Improvement of microbiological qualities of namphrik by gamma irradiation

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Abstract. Twenty samples of Namphrik from commercial markets were evaluated the microbiological qualities. It was found that 15 samples did not meet Thai Community Product Standard. The total plate count (TPC) in 15 samples were higher than the maximum limits (1.60x10⁴ – 4.4x10⁵ CFU/g). In addition, the other pathogens were higher than the maximum limits such as B. cereus in 11 samples (2.10x10³ – 6.10x10⁴ CFU/g) S. aureus in 2 samples (15 – 40 CFU/g) Clostridium perfringens in 4 samples (1.00x10² – 8.8x10³ CFU/g) and yeast&mold in 9 samples (3.00 x10⁰ – 9.00x10³ CFU/g). To reduce TPC and pathogenic bacteria, the gamma irradiation were applied at 3.28 - 4.43 kGy. The results indicated that the irradiation can reduce the TPC around 1.2 – 3.9 log cycles and eliminate pathogens bacteria in the product to make all of 15 samples qualified to the standard. The sensory evaluation was conducted in Namphrik Narok by using difference from control test to determine whether the consumers can differentiate between the non-irradiated and irradiated. The result showed that the consumers can significantly differentiate the color, odor and flavor (p<0.05). However, the preference test showed that there was no significant preferences at p>0.05. Both non-irradiated and irradiated were scored at 6.4 (slightly to moderately preference). Thus the gamma irradiation can be used as a tool to improve the microbiological qualities of the Namphrik Narok product without effecting the consumer preference.

1. Introduction
Namphrik is traditional Thai foods consisting of several dried ingredients such as chili, garlic, scallion, herbs, blended fish or shrimp etc. Spices and herbs may be contaminated to a wide range of microorganism during pre- and post-harvest. Such contamination may occur during processing, storage, distribution, sale and/or use [1]. Spices have been used in many industries, with the food industry and catering. Dried materials from plant origin and spices are commonly heavily contaminated with moulds and bacteria [2]. About 138 samples of 15 different spices obtained from common markets were evaluated fungi. The result show that Aspergillus, Penicillium, and Rhizopus were detected in range of 5325–6800 cfu/g [3]. Thai people preferred to eat Namphrik with hot cooked rice, fresh vegetables and other meals. Due to consisting of dried ingredients, Namphrik trends to be high microbial contamination. In addition, there was not any heat processing before eating that may be cause diarrhea in human. Several methods have been using for decontamination in herbs and spices such as carbon dioxide under pressure, microwaves, high pressure and ionizing radiation [4] etc. Irradiation was suitable to reduce the contaminated microorganism. In pararell, we were studied the effect of irradiation on sensory acceptance.
2. Materials and methods

2.1. Market survey

Twenty samples of Namphrik were collected from commercial market and evaluated the microbiological qualities according to Thai community product standard (No.130/2556) as shown in Table 1.

| Types of Microorganisms | Thai community product standard (No.130/2556) |
|-------------------------|---------------------------------------------|
| Total Plate Count       | $< 10^4$ CFU/g                              |
| Total Yeast & Mold      | $< 100$ CFU/g                               |
| *Escherichia coli*      | $< 3$ MPN/g                                 |
| *Staphylococcus aureus* | $< 10$ CFU/g                                |
| *Bacillus cereus*       | $< 10^2$ CFU/g                              |
| *Clostridium perfringens* | $< 100$ CFU/g                             |
| *Salmonella* spp.       | Not detected in 25 g                        |

2.2. Gamma irradiation process

Gamma irradiation process was conducted at Thai Irradiation Center, Thailand Institute of Nuclear Technology (Public Organization) using cobalt-60 gamma source (The multipurpose Irradiator JS 8900). Namphrik was irradiated with gamma rays at 3.28-4.43 kGy. Irradiated and non-irradiated samples of Namphrik were stored at room temperature. The evaluation of microbiological properties and sensory were evaluated after irradiated 5 and 8 days, respectively.

