Research article

Proposal of New Pickles to Improve Food Sanitation at Wet Markets in Cambodia

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Abstract The lack of heat treatment is one possible factor leading to highly contaminated pickles with microbes, including the bacteria that cause food poisoning. A heating process that sterilizes food products is effective in reducing the microbial content of pickles. We applied heat treatments to ensure that homemade pickles were safe to consume. In this study, 2 kinds of pickled young papaya were made to develop a new, safe processed food that effectively utilizes agricultural products. The objective was to evaluate the possibility of acceptance of these samples in Cambodia and other Asian countries. The sensory evaluation indicated that the samples were acceptable but still need further improvement.

Keywords young papaya, pickle, heat treatment, sensory evaluation, acceptability

INTRODUCTION

Pickles are a popular ready-to-eat food, and most pickles are produced in traditional ways in Cambodia. Pickles are easy to make, and do not require for any special equipment or skills. The basic procedure for making pickles is to wash the vegetables and then add sugar, salt, and other ingredients such as fish sauce, soy sauce, garlic, chili, and rice. Most pickles are stored in jars and placed in the sun or in a room at ambient temperature for 1 to 4 days. Pickles are commonly sold in wet markets in Cambodia. Almost all pickles sold in the wet markets are made without any heating process. Furthermore, the pickled product is displayed in a wet market under poor storage conditions; for example, there is no temperature control and no packaging. The hygiene practices of the local wet markets are very poor, which has subsequently led to food contamination. This situation is risky, and food poisoning incidents are often associated with these pickled products (Anal et al., 2019). Chrun et al. (2017) also pointed out the poor hygiene at the local wet markets in Cambodia and the necessity of identifying the source of contamination. According to reports by Muramatsu et al. (2020a, 2020b), the pickles sold at the wet markets in Cambodia are highly contaminated with microbes, including bacteria that cause food poisoning. In addition, the inspection of wet markets showed that the pickle products were not handled in a hygienic manner. It is necessary for food handlers to receive practical knowledge on food hygiene to prevent the spread of bacterial food contamination. This contamination could be caused by a manufacturing process that does not use heat treatment. Pasteurization destroys pathogenic microorganisms in certain foods and beverages. A new pickling method that adds heat treatment to the production process is needed to reduce the risk of food poisoning posted by pickled products. Adding a pasteurization procedure to the production process can improve food safety and/or food sanitation (Breidt et al., 2004). A heating process that pasteurizes foods to reduce food spoilage microbes can be applied to many kinds of food products.

We conducted a survey of Cambodians in their twenties and thirties regarding pickles via the Messenger App and received 30 responses. Some respondents mentioned that they enjoy eating pickles on a daily basis but that consuming pickles causes them to vomit, experience diarrhea and bloat, and have headaches. The majority of respondents suggested that pickles should be made in a safe and high-quality manner, including packaging. The necessity of improving and guaranteeing food sanitation and safety were also recognized in this survey.

In Cambodia, papaya is an important agricultural product and an existing resource that is easy to grow and maintain. People can grow papaya in their homes or on a large scale in all areas of the country. People grow papaya as their livelihood, they consume it, and they sell it fresh in wet market (MAFF/GDA, 2010). Papaya can be harvested and is available year-round. A small amount of mature papaya (which is light yellow in color) is often pickled, but young fresh papaya is not pickled. Young fresh papaya or young papaya is unripe papaya before it ripens to yellow. Young papaya is also called "green papaya". The colors of the pericarp and the flesh of fruit of young papaya are green and white, respectively.

In this study, 2 kinds of pickled young papaya were developed to test a new, safe, processed food. These pickles are kinds of quick pickles and are not fermented pickles. This study aimed to find the new usage of young papaya to develop microbiologically safe pickles. We examined the possibility of acceptance of these samples in Cambodian and Asian markets. Heat treatment was added to the production process. The pickles were packed in a glass bottle, which is easy to pasteurize and enhances product value, quality, and safety. Glass bottles are readily accessible in Cambodia at a reasonable price and can be reused. Fresh young papayas are also reasonably priced and easy to find in Cambodia.

OBJECTIVE

The objectives of this study were 1) to develop pickled young papaya processed with heat

treatment and 2) to evaluate the possibility of acceptance of the pickles that ensure food sanitation in Cambodian and Asian markets.

METHODOLOGY

Materials and Pickle Production Process

Young papaya (*Carica papaya*) imported from Thailand were purchased at a supermarket in Tokyo, Japan. Before testing, the young papayas were stored in a refrigerator at approximately 4°C.

