii* ssp. *bulgaricus, L. acidophilus,* and *Streptococcus thermophilus*, which convert lactose to lactic acid (3, 4). The combination of these LAB in yogurt fermentation contributes to the acidity, taste, and texture of the end product (1). Before the fermentation process, sugar and sweetener may be added to milk to increase the viability of LAB, thus increasing yogurt acidity by decreasing its pH (2, 5).

Commercial yogurt containing certain sugars and LAB species can be easily found in any grocery store. However, some Indonesian families prefer to make their own yogurt at home because it is cheaper and considered healthier. The family members can choose their preferred milk to be fermented, which may include low fat, skim, full-cream, or flavored milk. In addition, they can determine the amount of sugar added to the milk and select their own LAB starters, which are commercially available. While yogurt fermentation is usually performed in a closed fermenter in an aseptically controlled room, yogurt can also be made at home using LAB culture starters and applying proper hygiene and sanitation procedures. Since the family members know and understand the ingredients and composition of their homemade yogurt, they tend to be convinced that it is healthier than the commercial ones. Some family members may even start to produce homemade yogurt for small-scale business purposes. Therefore, they require fundamental knowledge and skills to properly conduct the yogurt fermentation process. In this outreach activity, we provide training to residents in Bogor, Indonesia, for simple and feasible yogurt production methods scaled for home use.

PROCEDURE

The participants were residents of Bogor, Indonesia, allocated into eight groups of five. They prepared and sanitized the kitchen equipment according to the yogurt making procedure (Appendix 1). All glass jars, wooden stirrers, and stainless steel spoons were washed with soap, rinsed with clean water, sanitized by soaking in boiling water, air dried, sprayed with 70% v/v ethanol, and air dried again. The yogurt making process was performed in three steps: preparation of the starter cultures, preparation of milk, and fermentation (Appendix 1). It was followed by a sensory evaluation of pre-made yogurt that had been previously prepared by the instructors in a controlled laboratory setting and the homemade yogurt that was produced by the participants during the outreach program. Pre-made yogurt made with the same recipe was used to train and familiarize the participants with the sensory properties of yogurt, including taste, texture (consistency), aroma, and color.

Two types of LAB starter culture were used as the inoculum and four types of milk as the substrates. In the food fermentation laboratory, single-strain cultures of *L. delbrueckii* ssp. *bulgaricus* and *S. thermophilus* were previously prepared by the instructors by growing the pure cultures of LAB into pasteurized skim milk and incubating them at 37 °C for 16 to 18 h (6). Another type of inoculum was a commercial plain yogurt which contained live cultures of *L. delbrueckii* ssp. *bulgaricus* and *S. thermophilus,* as was described in the packaging label. Different types of milk were purchased from a grocery store, including skim milk, pasteurized full-cream (whole) milk, ultra-high temperature (UHT)–processed full-cream milk, and UHT-processed low-fat milk. All milk was purchased in liquid form, except for powdered skim milk. Sugar was added to the powdered skim milk, which was then dissolved in pre-boiled water and pasteurized at 85 °C for 15 min. Through this step, participants were taught the importance of heat treatment on the milk substrate and the effect of sugar addition on the finished yogurt. Sugar was added to skim milk to provide an additional carbon source for the LAB (7). The pasteurized milk and UHT milk were warmed to 40 °C and used directly for inoculation without any additional ingredients. The concentration of the commercial plain yogurt that was used as the inoculum was doubled from the single-strain cultures to counteract the potential dilution of bacterial count in the commercial product. This treatment could mimic the backslopping technique used in various food fermentation (8).

All glass bottles containing inoculated milk were placed on a clean, disinfected bench. Milk fermentation was performed at room temperature (28–30 °C) for 24 hours, instead of using an incubator, to mimic the limitation of equipment in the home kitchen. The fermentation required a longer incubation time due to the lower temperature in the incubation location. Such modifications and reasoning were explained to the participants to demonstrate how to control bacterial growth. After fermentation, participants were asked to analyze the pH, to observe the texture, color, and aroma, and finally to taste the yogurt (Appendix 2).