2.3. Determination of microbiological

Total plate count (TPC), Total Yeast & Mold (TYM), *Bacillus cereus*, *Clostridium perfringens* and *Salmonella* spp. were determined according to the method of Bacteriological Analytical Manual Chapter 3 [5], Chapter 18 [6], Chapter 14 [7], Chapter 16 [8] and Chapter 5 [9] respectively. *Staphylococcus aureus* and *Escherichia coli* were determined according to the method of AOAC (2003.11) [10] and AOAC (2005.03) [11].

2.4. Sensory evaluation

Sensory evaluation of irradiated and non-irradiated samples was conducted by 18 panelists after irradiated for 8 days. Difference from control test and preference tests were conducted in Namphrik to determine whether there is a statistically significant difference and preference between the non-irradiated and irradiated groups. Difference from control test was evaluated color, odor and flavor. Preference test was evaluated using a 9 point hedonic scale (1 = Extremely Dislike to 9 = Extremely like). The data were analyzed by MINITAB software. Mean values and standard error of mean are reported and significant difference was defined at P <0.05.
3. Results and discussion

3.1. Microbiological qualities of namphrik in the market

Twenty samples of Namphrik from commercial market were evaluated for microbiological qualities. It was found that 15 samples were not complied with the Thai community product standard No. 130/2556 because TPC was higher than the maximum limits (15 samples) and also the pathogenic microorganisms was exceeded the limits such as *Bacillus cereus* (11 samples), TYM (9 samples), *Clostridium perfringens* (4 samples), *Staphylococcus aureus* (2 samples) as shown in table 2 and 3. The market surveys in qualities of Namphrik have not widely studied. In agreement with Thai Health Promotion Foundation reported that 15 of 35 samples were nonqualified to the standard due to exceeding of TPC and pathogenic microorganisms exceeding the limits such as *Bacillus cereus* (13 samples), *Clostridium perfringens* (1 samples), *Escherichia coli* (14 samples) and Coliform bacteria (7 samples) [12]. It seems that the results of this study supported the report of Thai Health Promotion Foundation. However, *Escherichia coli* and *Salmonella* spp. were not detected in this study. The report of Thai Health Promotion Foundation also reported that 0.8% of consumers having diarrhea every times and 13.7% of consumers sometimes having diarrhea after eating Namphrik.

Table 2. The pathogenic microorganisms exceeding the limits in non-irradiated Namphrik

| Microorganisms          | Nonqualified samples | CFU/g          |
|-------------------------|----------------------|----------------|
| Total plate count       | 15                   | 1.60x10⁻⁴ - 4.4x10⁻⁵ |
| *Bacillus cereus*       | 11                   | 2.10x10⁻³ - 6.10x10⁻⁴ |
| Total Yeast & Mold      | 9                    | 3.00 x10⁻² - 9.00x10⁻³ |
| *Clostridium perfringens* | 4                 | 1.00x10⁻² - 8.8x10⁻³ |
| *Staphylococcus aureus* | 2                   | 15 - 40        |
| *Escherichia coli*      | 0                   | -              |
| *Salmonella* spp.       | 0                   | -              |