To develop the composition of seasoning, we first processed 3 kinds of pickles based on a book of Japanese recipes and Cambodian homemade recipes. These pickles were evaluated by 8 Cambodians in Phnom Penh, Cambodia. Based on the evaluation results and comments from the panelists, we revised and decided on 2 types of seasoning: sour pickles and salty pickles. Table 1 shows the seasonings used to make the 2 types of pickled young papayas. The green pepper in Table 1 was a fresh green pepper (*Piper nigrum*). The compositions of the pickles processed in this study are presented in Table 2.

Table 1 Seasonings used to make the 2 types of samples

Seasoning	Sample	
	Sour	Salty
Sugar (g)	115	110
Salt (g)	12	25
Vinegar (ml)	300	190
Water (ml)	200	190
Soy sauce (ml)	-	11
Fish sauce (ml)	-	59
Green pepper (piece)	20	-
Chili (piece)	-	1

**6-8 pieces of young papaya (about 30-40 cm^3)*

Table 2 Compositions of the 2 types of pickled young papayas

Component (%)	Sample	
	Sour taste	Salty taste
Moisture	81.2	73.5
Protein	0.6	1.4
fat	0	0
Ash	1.4	5.0
Carbohydrates	16.8	20.1
(Sugar)	(13.6)	(17.2)
(Dietary fiber)	(3.2)	(2.9)
Salt equivalent	1.1	4.6

Fig. 1 shows the production process for the 2 types of pickles. After the peel was removed from the young papaya, it was cut into a rectangular parallelepiped (10 mm in depth and width, and 50 mm in height) using a knife. The liquid seasoning was heated to boiling, and the spice and 6-8 pieces of young papaya were placed into a glass bottle up to 3-5 mm from the bottle lid. After closing the lid of the bottle (sealing), the bottle was turned upside down. The hot glass bottle filled with seasoning and young papaya was submerged in hot water at a temperature of 70°C. The hot water was heated to boiling. After coming to a boil, the glass bottle was maintained in boiling water for 10 minutes to raise the center temperature above 75°C. After this pasteurization, the glass bottle was cooled at room temperature (approximately 25°C) in the inverted state. The pasteurization conditions and methods adopted in this study conformed to the regulations for enforcement of the food sanitation act in Japan. The pickles were then stored at room temperature for 4 days. The pH values of the liquid seasonings were 3.60 for the sour pickles and 3.35 for the

salty pickles. Fig. 2 shows photographs of the sour and salty samples. The appearances of the sour and salty samples were light and dark yellow, respectively. The heating treatments, i.e., the heating of the liquid seasoning, the hot packing, and the pasteurization were important additions to the production process to improve and/or maintain food sanitation.

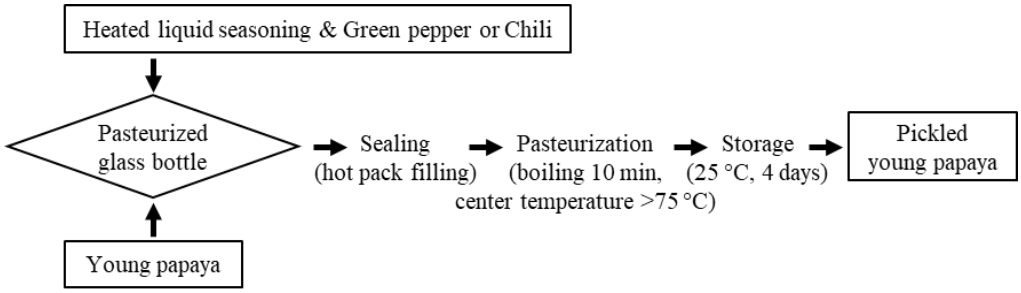


Fig. 1 Production process for the 2 types of pickled young papayas: sour and salty

Fig. 2 The appearance of sour and salty pickles

Sensory Evaluation of Pickled Young Papaya

The color, sweetness, sourness, saltiness, flavor, texture, and overall evaluation of each sample were quantified using a five-point hedonic scale (1: strongly dislike, 2: dislike, 3: neutral, 4: like, and 5: strongly like) for the sensory test (preference type). The sensory evaluations were conducted in Japan (Setagaya) and in Cambodia (Phnom Penh). Table 3 presents the panelist demographics. The total number of panelists was 32, and the nationality of all panelists was Asian. The panelists "Cambodia-1" evaluated only the sour sample in Cambodia; otherwise, the panelists evaluated both samples in Japan. The panelists were divided into 2 panels: Cambodian and non-Cambodian for the statistical analysis of the sensory evaluation results. The sour and salty samples were tested by 15 Cambodian panelists and 17 non-Cambodian panelists (total, 32 panelists) and 7 Cambodian panelists and 17 non-Cambodian panelists (total, 24 panelists), respectively.