SAFETY ISSUES

Yogurt making was done in a home-scale kitchen following procedures that had been approved by the quality assurance team at the Faculty of Biotechnology, Atma Jaya Catholic University of Indonesia. This activity is considered exempt from the requirement of Institutional Review Board (IRB) approval. In addition, food fermentation is a common practice in many Indonesian households, and they are able to safely produce traditional fermented foods across generations, such as *tape* (fermented cassava), *tempe* (fermented soybean), and *dadih* (fermented buffalo milk). The risk of possible foodborne pathogen contamination can be minimized

by following laboratory safety practices and ensuring good personal hygiene and sanitation procedures (9, 10), all of which were taught during the training. Single-strain starter cultures of food-grade LAB were prepared by the instructors in the laboratory following ASM BSL1 guidelines (10). The other activities conducted during the outreach program were done by the participants under careful monitoring by the instructors and laboratory assistants. Several control measures were applied to maintain food safety and avoid failure of fermentation, such as aseptic technique and application of proper fermentation temperature and time during sanitation, milk pasteurization, and fermentation. The success of yogurt fermentation was characterized by lactic acid production, which decreases the pH, increases the consistency, and inhibits the growth of spoilage and pathogenic microorganisms (2, 8).

ASSESSMENT

Upon completion of the sensory evaluation of the pre-made yogurt samples, participants were asked to record the pH and sensory properties of their own yogurt, evaluate the difference of each treatment, and choose their preferred yogurt (Appendix 2). The average final pH after fermentation was 4.5. Participants also learned that different milk types, which varied in their fat content, contributed to the consistency (texture) and mouthfeel of the yogurt. The lower the fat content, the thinner the consistency of the yogurt, except for skim milk made with 15% skim milk powder and 4% sugar, which would increase the consistency of the yogurt. Yogurt made with skim milk and sugar was the preferred yogurt due to its mild acidic taste and medium thick consistency. The addition of sugar before fermentation could increase the sweetness and provide a mild acidic taste to the yogurt since some sugars were converted into lactic acid. Both types of starter cultures could be used to produce yogurt. The results also confirmed the importance of milk pasteurization and kitchen cleanliness to achieve successful fermentation.

A questionnaire was provided to assess the participants' interest in learning activities (Appendix 3). Since most of the participants (87.5%) had never made yogurt at home, they found that these learning activities were interesting and provided them with new knowledge and instructions that were easy to follow. Almost all participants (97%) even tried to reproduce their own yogurt at home, reporting to the instructors every week for a month.

CONCLUSION

This outreach program was designed to train families from a nonscience background residing in Bogor to make yogurt at home. It was intended to introduce some fundamental concepts of microbiology, such as how to utilize "good" bacteria in food application, how to control microbial growth through proper heat treatment and inoculation of starter cultures, and how to enrich the environment to support LAB metabolism. The participants' interest in these learning activities suggests that the yogurt-making activity could serve as an effective active learning tool for nonscience participants, particularly regarding the food fermentation process. Furthermore, the experiments could be modified for undergraduate level microbiology laboratory courses.

SUPPLEMENTAL MATERIALS

Appendix 1: Yogurt making procedure
Appendix 2: Worksheet
Appendix 3: Questionnaire

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REFERENCES

1. Mazahreh AS, Ershidat OTM. 2009. The benefits of lactic acid bacteria in yogurt on the gastrointestinal function and health. Pakistan J Nutr 8(9):1404–1410.
2. Hartati AI, Pramono YB, Legowo AM. 2012. Lactose and reduction sugar concentrations, pH, and the sourness of date-flavored yogurt drink as probiotic beverage. J Appl Food Technol 1(1):1–3.
3. Legowo AM, Kusrahayu, Mulyani S. 2009. Milk technology. Diponegoro University Press, Semarang, Indonesia.
4. Yildiz F (ed). 2010. Development and manufacture of yogurt and other functional dairy products. CRC Press, Boca Raton, FL.
5. Gad AS, Kholif AM, Sayed AF. 2010. Evaluation of the nutritional value of functional yogurt resulting from combination of date palm syrup and skim milk. Am J Food Technol 5(5):250–259.
6. Apostolidis E, Kwon YI, Ghaedian R, Shetty K. 2007. Fermentation of milk and soymilk by *Lactobacillus bulgaricus* and *Lactobacillus acidophilus* enhances functionality for potential dietary management of hyperglycemia and hypertension. Food Biotechnol 21:217–236.
7. Drake M, McKillip J. 2000. Fermentation microbiology: making cheese, yogurt and buttermilk as a lab exercise. Am Biol Teach 62:65–67.
8. Holzapfel WH. 2002. Appropriate starter culture technologies for small-scale fermentation in developing countries. Int J Food Microbiol 75:197–212.
9. UCSF Institute for Health & Aging. 2013. Green cleaning, sanitizing, and disinfecting: a toolkit for early care and education. University of California, San Francisco, CA.
10. Emmert EAB. 2013. Biosafety guidelines for handling microorganisms in the teaching laboratory: development and rationale. J Microbiol Biol Educ 14:78–83.