3.2. Effect of irradiation on Microbiological qualities

The irradiation technology is one of method to use to decontamination in many foods. It has been suggested as the nonthermal method for destroying pathogenic and spoilage microorganisms in the final product. The nutritional properties of irradiated food is the same as non-irradiated product [13, 14]. The sensory characteristics of foods may may not alter. Nonqualified samples from market survey were irradiated at 3.28 to 4.43 kGy. The microbiological tests were conducted after 5 day of irradiation. TPC of nonqualified samples were reduced to the acceptable level of the standard. The applied doses can lower TPC from 1.2 to 3.9 log cycle and the average reduction was 2.4 log cycle reduced from the original level. The effect of radiation on pathogenic decontamination was shown in table 3. All of TYM, *Staphylococcus aureus*, 10 of 13 *Bacillus cereus* and 3 of 4 *Clostridium perfringens* were reduced lower than the detection limits which were <10 CFU/g or <100 CFU/g depending on methods. Irradiation at the dose of 3.28-4.43 kGy was sufficient to improve the microbiological qualities of unqualified samples.
| Standard                                      | Sample          | No.1 | No.2 | No.3 | No.4 | No.5 | No.6 | No.7 | No.8 | No.9 | No.1  | No.2  | No.3  | No.4  | No.5  | No.6  | No.7  | No.8  | No.9  | No.10| No.11| No.12| No.13| No.14| No.15| No.16| No.17| No.18| No.19| No.20| No.21| No.22| No.23| No.24| No.25| No.26| No.27| No.28| No.29| No.30| No.31| No.32| No.33| No.34| No.35| No.36| No.37| No.38| No.39| No.40| No.41| No.42| No.43| No.44| No.45| No.46| No.47| No.48| No.49| No.50| No.51| No.52| No.53| No.54| No.55| No.56| No.57| No.58| No.59| No.60| No.61| No.62| No.63| No.64| No.65| No.66| No.67| No.68| No.69| No.70| No.71| No.72| No.73| No.74| No.75| No.76| No.77| No.78| No.79| No.80| No.81| No.82| No.83| No.84| No.85| No.86| No.87| No.88| No.89| No.90| No.91| No.92| No.93| No.94| No.95| No.96| No.97| No.98| No.99| No.100| No.101| No.102| No.103| No.104| No.105| No.106| No.107| No.108| No.109| No.110| No.111| No.112| No.113| No.114| No.115| No.116| No.117| No.118| No.119| No.120| No.121| No.122|
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3.3. Sensory evaluation

3.3.1. Difference from control test. The difference test was evaluated the changes in color, odor and flavor. The panels compared the aspects to give scores how much the difference between the control (non irradiated) sample and the test samples. The result showed that the panelists can significantly differentiate the color, odor and flavor (p<0.05). But the level was at slight (score=1) to very slight (score=2) differences in irradiated samples as shown in table 4.

Table 4. The result of Difference from control test of irradiated and non-irradiated samples.

|       | Non-Irradiated         | Irradiated         | P-value |
|-------|------------------------|--------------------|---------|
| Color | 0.611 ± 0.916          | 1.111 ± 1.023      | 0.035   |
| Order | 0.500 ± 0.786          | 0.944 ± 1.056      | 0.007   |
| Flavor| 0.611 ± 0.916          | 1.000 ± 1.188      | 0.004   |

3.3.2. Preference test of irradiated and non-irradiated samples. The test was designed to evaluate the preferences of panellists to the control and irradiated products. The preference test showed that there was no significant changes in preference at (p>0.05). Non-irradiated and irradiated samples were scored at 6.4 (slightly to moderately like) as shown in table 5. Although the results of the difference from control test showed that the panel can differentiate sensory aspects such as color, odor and flavor. The irradiation doesn’t affect the preferences of the product.

Table 5. The result of Preference test in of irradiated and non-irradiated samples.

|       | Non-Irradiated         | Irradiated         | P-value |
|-------|------------------------|--------------------|---------|
| Preference | 6.444 ± 2.502          | 6.444 ± 2.036      | 1.000   |

4. Conclusion
From this study, it was found that 15 from 20 samples did not meet Thai community product standard. The irradiation at doses 3.28-4.43 kGy can reduce TPC (1-3 log cycles) to be less than standard and eliminate pathogenic bacteria in all of the samples to make all of non qualifies samples to comply with the standard. Thus the dose of 3-4.5 kGy was appropriate to use as the generic dose to reduce microorganisms and pathogens in Namphrik. Although irradiation alters slightly sensory aspects, it doesn’t affect the preferences of the irradiated product. The gamma irradiation was suitable to use as a tool to improve the microbiological qualities of Namphrik product without altering the preference of customers.

5. Future study
Investigation of microbiological and physical quality of Namphrik Narok (non-irradiated and irradiated) after 3 and 6 months will be studied. We plan to study the effect of difference packages among glass bottle, plastic bag and aluminium bag on microbiological and physical quality of Namphrik Narok (non-irradiated and irradiated) to find the most suitable package for the product.

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