Table 3 Panelist demographics for the sensory evaluation of the samples

Nationality	Number	Age (Average)
Cambodia-1[a]	8	21-35 (28)
Cambodia-2[b]	7	23-38 (27)
Vietnam [b]	5	20-24 (22)
Thailand [b]	4	23-38 (29)
Myanmar [b]	3	22-25 (24)
Philippines [b]	2	29, 30
Indonesia [b]	2	24, 36
Sri Lanka [b]	1	26

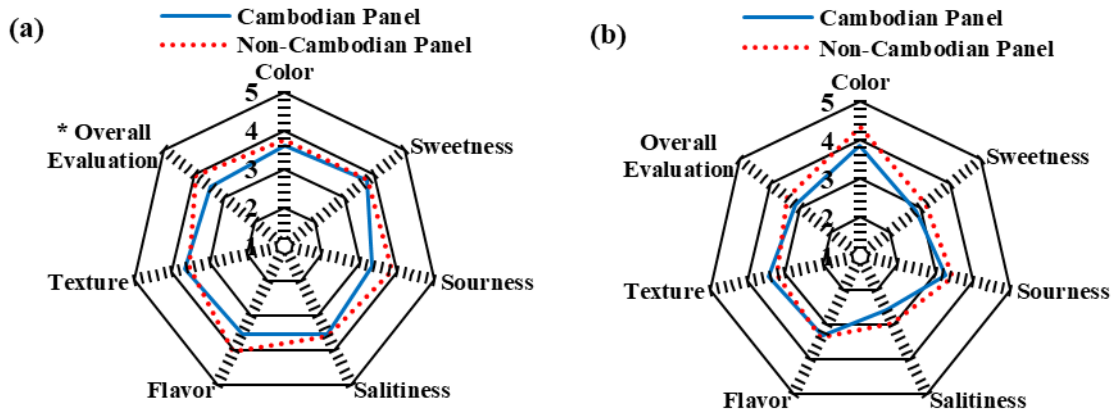
a: These panelists evaluated only the sour taste sample in Cambodia.
b: These panelists evaluated both samples in Japan.

RESULTS AND DISCUSSION

Fig. 3(a) shows the sensory evaluation results for the sour sample. The results for the Cambodian panel in Fig. 3(a) include the panelists "Cambodia-1" and "Cambodia-2" shown in Table 3. The average scores of the sensory evaluation characteristics of the sour sample ranged from 3.3-3.7 for Cambodians and 3.6-3.9 for non-Cambodians. The overall evaluation shows whether the pickled product was judged overall to be acceptable or not acceptable. The average overall evaluation was scored 3.5 by Cambodians and 3.9 by the non-Cambodian panelists. The non-Cambodian panel gave higher scores than the Cambodian panel, and the sour sample was more preferred by non-Cambodians than by Cambodians. The average values of each evaluation characteristic for the sour sample were tested for differences (t test) between the Cambodian and the non-Cambodian panels, and there were no significant differences (at the 5% significance level) for any characteristics, except for the overall evaluation. The overall evaluation score of the non-Cambodian panel was significantly higher, and this result showed the high acceptability of the sour sample by the non-Cambodian panel. These results indicate that the sour sample was acceptable by Cambodians and other Asians because the overall evaluation scores for both panels were over 3.0. In addition, the t test for each characteristic and for the average value between the panelists of "Cambodia-1" and "Cambodia-2" (Table 3) showed no significant differences. This result suggests that the evaluation results obtained in Japan could be applied to evaluate the acceptability of the samples in Cambodia.

Most panelists evaluated the texture as adequate but not firm. Some Cambodian panelists commented that the sweetness was adequate, and if the sourness and saltiness were reduced slightly in the sour sample, the evaluation of this sample would increase. In contrast, some non-Cambodian panelists stated that the sourness was adequate, and increasing the sweetness and saltiness slightly might improve the score.

The sensory evaluation of the salty sample is presented in Fig. 3(b). The average scores for the salty sample were 2.6-3.9 for Cambodians and 2.9-4.3 for non-Cambodians. The t test showed no significant differences in the average values for each characteristic between the Cambodian and the non-Cambodian panels. Except for the texture, the non-Cambodian panelists assigned higher scores than the Cambodian panelists on all characteristics. The average values for color were nearly 4.0, and the color of the salty sample was favored by both panels. Although the average values of saltiness for the Cambodian and the non-Cambodian panels and sweetness for the Cambodian panel did not exceed 3.0, the overall evaluation scores were 3.1 for the Cambodian panel and 3.4 for the non-Cambodian panel.



The symbol (*) means a significant difference ($p < 0.05$)

Fig. 3 Comparison of sensory evaluation of pickled young papaya between Cambodian and non-Cambodian panels (a) sour sample; (b) salty samples

The panelists commented that the dark yellow color of the salty sample was attractive and looked delicious, but the texture was soft, and a crunchier texture might change the evaluation. Most Cambodian panelists indicated that the taste of the salty sample was salty and lacked

sweetness. Although there are opportunities for improvement regarding the taste and the texture of the salty sample, i.e., lowering the salt content, increasing the sweetness, and increasing the crunchiness, the acceptability of the salty sample was indicated by the overall evaluation scores (over 3.0).

To improve food sanitation, heat treatments were added to the production process of the sour and salty samples. These samples received mostly favorable evaluations from Cambodian and Asian panelists. The heat treatments and the preservation period also affected the texture of the pickles. Therefore, it would be useful to investigate the relationships between these factors. Further studies will require more panelists to analyze the evaluation of pickles in detail and to assess their acceptability. We will optimize the process to produce safe, high quality, and more acceptable pickles.

CONCLUSION

Young papaya was used to develop a new pickle product in this study. The heat treatments, i.e., the heating of liquid seasoning, a hot pack, and pasteurization were added to the production process to improve and guarantee food safety. Two types of young papaya pickles, the sour and salty, were made and evaluated by Cambodians and Asians in Cambodia and Japan. The color, sweetness, sourness, saltiness, flavor, texture, and overall evaluation of each sample were quantified using a five-point hedonic scale (1: strongly dislike, 2: dislike, 3: neutral, 4: like, and 5: strongly like) for the sensory test (preference type). The sensory evaluation indicated that the samples were considered to be acceptable but needed further improvement. Because both pickles received mostly favorable evaluations from Cambodian and Asian panelists based on the overall evaluation scores (over 3.0), both pickles were potentially acceptable as new processed foods in Cambodia and in other Asian countries. This finding will be useful for food preservation, reducing postharvest losses, providing jobs for domestic Khmer people (particularly women), and increasing the income of citizens as well as the Cambodian nation.

REFERENCES

Anal, A.K., Perpetuini, G., Petchkongkaew, A., Tan, R., Avallone, S., Tofalo, R., Nguyen, H.V., Chu-Ky, S., Ho, P.H., Phan, T.T. and Wache, Y. 2020. Food safety risks in traditional fermented food from South-East Asia. Food Control, 109, 1-9, Retrieved from DOI https://doi.org/10.1016/j.foodcont.2019.106922

Breidt, J.F., Hayes, J.S. and McFeeters, R.F. 2004. Independent effects of acetic acid and pH on survival of escherichia coli in simulated acidified pickle products. Journal of Food Protection, 67 (1), 12-18, Retrieved from DOI https://doi.org/10.4315/0362-028X-67.1.12

Chrun, R., Hosotani, Y., Kawasaki, S. and Inatsu, Y. 2017. Microbiological hazard contamination in fermented vegetables sold in local markets in Cambodia. Biocontrol Science, 22 (3), 181-185, Retrieved from DOI https://doi.org/10.4265/bio.22.181

General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries (GDA, MAFF). 2010. Technical book of crops in Cambodia. GDA of MAFF, Cambodia, Retrieved from http://www.maff.gov.kh

Muramatsu, S., Uchino, M., Sorm, S., Tanikoka, Y., Oka, D., Muramatsu, Y., Nakajima, T., Sekido, M., Nakamura, T., Chay, C. and Mihara, M. 2020. Evaluation of bacterial contamination levels in pickles sold at wet market in Cambodia, Part 2, Detection of several food-poisoning bacteria of 48 samples from Phnom Penh. International Journal of Environmental and Rural Development, 11 (1), 121-126, Retrieved from DOI https://doi.org/10.32115/ijerd.11.1_121

Muramatsu, S., Uchino, M., Tanikoka, Y., Sorm, S., Oka, D., Muramatsu, Y., Nakajima, T., Sekido, M., Nakamura, T., Chay, C. and Mihara, M. 2020. Evaluation of bacterial contamination levels in pickles sold at wet market in Cambodia, Part 1, In case of samples from Kampong Cham and Phnom Penh. International Journal of Environmental and Rural Development, 11 (1), 115-120, Retrieved from DOI https://doi.org/10.32115/ijerd.11.1_115